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Final Report of the NEW ENGLAND ENERGY CONGRESS

A Blueprint for Energy Action

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NEW ENGLAND CONGRESSIONAL CAUCUS

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Energy Task Force Co-Chairmen

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ADVISORY AND SELECTION COMMITTEE

A distinguished Advisory and Selection Committee assisted the New England Congressional Caucus and Tufts University in late 1977 and 1978 in laying the foundation for and outlining the format of the New England Energy Congress. In addition, the Advisory and Selection Committee was responsible for selecting the 120 delegates from a list of over 500 applicants.

John G. Buckley
Vice President, Northeast Petroleum Industries, Inc., Boston, MA

Patrick F. Connolly
Vice President, Energy and Transportation Department, 1st National Bank of Boston, Boston, MA

Lawrence Gleeson
President, Maine Hydroelectric Development Corporation, Belfast, ME

Dante G. Ionata
Director, Energy Capability & Management, Rhode Island Energy Office, Providence, RI

W. Robert Keating
Energy Program Director, New England Regional Commission, Boston, MA

Lawrence Levy
President, Northeast Solar Energy Center, Cambridge, MA

Harold J. Keohane
Regional Representative, U.S. Department of Energy — Region I, Boston, MA

Raymond J. Moran
Executive Vice President, New Hampshire State Labor Council, AFL-CIO, Manchester, NH

William F. Morrill
Executive Director, Berkshire-Litchfield Environmental Council, Inc., Lakeville, CT

Robert T. Roth
Energy Project Director, Low Income Planning Agency, Hartford, CT

Christine B. Sullivan
Former Secretary of Consumer Affairs, Commonwealth of Massachusetts, Boston, MA

Arpad Von Lazar
Professor, Fletcher School of Law & Diplomacy, Tufts University, Medford, MA

Robert C. Young
General Manager, Burlington Electric Department, Burlington, VT

NEW ENGLAND ENERGY CONGRESS STAFF

Bailey Spencer	Coordinator
Amy Blum	Administrative Assistant
Lock Pawlick	Staff Assistant
Steve Morgan	Staff Researcher, New England Energy Supply Committee
Norman Stein	Staff Researcher, New England Energy Demand Committee
Ann Carey	Staff Researcher, Energy Conservation Committee
Ed Kaynor	Staff Researcher, Regulatory and Institutional Processes Committee
Allen White	Staff Researcher, Economic Development through Alternative Sources of Energy Committee
David Kathan	Staff Researcher, Energy Economics and Financing Committee

INTRODUCTION

RATIONALE

Observers often characterize the American political system as a fragile balance among widely diverse regions and interests. Through compromises, trade-offs, and at times, by achieving a consensus, policy is developed which attempts to simultaneously reconcile these differences while promoting the common good.

Periodically an issue arises which threatens this balance and results—sometimes for a period of years—in confrontation and deadlock. In the 50's and 60's, civil rights and Vietnam were such issues. Since the oil embargo of 1973-4, attempts to design a realistic, equitable, and widely accepted energy policy have met a similar fate.

Increasingly, energy is perceived as the single most significant public policy issue facing the United States in the 1980's and beyond. Yet as news stories tell of elderly tenants unable to afford the escalating costs of heating their apartments and of businesses experiencing severe economic hardship due to energy supply disruptions, the governmental mechanism which must address these problems is stalled. Energy production, energy prices, and vulnerability of supply have become critical issues to resolve. Breaking the energy deadlock is essential.

The factors which have caused the deadlock are extraordinarily complex. More than any other current issue, energy policy cuts across all political, economic, and social lines. More often than not, two or more sides exist on energy questions, each with active support and compelling arguments. This divisiveness has resulted in a situation where the various regions and interests find themselves strong enough to cast a veto but too weak to impose their will.

Breaking the deadlock and reconciling the differing needs and priorities will require a concerted national commitment. To be successful, the effort must be guided by three general principles. First, the effort will require that the unique problems and resources of the various regions and interests are all carefully considered. Any and all efforts that promote the articulation and synthesis of these differences must be encouraged. Second, flexibility must be maximized to allow for appropriate solutions to particular problems. It is especially important that regional, state, and local self-help is encouraged. Third, the effort will require time, particularly that time which is invested in listening to the positions of others.

For the past year, the New England Energy Congress has been guided by these general principles in developing a regional energy action plan. Created as an advisory mechanism for the region's Congressional delegation, the Energy Congress has made important progress towards breaking New England's energy deadlock.

PROCESS

Structure

Sponsored by the New England Congressional Caucus and Tufts University, the Energy Congress consists of 120 delegates who represent twelve constituencies (environmental, utility, low income, industry and manufacturing, consumer, small business, R & D, government, education, finance, labor, and unaffiliated) and are proportionally balanced among the six states of New England. Since May 1978, six committees of twenty delegates apiece have been working to frame and substantiate energy action recommendations. Committee jurisdictions include New England Energy Supply, Economic Development through Alternative Sources of Energy, New England Energy Demand, Energy Conservation, Regulatory and Institutional Processes, and Energy Economics and Financing. This report presents the findings and recommendations that have resulted from their work.

Decision-making

Central to the success of the Energy Congress, and reinforcing its underlying principles and organizational structure, has been a reliance on consensus decision-making. Impractical and unworkable for the United States Congress, decision-making by consensus has been an effective and manageable approach for the Energy Congress. To approve a recommendation, each of the six committees worked to achieve consensus among its twenty diverse and representative members. This effort resulted in a careful balancing of social, economic, and environmental concerns.

In November 1978, after six months of committee deliberations, the preliminary findings and recommendations were released in the *Preliminary Report for Public Review*. The release of the report marked the beginning of a three month phase of intensive review which included Public Hearings in each New England state; the receipt of more than 150 written public commentaries and critiques (see Appendix I for details); and significant intercommittee debate and synthesis. Individual committees continued to convene, incorporating public input, refining recommendations, completing on-going research and integrating and synthesizing their findings with the findings of other committees.

On February 24, 1979, a Plenary Session of all 120 delegates was held to review, debate, and approve, by majority vote, the report of the six committees. Each committee, having achieved agreement among its own membership, presented their findings and recommendations—refined and synthesized over the preceding three months—to the full Energy Congress. After an open debate, which resulted in some further refinements, each committee's report and several intercommittee joint reports were brought to the floor to be approved or rejected in their entirety. All reports were overwhelmingly approved. The vote totals are noted below.

Vote Totals of Committee Reports

	Supply		Altern		Demand		Conser		R & I		E & F		Res Pkg	
	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
February 24	44	12	48	4	49	3	51	1	43	6	50	2	46	1
Phone Poll	34	2	35	3	35	2	37	1	35	2	35	2	35	3
TOTAL	78	14	84	7	84	5	88	2	78	8	85	4	81	4

The final step in the process involved approval of the executive summaries of each committee and the executive summary of the full Energy Congress by all delegates. This was done by mail and telephone in April. The results are summarized below.

Vote Totals of Executive Summaries

	Congress Wide		Supply		Altern		Demand		Conser		R & I		E & F	
	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N	Y	N
Phone Poll Total	90	6	84	11	92	3	94	2	94	1	94	1	95	1

The decision-making process utilized by the Energy Congress encouraged the committees to work to achieve consensus, included an extensive period of public review and comment, set aside several months for intercommittee debate and synthesis, and provided an opportunity for all delegates to accept or reject the reports and executive summaries. The result is a document that has incorporated and integrated a very broad range of views and perspectives into a blueprint for energy action that is both technically sound and politically, socially, and economically balanced.

Contribution of Volunteer Time and Resources

The work of the New England Energy Congress would not have been possible without the enormous contribution of volunteer time and resources made by the 120 delegates, the numerous Resource Consultants, the members of the Advisory and Selection Committee, and many, many others. Relying on a rough and probably conservative means for estimating the size of the volunteer contribution of the delegates alone, the following figures have been generated.

The delegates to the New England Energy Congress contribued 8232 person hours to attend 153 committee and subcommittee meetings, the Convention of December 2, several Plenary Sessions, and Public Hearings in each New England state. In addition an estimated 2000 person hours were contributed by delegates for research, writing, and telephone conversations. Further, an estimated 2500 person hours were spent traveling from across the region to meetings. The total of these volunteer contributions is 12,732 person hours. Calculated at $20/hour, the value is $254,640—roughly equivalent to the actual expenditures for the entire year-long effort.

Task Force for Implementation

As this report is released, plans are being made to organize a Task Force for Implementation of the New England Energy Congress. The function of this group will be two-fold. First, working in an advisory capacity to the New England Congressional Caucus, the Task Force will attempt to provide concrete suggestions concerning the actual implementation of Energy Congress recommendations. Since many recommendations urge action at the regional, state and local levels, the Task Force will, hopefully, also become a useful resource for state and local, as well as federal, officials.

The second function of the Task Force will be to maintain a representative regional forum to discuss and contribute to the resolution of critical energy problems as they arise. Shortages, mandatory conservation measures, fuel allocation, energy and public health, and, quite likely, issues and events that are impossible to anticipate, all are potential topics where the Task Force might well make a contribution.

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EXECUTIVE SUMMARY OF THE NEW ENGLAND ENERGY CONGRESS

THE NEW ENGLAND ENERGY SITUATION

The Problems of Supply and Price

The future of New England is becoming increasingly threatened as the region's energy situation continues to worsen. New England is overwhelmingly dependent on oil, with fully 80% of its energy requirements derived from this single source. This statistic poses a double threat to the region and its economic prosperity, as oil dependency means extreme supply vulnerability and substantially higher prices than the national average. (See Figure 1.)

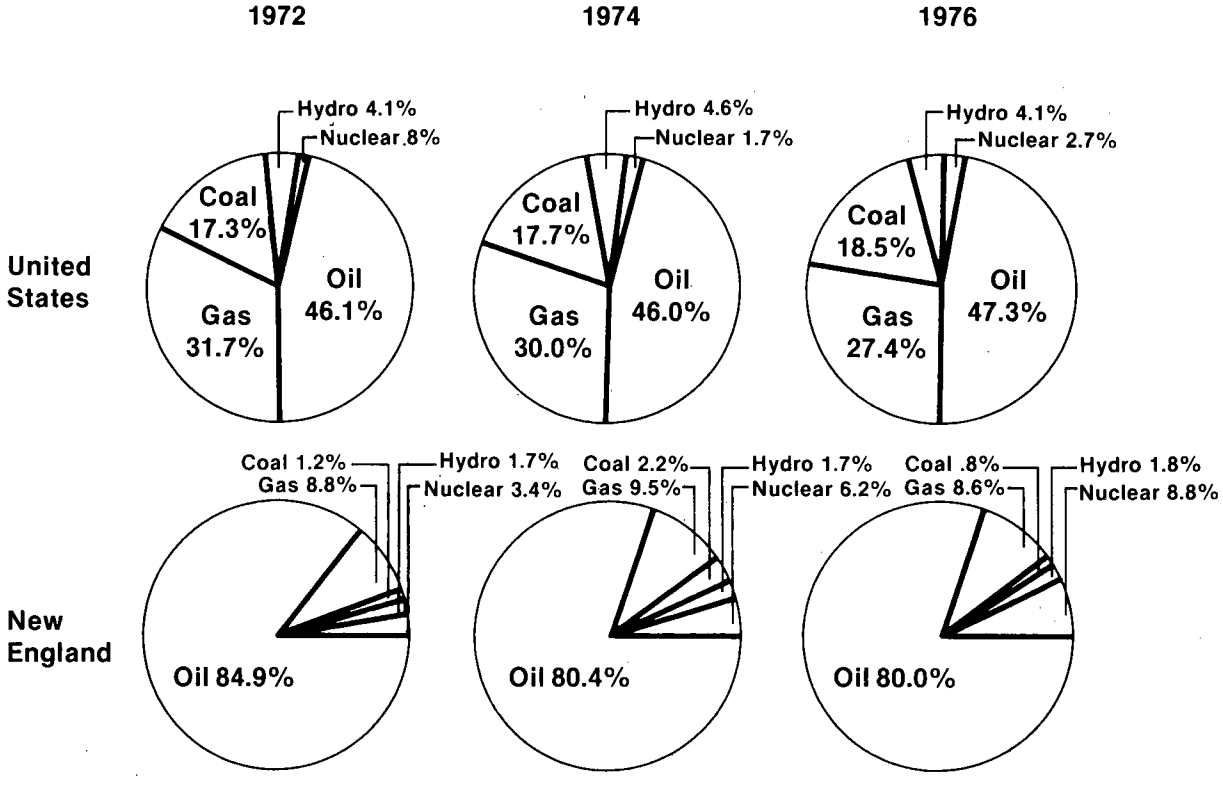
The severity of the problem is dramatically evident in the most recent New England data (1976):

- 80% of the region's total energy is oil (47% national average)
- 79% of the oil consumed in the region is imported (39% national average)
- 63% of all regional energy sources is imported oil (18% national average)
- 40% of all regional energy sources is OPEC oil (13% national average)
- Energy costs are 26% higher in New England than the national average

There are many factors which have led to this situation. New England lacks large reserves of fossil fuels similar to those of other regions. New England's geographical location places it at the end of domestic oil and gas pipelines and remote from the nation's coal mines. The availability of natural gas to the region has been severely restricted due to national regulatory policy. Coal burning in New England has declined significantly in recent years due to increasing economic, health, and environmental difficulties. Nuclear power, which has operated in New England since 1961 and currently supplies 32% of the region's electricity (compared to 12% for the country as a whole), has served to protect New England from an even greater dependence on imported oil. Nonetheless, regulatory delays, escalating costs, revised demand forecasts, environmental, health, and safety concerns and political controversy have all contributed to a slower than predicted growth in nuclear generating capacity. Finally, the energy sources which New England does enjoy in relative abundance—wood, hydroelectric, solar, solid waste, and wind—have not benefitted from the massive governmental financial incentives which have been extended to fossil fuels and nuclear power.

The Arab oil embargo of 1973-4 marked the end of the era of cheap foreign oil. The intermittent supply disruptions and quadrupling of oil prices that followed have hit New England especially hard. International events like the 1979 Iranian revolution and the ensuing dramatic jump in OPEC prices provide little reassurance that the future will bring relief.

FIGURE 1
Total Energy Consumption By Source
United States and New England - % Of Total



Sources: U.S.-DOE Monthly Energy Review
N.E.-DOE Boston

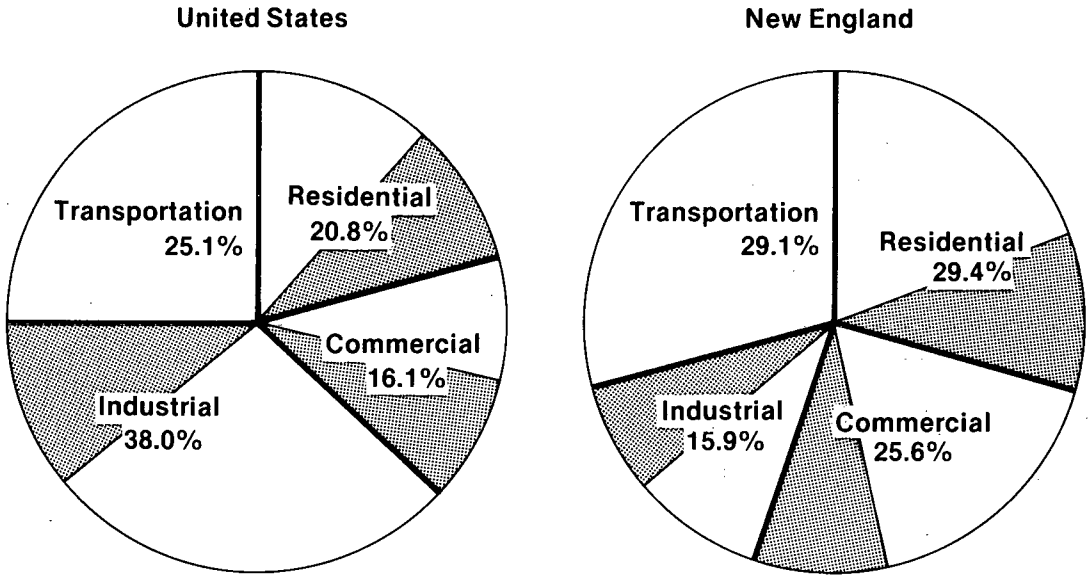
Current and Future Demand

New England's current energy consumption pattern is quite different from that of the nation as a whole. The residential sector (30% vs. 21% nationally in 1975) and the commercial sector (25% vs. 16% nationally) are both relatively large. The industrial sector (16% vs. 38% nationally) is relatively small. Only in terms of transportation consumption are the figure approximately the same (29% vs. 25% nationally). (See Figure 2.)

The implications of these differences on designing an effective regional energy action strategy are profound. Primary among them is the need to put major emphasis on the space and water heating demands of the residential and commercial sectors.

The overall demand rate projected by the Energy Congress for New England for the period 1978-1985 is 1.5%, with a somewhat higher growth rate for electricity. This rate of growth would increase energy consumption from the 1978 level of approximately 3 quads (3×10^{15} BTUs) to 3.45 quads by 1985. A vigorous energy action program, as proposed by the Energy Congress, could lower the growth rate below 1.5%.

FIGURE 2
Energy Consumption In 1975
By Sector



Source: DOE-Federal Energy Data System-February 1978
Electricity, U.S. 28.9% and N.E. 26.2%, including generation and transmission losses, allocated to end use sectors as shown by shading.

The Task of the Energy Congress

The Energy Congress was launched with the acknowledged objectives of reducing the region's overwhelming dependence on foreign oil and its cost disadvantage compared to the rest of the country. The passage of the 1978 National Energy Act will assist in reaching these goals. Nevertheless, while the NEA is regarded as a step in the right direction, especially in terms of its conservation measures, much remains to be done.

The work of the New England Energy Congress, summarized below, contains a wide range of action recommendations. Recommendations addressing the demand side of the energy equation are presented first. Analysis and recommendations addressing supply options follow.

It should be noted that while many of these recommendations deal with the specific problems and resources of New England, many more recommend action that would benefit the nation as a whole. Their implementation would significantly brighten the region's and the nation's energy future.

DEMAND: STRATEGIES TO REDUCE ENERGY CONSUMPTION

Conservation is the most sensible and cost-effective short-term strategy for addressing our current energy dilemma. In terms of dollar savings, employment, and regional economic improvement, conservation policies will facilitate the transition to a more desirable energy mix.

I. Residential Sector

In the residential sector, where almost one quarter of our region's energy is consumed in petroleum alone, the greatest opportunities are present. With an aging housing stock, a greater proportion of multi-family dwellings than in the nation as a whole, and a large low income population (16% of all households), New England's residential sector has some unique problems to overcome. Conservation strategies must move considerably beyond the provisions of the 1978 National Energy Act to have a substantial impact. Three barriers presently handicap the residential consumer: 1) a lack of information on payback schedules, reliable contractors, etc.; 2) a lack of standards forthcoming from state and federal agencies; and 3) a lack of money to invest in weatherization improvements.

Major attention was given to assessing New England's housing stock. Using the REFORM computer model owned by the New England Regional Commission, with program variables provided by the Massachusetts Audubon Society to more closely fit current experience, a base case was established for housing stock in New England today. Once this was done, the conservation potential in the sector was calculated based upon improved weatherization and improved heating system efficiencies. The conclusions drawn from this model strongly suggest that heating fuel consumption would drop, in absolute terms, between 1978 and the year 2000 if limited measures were implemented.

Among the recommendations to stimulate residential conservation is an expanded tax credit allowance covering 30% of the first $4,000 and 20% of the next $8,000 expended for conservation home improvements. These tax credits should be refundable in order to include low income residential consumers. Expansion of the solar and conservation loan programs as outlined in the National Energy Act is desirable. Special mandatory retrofit programs and tax credits are recommended for tenant occupied buildings. A conditional prohibition on the installation of electric space heating in all new buildings is urged, and minimum mandatory thermal and lighting standards are proposed for adoption in every state.

Consumer protection is a major concern, and several recommendations are proposed: (1) mandatory licensing programs, with adequate consumer representation on all boards, for installers of weatherization materials, alternative energy equipment and fossil fuel heating systems; (2) the development of national performance standards; (3) Federal Trade Commission action to minimize deception in advertising and product labeling; and (4) building owner disclosure of previous annual energy consumption to prospective buyers and tenants.

LOW INCOME HOUSEHOLDS REQUIRE IMMEDIATE ASSISTANCE

Over half a million households in the region pay 29-34% of their before tax earnings for energy expenses. Combined with housing costs, many of these low income families must devote over 70% of their income to shelter related expenses. In the winter months, when fuel bills are highest, the proportion rises to 80-90% for thousands of families. Recognizing that present energy prices are not affordable for 16% of the region's households, and that future energy prices could bring catastrophic hardships, a special emphasis is placed upon assisting low income families. Specifically, an expanded Emergency Assistance Program is

recommended, with an initial appropriation of $2 billion, and with annual increases tied to fuel and utility price indices. Eligibility would be based on 150% of federal poverty levels; benefits should take the form of cash payments administered by IRS or HEW. New England utilities are urged to follow NEA guidelines on termination procedures and asked to adopt rate structures which encourage conservation and minimize price increases associated with minimum and necessary basic consumption levels.

Several recommendations are proposed to improve the Federal Weatherization Program which is designed to assist conservation efforts to low income people, a great percentage of whom live in energy inefficient housing, without minimal insulation and other weatherization protections. By committing substantial resources to residential conservation to low income households, up to 50% savings in fuel oil bills can be expected. By increasing the National Weatherization Program from $200 million to $960 million annually, 5 million low income owner occupied homes in the country can be weatherized by 1988 (300,000 in New England). A separate program is recommended for rental units. Amendments to the Energy Conservation and Production Act of 1976 are proposed to increase maximum expenditures per dwelling unit to $1920 to cover labor ($800), materials ($800), and administration and related expenses ($320). A variety of federal procurement practices and HUD demonstrations are also urged to assist public housing dwellers.

Finally, it is proposed that federal legislation be enacted to assist states in setting up an office of low income consumers counsel and a committee to fund intervention by experts on behalf of low income energy consumers. These programs would guarantee continuous and competent representation of low income interests in the public utility regulatory process.

II. Commercial Sector

New England's commercial establishments are significantly more dependent on oil than their counterparts elsewhere in the country. Given the Energy Congress projection of 2.5% commercial demand growth from now until 1985, this sector is capable of considerable conservation savings.

To assist both large and small businesses in making energy conservation investments, the following are recommended: (1) the establishment of an energy information brokerage which would provide decision relevant information on conservation measures and maintain a network to put business and industrial representatives in touch with conservation service suppliers; (2) government research efforts aimed at improving the energy efficiency of existing buildings; (3) energy performance standards and financial incentives for new and existing commercial structures; (4) a locally operated, federally supported review process to ensure that all new commercial buildings are designed and built to provide cost-effective conservation, prudent fuel choice, and desirable operational flexibility, without imposing undue regulatory burdens; and (5) that any benefits, taxes, or any other mechanisms, intended to promote conservation in the commercial sector, be applied throughout the commercial sector—to all entitites, whether profit-making, not for profit, or governmental.

III. Industrial Sector

New England's relatively small industrial sector has one very significant opportunity for conservation: cogeneration. Coal, oil, gas and wood-fired cogeneration could provide over 1000MW of capacity to the region by the mid-80's, according to a study by the Massachusetts Energy Office. The Energy Congress urges further study on the probable impact of cogeneration, and suggested regulatory reform to enable the expeditious consideration of cogeneration and other energy production within the context of the energy facility siting process.

The industries which can make operational—as opposed to capital intensive—changes offer the greatest potential for conservation. Additional conservation which is dependent upon capital input for changes to buildings and equipment will provide less dramatic savings and will take place

over a much longer period. Studying the adoption of cost-effective innovations in industrial energy-using equipment both in terms of its impact on regional energy usage and in terms of the improvement of the competitive position of regional industry is also recommended.

IV. Transportation

The 1985 estimate by the Energy Congress assumes virtually no growth over 1975 consumption in the transportation sector. The estimate is strongly influenced by the federally mandated new car fuel efficiency improvements between now and 1985. Improved new car fuel efficiency standards implemented beyond 1985 would have additional significant impact on reducing energy demand, despite an increase in the region's inventory of cars and trucks.

Maximizing the efficiencies of each of the four consumptive transportation modes—auto, truck, rail and air—and determining how shifts from less efficient to more efficient modes can be encouraged are the twin emphases of demand reduction strategies in this sector. For the automobile, maintaining fuel economy and emission standards through 1985 is a priority and improving them to a standard of 34MPG by the year 2000 is recommended. Improving light truck fuel economy by imposing more stringent standards for the model year 1981 is recommended. Expanding and funding car pool and van pool programs, administered at the state and local levels is also recommended, as is strict enforcement of the 55 MPH speed limit. The Department of Energy is requested to maintain an emergency plan for rationing, and the Interstate Commerce Commission is urged to give high priority to energy conservation in its reexamination of trucking regulations.

The completion of the Northeast Corridor Improvement Project within the bounds of its original performance goals is a critical priority for rail improvement. Studying the feasibility of restoring and improving the inland route for possible linkages of Springfield, Hartford, and Worcester by fast rail is further recommended. A fully funded Amtrak and the encouragement of integrated truck/rail service are also recommended. Tightening cruising and landing procedures to reduce airline speeds, revising airport descent profiles, reducing ground delays, and providing NASA with adequate funding to research improved aircraft engine efficiency are urged to assist conservation among the airlines.

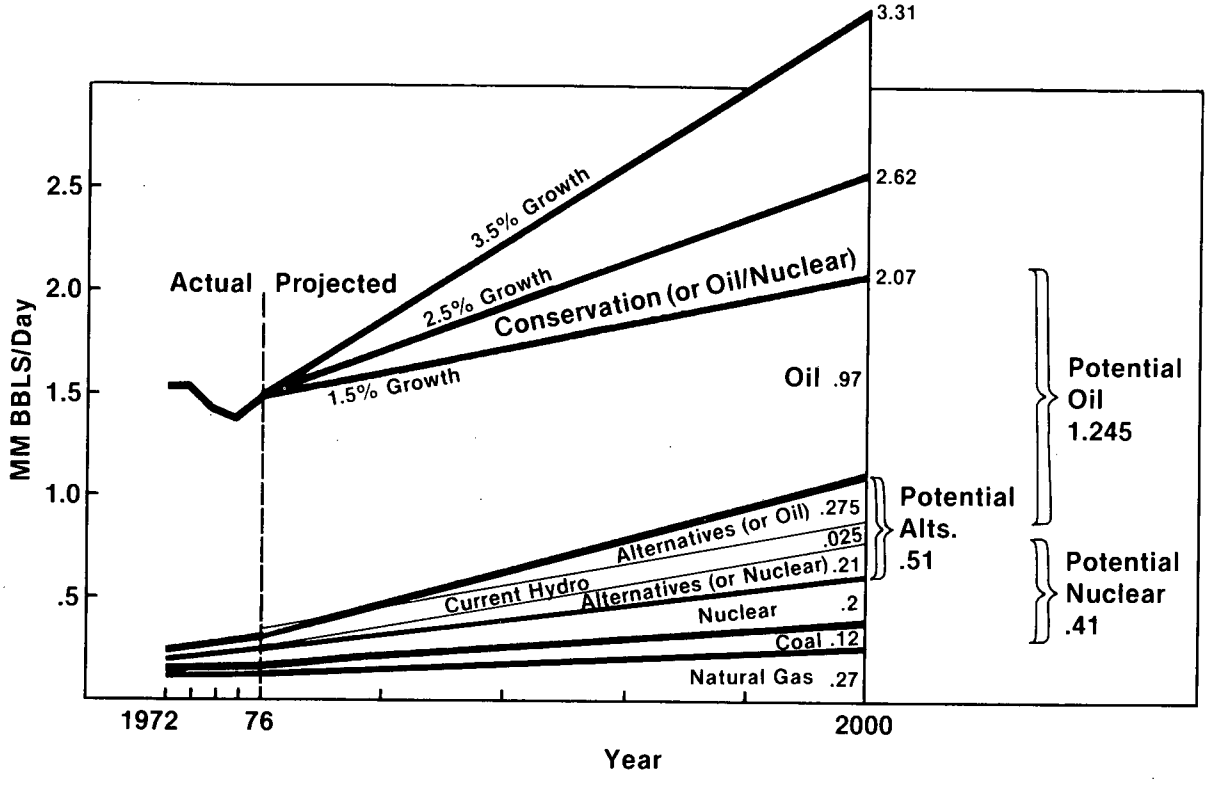
Finally, modal shifts would be encouraged by the following: (1) eliminate the "Contract Authority" which allows the Federal Highway Administration to obligate authorized highway funds prior to the appropriation of funds; (2) consider conservation and alternative transportation modes in the planning and construction of projects funded from the Highway Trust Fund; (3) encourage the substitution of communications services for personal transportation; (4) expand bikeways programs, parking facilities for bicycles, safety programs and public education efforts encouraging the use of bicycles; (5) develop a national land-use planning act; (6) expand and improve intracity and intercity bus services by upgrading facilities and vehicle fleets and providing frequent and reliable express service routes; and (7) discourage urban automobile use by increasing parking fees and tolls in congested areas, vigorously prosecuting violations, and investigating the potential of light rail as well as bus service in specific metropolitan areas. Swift adoption of these modal shift measures could reduce total transportation demand by 4% by 1985.

SUPPLY: OPTIMAL MIX AND RECOMMENDATIONS

The Optimal Supply Mix for the Year 2000

Agreement on a balanced, flexible energy mix for New England (see Figure 3) by the year 2000, which would meet the objective of reducing the region's overwhelming dependence on imported oil, was a major accomplishment of the Energy Congress. This optimal supply mix is predicated upon the achievement of a significant level of conservation. It balances the

FIGURE 3
New England Energy Mix
1978-2000



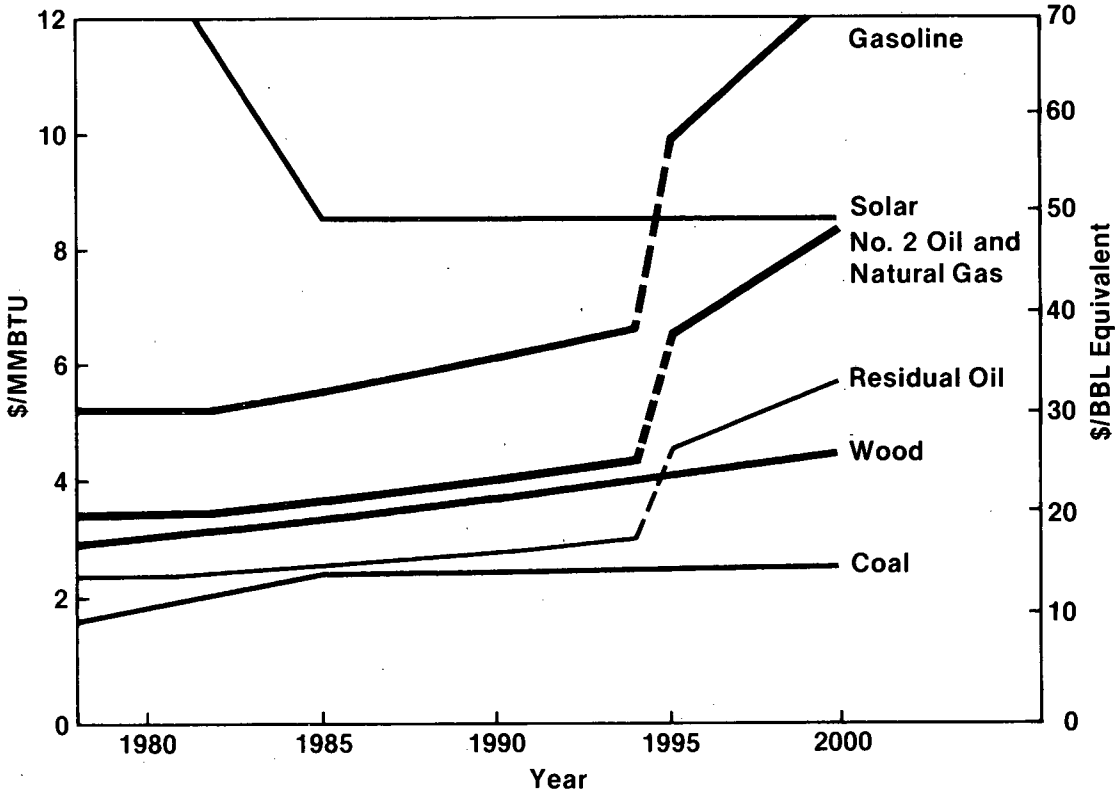
Projection calculated for the single year 2000.
Growth rates are represented as a straight line between point estimates for 1976-2000.

environmental, social, and economic needs of New England with the energy demand projected for the region.

In developing the supply mix, several general conclusions were reached. First, it was determined that sufficient total energy supplies will be available to New England to the extent needed through the year 2000 and that the region will not run out of any particular energy resources in that timeframe. Nevertheless, periodic supply disruptions such as the 1973-4 Arab oil embargo and the 1978-9 Iranian revolution are anticipated. Second, all energy sources will be very expensive (See Figure 4). Consumers should expect to pay significantly higher prices for energy. Third, when new energy facilities have to be developed in New England, they should be built expeditiously, consistent with social, safety, economic and environmental concerns.

The supply mix, based on 1.5% annual energy demand growth through the year 2000, represents an achieveable, desirable, yet flexible target for regional energy planning. As shown in Figure 3, a significant increase is anticipated in natural gas use, from the current 8% contribution to 13% in the year 2000. Coal, in contrast to other regions, is seen as playing a relatively minor role, contributing only 5-6% to the total supply. The percentage supplied by nuclear power is projected to be approximately the same as in 1978 and represents 9.6% of the mix. Alternative sources—renewable, indigenous energy resources—are seen as potentially contributing 25% of total energy supplies. Achieving this level of alternative supply will require a major public and private effort and can be reached if the commitment is forthcoming. However, if development of alternative sources does not proceed in a timely manner, the supply mix does provide a backup of oil, nuclear, and/or coal. Reciprocally, if alternative supplies (and/or conservation) exceed their targets, oil, nuclear,

FIGURE 4
Projected Fuel Costs To The Consumer
To The Year 2000 In 1978 $



The committee examined prices for the 3 years: 1978, 1985, and 2000.

and/or coal use may be lowered. Finally, the balance or 47% of the total mix is oil. While oil is still the single largest source of energy, its contribution is significantly lower than the current level of 80%. Additional details on each supply source and its role in the overall mix follow.

I. Natural Gas

As seen from the bottom line in Figure 3, the potential which natural gas has for relieving New England's heavy dependence on foreign oil is recognized. An increase from the equivalent of about 120,000 BBL/day (8% of total energy in New England) in 1978 to 270,000 BBL/day (13% of total) in the year 2000 is indicated for the region. This would represent, exclusive of fuel for electric power generation and transportation fuel, about 30% of New England's requirements in the year 2000. While such a usage would represent a substantial increase, it would still be less than nationwide levels, expressed as a percentage of total energy use.

Increased domestic natural gas production, gas imports from Mexico, Canada, and other countries, and the development of synthetic gas from coal, wood and wastes should supplement existing gas supplies. This, combined with reduced boiler fuel use of natural gas nationwide, would allow for increased gas consumption in New England.

II. Coal

The second line from the bottom of Figure 3 shows that the Energy Congress does not place a great emphasis on coal. Ten million tons of coal per year are projected for the year 2000. This

assumes the conversion of three boilers at Brayton Point, the construction of a Sears Island coal burning plant in Maine, and the coal boilers in use in New Hampshire. There is a commitment to probably no more than one or two additional coal burning electric plants by the end of the century. High costs due to transportation, health and environmental considerations are major reasons why we do not expect a greater increase in coal consumption in New England, even though coal offers an abundant national supply for at least another century or more. However, if significant and economically viable reserves are discovered in the Narragansett Basin of Massachusetts and Rhode Island, prospects for increased coal burning in the region after 1990 could brighten.

III. Nuclear

The third line from the bottom of Figure 3 indicates that in additon to the nuclear generation capacity operating in 1979, 3450 MW of new capacity will be required by the year 2000, even if all the projected alternative fuels proposed are developed. In addition, nuclear energy could supply another two hundred and ten thousand barrels of oil equivalent by the year 2000 in the event that the alternatives considered do not fulfill their total projections. In the event that conservation does not reduce the electricity growth rate to 2.2% or less, more nuclear or coal plants may be required.

IV. Alternatives

As seen from the fourth line from the bottom of Figure 3, the projected contribution of the alternative energy sources range up to the equivalent of more than 500,000 barrels of oil per day, or 25% of the region's need in 2000. To develop this large and diversified group of energy sources will require significant financial incentives and investments as well as a large R & D program similar to that afforded present day fuels during their development phase. (See Table 1.) The alternatives total reflects a commitment to double the contribution of hydroelectric energy by the turn of the century. It projects the equivalent of a 10 percent increase in woodburning every year from now until 2000. This represents about 250,000 barrels of oil per day equivalent, or ½ the total alternative contribution by 2000.

Solid waste electricity production and cogeneration is counted upon to provide 740 MW (4 MMBBL/yr) by the year 2000. Wind power is expected to become cost competitive in the mid-eighties delivering over 3% of electricity by the year 2000. Tidal power will be a uniquely New England resource, with 2 to 3 demonstration projects undertaken along Maine's coast. Photovoltaics is projected to provide as much as 10% of our electricity needs by the year 2000.

The direct solar contribution to space and water heating is calculated with the assumption that an increasing percentage of new housing, reaching 50% in the year 2000, will utilize solar energy. Nearly one-half of existing units are assumed to be retrofitted with solar hot water heaters by the year 2000.

V. Oil

Oil is counted upon to provide 970,000 barrels per day, or less than half the total energy requirements for 2000. This represents a significant drop (from 1.3 million barrels per day in 1976) in New England's reliance upon oil, and reduces our present 80% dependence to 47% by the year 2000. Thus, while the region's percentage reliance on oil declines, oil will still remain the single largest source of energy for the year 2000. The availability of this oil presupposes that steps will be taken by the U.S. and foreign governments to reduce the demand for and stimulate the supply of oil worldwide. Measures should be implemented to deal with periodic supply interruptions. Exploration programs should be encouraged in as many countries as possible; international trade policies should establish an environment to encourage producing countries to make oil exports available to meet world demand. While oil supplies may tighten in the 1990's, New England is still expected to be able to supply at least one-half of its energy needs with petroleum in 2000.

Table I

Additional New England and U.S. Federal Financial Requirements for Alternative Energy Projects: 1980-1985
(In Millions of Dollars)

A. Additional Budget Outlay for New England and U.S.: 1980-1985

Fuel	Program Expansion		Grant		Study		TOTAL	
	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.
Wood	**5**	*25*				*10*	**5**	*35*
Solar			**165**	*3460*			**165**	*3460*
Solid Waste		*.5*	**40**	*200*	**.5**		**40.5**	*200.5*
Wind	**50**	*500*					**50**	*500*
Hydro								
Tidal			**2**		**.25**		**2.25**	
Peat and Others[1]			**.25**		**.75**		**1**	
	55	*525.5*	**207.25**	*3660*	**1.5**	*10*	**263.75**	*4195.5*

TOTALS

Total Additional Outlay Over 5 Years for New England	**$263.75**
Average Annual Additional Outlay for New England	**$ 52.75**
Total Additional Outlay Over 5 Years for U.S.	*4195.5*
Average Annual Additional Outlay for U.S.	*839.1*

B. Additional Loan and Loan Guarantees for New England and U.S.: 1980-1985

Fuel	Loan		Loan Guarantees		TOTAL	
	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.
Wood			**200**	*600*	**200**	*600*
Solar						
Solid Waste			**160**	*800*	**160**	*800*
Wind	**75**	*750*			**75**	*750*
Hydro		*330*				*330*
Tidal						
Peat and Others[1]			**10**		**10**	
	75	*1080*	**370**	*1400*	**445**	*2480*

TOTALS

Total Additional Loan and Loan Guarantees for New England	**$445**
Average Annual Additional Loan and Loan Guarantees for New England	**89**
Total Additional Loan and Loan Guarantees for U.S.	*2480*
Average Annual Additional Loan and Loan Guarantees for U.S.	*496*

Suggested New England numbers shown in **bold**.
Suggested U.S. numbers shown in *italic*.

[1]Includes Methane and Alcohol.

The utility requirements for residual fuel oil for New England by the year 2000, assuming a 2.2% electricity growth rate, will be less than 60,000 barrels of oil per day. With the Congressional prohibition against new oil burning boilers, utilities will be looking to meet future electricity demands through improved load management, alternative energy sources, cogeneration facilities, nuclear generating facilities, and coal-fired boilers.

Summary of Supply Recommendations

I. Alternatives

A comprehensive set of recommendations has been developed. The programs, policies and studies recommended constitute an intensive stimulus to spur alternative energy use as a substitute for non-renewable energy use in the region, and are focused on the achievement of specific, significant levels of utilization by 1985. The overall program described below, and the tentative costs indentified, represent a "critical mass" level of funding for alternative energy in the region. A portion of this funding may be provided as a result of programs of the National Energy Act of 1978, but generally, the recommendations specify measures *not* taken as part of the NEA.

It is important to note that alternative energy sources will not come cheaply. All forms of alternative energy require various types and degrees of subsidization to become cost competitive, just as fossil fuels and nuclear power have required. The most competitive alternatives today are hydro, passive solar, solar hot water heating, wood, and solid waste. Significant penetration by these energy sources in the region will take more time than is deemed prudent unless the correct policies are pursued by the U.S. Congress and the various state and local governments now.

The outline of the program is as follows:

A. Stimulate and subsidize the commercialization of the alternatives and the development of active markets in New England. More specifically, approximate goals and their costs through 1985 are:

1. Wood

   200 MW of new electrical capacity (1.7 MMBBL/yr) including co-generation, encouraged by tax credits, loan guarantees ($100 million in New England, $200 million nationally) and regulatory reform.

   60 x 10^{12} BTUs/year of direct thermal applications (10 MMBBL/yr) for industry, encouraged by loan guarantees ($100 million in New England, $400 million nationally).

   54 x 10^{12} BTUs/year in residential applications (9 MMBBL/yr) encouraged by tax credits for wood stoves and furnaces.

   Assist the development of a wood supply infrastructure thru tax credits.

   Undertake or complete studies of environmental impacts of wood energy use ($10 million, nationally).

   Expand forestry management services ($5 million in New England, $25 million nationally).

2. Hydro

   375 MW of small-scale and utility applications (2 MMBL/yr) encouraged by feasibility study loans ($10 million nationally per year for 3 years) and construction/engineering loans ($100 million nationally per year for 3 years), in addition to presently allocated funding, and thru tax incentives and federal and state regulatory reform.

   Create a limited liability insurance program.

3. Solar

   Active: 25 x 10^{12} BTUs/year solar heating applications ($4 MMBBL/yr) encouraged by grants ($35 million in New England, $692 million nationally per year for 10 years) and refundable tax credits.

   Passive: Modify the National Energy Act and induce state and local bodies to reduce barriers to passive design.

4. Solid Waste

   25 x 10^{12} BTUs/year utilized in various applications (4 MMBBL/yr) with particular emphasis on cogeneration, funded with PL 95-238 Construction Grants ($40 million in New England, $200 million nationally) and loan guarantees ($160 million in New England, $800 million nationally) thru 1985.

   Develop DOE program to promote technological transfer ($.1 million per year nationally), New England Site Specific Planning Study ($500,000), and regulatory reform.

5. Wind

   100 MW of capacity (.5 MMBBL/yr): 50 MW capacity at private installations from loan guarantees ($75 million in New England, $750 million nationally) thru 1985; and 50 MW encouraged by (a) federal purchases in New England (Supply Committee preference: $10 million in New England, $100 million nationally per year thru 1985) or (b) private financing (Alternatives Committee preference).

6. Tidal

   12.5 MW (0.7 MMBBL/yr) at a demonstration facility (approximately $2 million).

   Feasibility study of Half-Moon Cove Project ($250,000).

7. Peat

   40 MW (.3 MMBBL/yr) demonstration and prototype plant encouraged by loan guarantees ($10 million).

   Study of peat resources, feasibility study of small electrical peat generating plant ($500,000).

8. Methane from Animal Wastes

   Feasibility Study ($50,000).

9. Photovoltaics

   Grants to encourage the demonstration of residential and commercial photovoltaic applications, combined with a publicity effort to inform the public.

10. Miscellaneous

    Small Farm Energy Project ($250,000).

    Study potential of alcohol production from biomass and fund a demonstration project ($200,000).

    Encourage production of methane from sewage sludge.

    New England should make a regional commitment of funds to solve its own energy problems.

    A New England Energy Demonstration Authority should be created.

    Support a study of New England Renewable Energy Potential.

    Maintain and expand the National Science Foundation Appropriate Technology Program.

B. Provide support for this development, identify and remove potential barriers and address long term problems and potentials. Measures include:

1) Establishing just and reasonable rates for small power producers, for the sale of surplus power and the purchase of supplementary energy.

2) Implementing appropriate regulatory reform relating to alternative energy as required for the achievement of commercialization goals.

3) Revising the public utility commission guidelines for reviewing alternative energy systems.

4) Conducting studies of the business and employment benefits resulting from the use of alternative and conventional energy systems ($500,000).

5) Requiring publicly assisted projects to utilize life-cycle cost analysis.

II. Fossil Fuels

A. Natural Gas

To expand natural gas use in the region, reduction of overlapping and duplicating regulation of gas facilities is urged, improved formal administrative procedures with state regulatory agencies are recommended, expedited purchases of Mexican and Canadian gas is called for, and the removal of the limitation on the availability of feedstocks for synthetic gas manufacture is sought. Guaranteed pipeline transmission is requested for New England gas companies which secure supplies outside the region. Orderly exploration and development of North Atlantic potential oil and gas reserves is recommended. Once all regulations pursuant to the Outer Continental Shelf Lands Act are finalized, a Georges Bank Lease Sale should proceed. In drafting its regulations, the Department of the Interior shall acknowledge the importance and uniqueness of Georges Bank as a fishery and shall implement administrative actions to coordinate consideration and design of a leasing program on Georges Bank with the Department of Commerce and New England Regional Fisheries Management Council.

B. Coal

Regional coal prospects center upon an evaluation of the Narragansett Coal Basin. A seven year, $10 million program is recommended to collect drilling data necessary to determine the quality and mining feasibility of the potential resource. Second, several recommendations are put forward relative to better understanding and minimizing of the public health dangers associated with coal burning. It is urged specifically that new coal plants be required to utilize the Best Available Control Technology (BACT) for sulfur and particulate controls.

C. Oil

The ability of oil to supply even one half of New England's fuel requirements will depend upon the international oil supply/demand balance. A wide variety of international oil supply forecasts for the period 1978-2000 were reviewed. The more pessimistic and optimistic forecast rejected, and the conclusion is that oil supply will be adequate to meet demands up to the mid-1990's, a more severe shortage could be expected to lead to substantial price increases of 50% or more. The supply of oil is very fragile and depends on the production of very substantial volumes of oil by a small number of major exporting countries such as Saudia Arabia, Iran and Iraq. Political disturbances, such as the 1973 Arab embargo and the 1978 Iranian revolution, result in supply interruptions and discontinuities in prices, e.g. sharp increases followed by slow declines in constant dollars (plateauing in current dollars). More permanent changes in production policies of major exporting countries could considerably affect the price and availability projection.

Given the above outlook, efforts should be made by all countries to explore for and develop additional oil reserves and avoid policies which limit supply. Specifically, a free market in refined products is urged. If protective policies are adopted for U.S. refineries, New England should not be penalized. The development of additional refining capacity on the U.S. East Coast, if economic, is desirable provided an environmentally acceptable site can be found. It should be noted that the Pittston (Maine) project, as presently proposed, may be inconsistent with the plans for a tidal power project.

Certain conditions must be present before consideration of the issue of setting domestic crude oil prices at a competitive world levels in the future, phased in over a period of years. These include an adequate showing that: significant additional production would likely result; that effective competition in the refining industry exists; that any detrimental effects on the region's and nation's economy would be minimal; that financial safeguards for low and moderate income consumers are in place; that world oil prices reflect the true U.S. marginal replacement cost; that additional profits on existing production resulting from any such price increases be reinvested in exploration, development and production of domestic sources; and that a set of stand-by controls are available in the event of unexpected price increases.

Further, any refinery protection policies which are or may be adopted should be considered in assessing whether any or all of the above conditions are met. It is not agreed whether these conditions are presently met or when they would be met in the future.

If these conditions are met, the setting of domestic crude oil prices at competitive world levels, phased in over a period of years, would be desirable to increase U.S. crude oil supply, restrain demand for oil, stimulate competition from alternative energy sources and reduce oil imports. In the meantime, crude oil price controls should be simplified as much as possible consistent with the intent of those controls.

Finally, funds should be appropriated to restore the national strategic storage system to its originally proposed timetable and ensure that adequate storage is easily accessible to New England, preferably in the Northeast. In addition, supporting international oil sharing programs for periods of shortage, the development of non-OPEC oil production and increases OPEC foreign investment which integrates these countries into world economy are also urged.

III. Nuclear

To the extent that a nuclear versus coal choice must be made for a new generating station, all costs — environmental, social, and economic — should be calculated and applied to the decision-making process. Second, nuclear licensing should be improved to balance the preeminent twin considerations of shortening the process while at the same time assuring that there is a quality review of decisions of whether to license the plant in the first instance. Heavy water and other type reactors should be given equal treatment in licensing procedure. Establishing a national waste disposal facility to be operational by the date recommended by the President's Interagency Review Group (1988-92) for disposal of high level nuclear waste is urged, and a moratorium on future construction is called for if that deadline is not met.

NEW APPROACHES

Meeting institutional barriers, addressing regulatory issues and providing adequate and appropriate financial support for the implementation of a comprehensive New England energy policy will require new approaches to some new and some old problems. Identifying the problems, studying options for their resolution, and choosing strategies for addressing them while

satisfying a host of environmental , social and economic criteria consumed a great deal of time and energy. The following summarizes a few of the new approaches needed to effect the transition to the twenty-first century.

I. Economic Cost Analyses

Current financing mechanisms encourage the installation of the lowest initial cost heating systems and ignore the higher operating costs that are subsequently passed on to residents. Electric resistance heating in the residential sector is a good example — the total New England housing stock is 12.2% electrically heated — yet this type of system consistently has proven to be the most expensive option available if total cost over time is calculated. If life-cycle cost analyses are utilized for calculating projected energy costs for future projects, hydroelectric, tidal, and solar technologies will particularly demonstrate their long-term economic benefits. Life-cycle cost analyses should be employed in all future energy cost estimates.

II. Community Scale Energy Projects

There are many innovative existing and planned projects built to the neighborhood or community scale. Low head hydroelectric projects in New Hampshire, a wood-fired electricity plant in Vermont, solid waste facilities in Massachusetts and Connecticut, wind generators in Rhode Island, and a tidal project in Maine are just some examples of community scale regional projects. Yet the historical evolution of increasingly larger, more centralized power stations has led to regulatory, institutional, and financial obstacles to the commercialization of community scale projects. Potential utility hook-ups to cogenerators and wind or photovoltaic systems suffer from inequitable, complex, and/or unclear regulatory procedures. Pricing for small-scale peaking systems and for back-up power supplied from the utility grid are currently unresolved issues which threaten the economic viability of some renewable sources. Equitable pricing schemes and time-of-day rates are two recommendations which could alleviate these difficulties.

III. Financing Requirements

To finance the transition to an energy economy based more heavily on renewables and less on conventional fossil fuels, a host of government financing schemes must be utilized. A mix of increased investment tax credits, accelerated depreciation allowances, loan guarantees, low interest loans, dividend/capital gain exemptions, together with credits, rebates, and grants to consumers is most desirable. Although such programs are costly — up to $1 billion federal dollars in addition to present commitments for renewables alone — substantial sceondary effects upon the regional and national economy ultimately will reduce the net cost to the government sponsor.

A thorough examination of the employment impacts, consumer savings, and economic multipliers which result from the development of alternative sources should be undertaken. In this light, the following recommendations are made: 1) a jobs impact analysis of all energy policies should be mandatory for all federal and state agencies; and 2) special government support should be provided to insure the access of low income people to energy conservation and renewable energy related jobs.

IV. Energy Planning

Future energy utilization can benefit from an improved planning process which incorporates the following elements: 1) involving more of the public affected by energy decisions; 2) utilizing benchmark planning techniques to document progress and problems; 3) creating a regional siting and planning capability to work on integrating state energy plans and regulatory jurisdictions which encompass regional concerns; 4) favoring incentives rather than regulatory restraints, when possible, to achieve a comprehensive energy policy; and 5) encouraging citizen energy education efforts which are required to effect a participatory planning process.

CONCLUSION

The New England Energy Congress represents an initial attempt to formulate a realistic, comprehensive, regional energy policy. This effort will hopefully be the first step of many to demonstrate a commitment to working to solve New England's energy problems. While federal support and dollars are sought to provide the initial leverage to move towards increasing self-sufficiency, the region must continue to work together, educate its people, and respond to emerging energy problems. The recommendations of the Energy Congress are directed to all levels of regional decision-making — federal, state, and local. The hope is that the work done here will assist all concerned. New England cannot afford to relax in its determination to forge an effective energy policy for itself.

Postscript

Throughout the year-long Energy Congress effort, the pace of events concerning the world, national, and regional energy situation has continued to accelerate. This past year saw the revolution in Iran, several large OPEC price increases, spot shortages in gasoline, a dangerously low heating oil inventory in New England, and numerous other energy crises. Even as this report is in final production, energy stories continue to dominate the headlines — none more dramatically than the nuclear accident at Three Mile Island in Pennsylvania.

Given the dynamic nature of energy issues, and recognizing the continuing need to respond to rapidly changing events, the New England Energy Congress is currently developing a mechanism which will allow it both to assist in the implementation of its recommendations and to address energy issues which demand immediate attention. By maintaining a smaller yet representative and diverse membership, the Energy Congress can make a unique contribution towards resolving the region's energy problems.

NEW ENGLAND ENERGY SUPPLY COMMITTEE

DELEGATES

Zeb D. Alford (Committee Chair)
President, New England Energy, Inc., Westborough, MA—utilities

Maggie Alston
Special Assistant for Community Affairs, Low Income Planning Agency, Inc., Hartford, CT—low income

John A. Bewick
Secretary for Environmental Afffairs, Commonwealth of Massachusetts, Boston, MA—government

William J. P. Cleary
President, Massachusetts State Labor Council, AFL-CIO, Boston, MA—labor

Steven Colome
Chairman, Greater Boston Group, Sierra Club, Boston, MA—environmentalists

J. Alan Cope (Co-Chair, Fossil Fuel Subcommittee)
Manager, Policy Development and Economics, Continental Oil Company, Stamford, CT—industry and manufacturing

Ed Curtis
E.J. Curtis Assoc., Nashua, NH—industry and manufacturing

Alan S. Davis
Director, Energy Project, National Consumer Law Center, Boston, MA—low income

Richard de La Chapelle (Chair, Nuclear Subcommittee)
Vice President/General Manager, GTE Sylvania, Hillsboro, NH—industry and manufacturing

Lola Dickerman
Director, Small Business Association of New England, Boston, MA—small business

Douglas Foy
Executive Director, Conservation Law Foundation, Boston, MA—environmentalists

Clement A. Griscom (Committee Vice Chair)
Associate Chief Scientist, Division of Marine Resources, University of Rhode Island, Kingston, RI—R&D

Sherry F. Huber
State Representative, Member of Joint Legislative Committees on Energy and Natural Resources, Augusta, ME—government

Norman Laberge (Chair, Alternatives Subcommittee)
Project Director, Pleasant Point Passamaquoddy Reservation Housing Authority, Perry, ME—consumers

Robert V. Laney
Former Deputy Director, Operations, Argonne National Laboratory, Grantham, NH—R&D

David Stowell Percival
Owner, Percival Logging Company, Andover, ME—small business
Kenneth G. Picha
Director, Office to Coordinate Energy Research and Education, University of Massachusetts, Amherst, MA—educators
Frank M. Sahlman
President, Topsham Telephone Co., Inc., West Topsham, VT—utilities
James W. Skehan, S.J. (Co-Chair, Fossil Fuel Subcommittee)
Director, Weston Observatory, Department of Geology and Geophysics, Boston College, Weston, MA—R&D
Daniel S. Waintroob
Director, Housing and Energy, Cranston CAP, Cranston, RI—low income
Nelson Works
Former Chief Administrative Officer, Federated Capital Corp. (Houston, Texas), Freedom, NH—finance

RESOURCE CONSULTANTS

Stephen J. Keating, Jr.
Director, Energy Management Division, State Department of Administrative Services, Hartford, CT
Wilfred H. Hall
Executive Director, Independent Oil Men's Association of New England, Portsmouth, NH
C. Russell Shaw
Director, Energy Conservation, Erving Paper Mills, Erving, MA
George B. Uihlein
Vice President, Operations, Southern Connecticut Gas Company, Bridgeport, CT
Bill Newbury
Scientific Staff, Massachusetts Audubon Society, Lincoln, MA

STAFF RESEARCHER

Steve Morgan
Bob Elgin
Technical Consultant

EXECUTIVE SUMMARY

Objectives

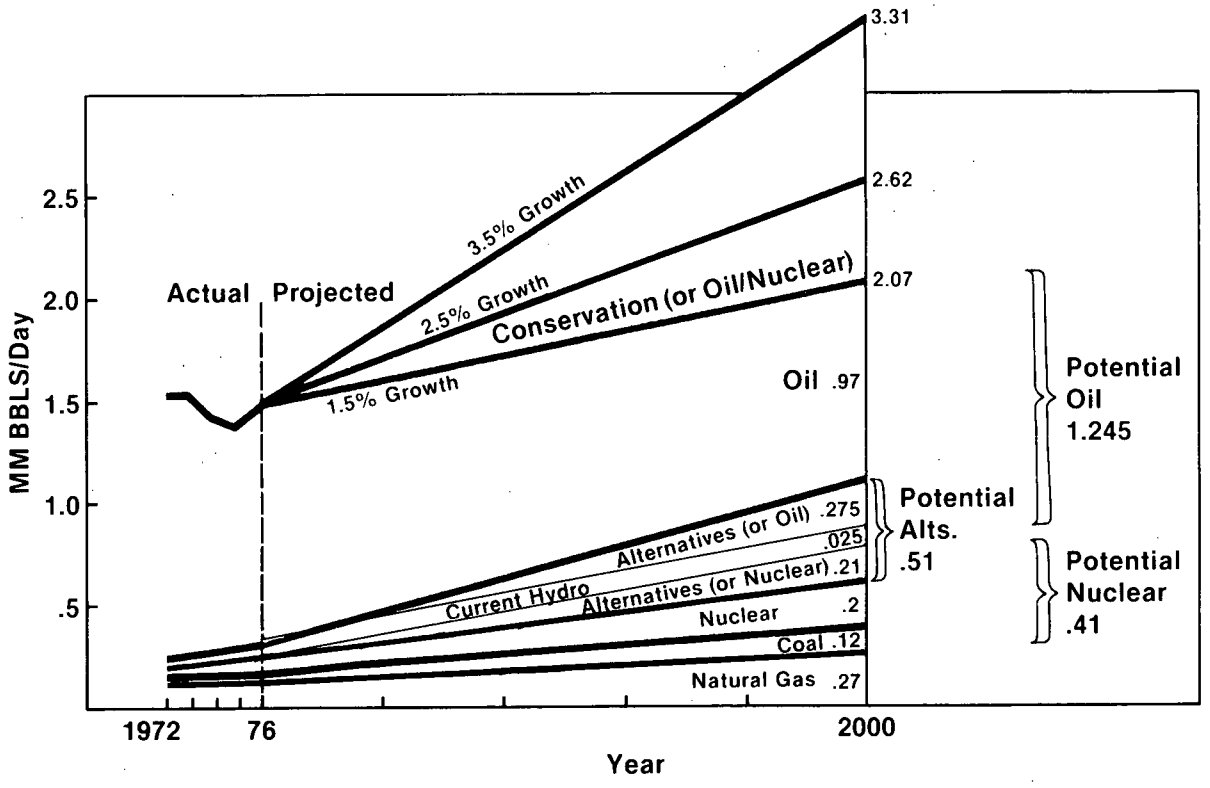
- Reduce New England's oil consumption from 80% of total energy supply in 1976 to less than 50% (about national average) in year 2000
- Encourage energy conservation
- Encourage development of alternative energy sources
- Encourage expansion of natural gas use
- Balance New England economic environmental/social needs with energy needs
- Provide flexibility to meet energy needs if alternative energy source development or demand for energy is different from that expected

Proposed New England Energy Plan 1979-2000

The Supply Committee of the New England Energy Congress reached unanimous agreement on a *balanced, flexible energy* mix (See Fig. 1) for New England by the year 2000 which would meet the objective of reducing New England's overwhelming dependence on imported oil. This proposed supply mix is predicated upon achieving a significant level of conservation. It balanced the environmental, social, and economic needs of New England with the energy needs projected for the region. The energy mix calls for a major development of alternative energy sources by the year 2000. It further calls for a back-up of oil, nuclear power and/or coal if the development of alternative sources doesn't proceed in a timely manner. We agreed that when new energy facilities have to be developed in New England, they should be built expeditiously, consistent with social, safety, economic and environmental concerns.

Not only was consensus reached on the supply mix, but initially unanimous agreement was reached on over a hundred policy recommendations by December 1, 1978, when the *Preliminary Report* of the Energy Congress findings was published. Following the public hearings in December, thirty-nine amended consensus policy recommendations emerged for the final report. Since this committee reached consensus with so many facets of the diverse New England political

FIGURE 1
New England Energy Mix
1978-2000



Projection calculated for the single year 2000.
Growth rates are represented as a straight line between point estimates for 1976-2000.

[1]See p. 133 for major definitions and assumptions used in Supply Committee calculations.

spectrum represented, we urge other regions of the country to undertake a similar process. In order to have a common background of information, we spent the first two months of our deliberation studying prices and expected availability of all forms of energy potentially available to New Englanders. We operated with three subcommittees—fossil fuels, nuclear, and alternative energy. Each subcommittee discussed the issues and reached consensus on which issues to present to the full committee for consideration. This process required a lot of time, effort, and patience by all participants. The mix agreed to by the committee reflects a process of compromise. While individual delegates are more or less comfortable with various energy source projections for the year 2000, all agree that our mix and the policies to achieve it are desirable and in the interests of New England.

Three significant agreements allowed the committee to reach unanimous consensus on an optimal energy mix for the region in the year 2000.

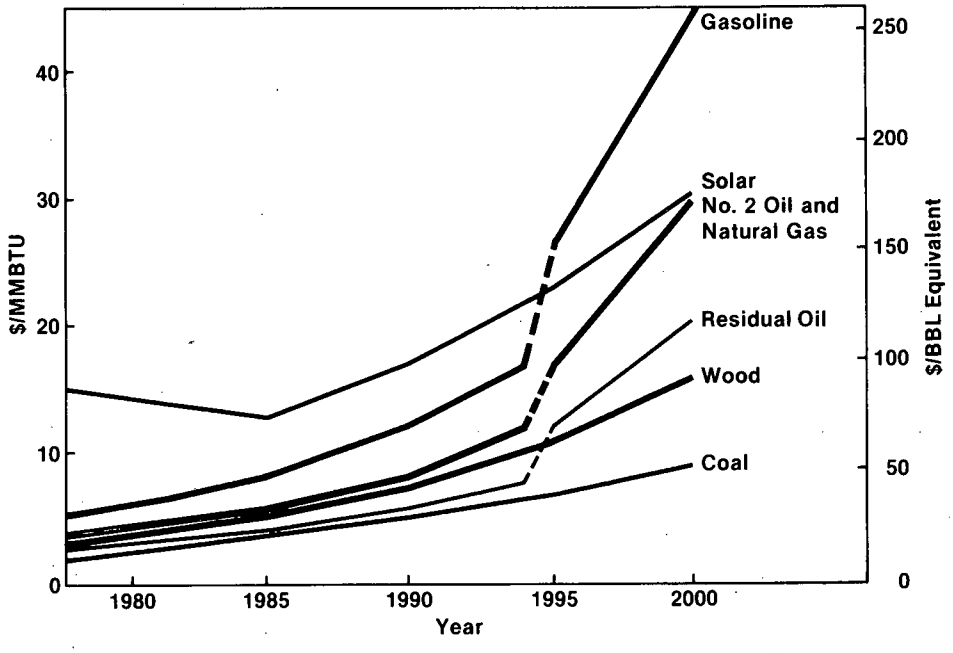
First, the committee emphasizes that conservation is the most sensible and effective strategy for facilitating our transition to a more desirable energy mix. To the degree that timely, appropriate, and cost-effective conservation efforts are directed at our residential, commercial, industrial, and transportation sectors, we can refrain from building more costly power stations. Also, by conserving energy, we can reduce our dependence upon imported oil and allow more time for the development of renewable energy technologies. While the passage of the 1978 National Energy Act does represent a national commitment to a serious conservaiton effort, it is only a start.

Second, The committee has determined that sufficient energy sources are available to New England to the extent needed through the year 2000. We do not expect to run out of any energy resources by the end of the century. We do expect to pay a higher price for energy and to experience periodic supply disruptions such as the 1973-74 Arab oil embargo and the 1978-79 Iranian Revolution. Our subcommittees have thoroughly explored and projected the available energy potential for coal, oil, natural gas, nuclear, and alternative energy sources for 1985 and 2000. Coal offers an abundant national supply for at least another century or more, and the alternatives have the potential to supply a large share of the energy we expect to consume by the year 2000 if we make a major effort before 1985. While oil supplies may tighten in the 1990's, we expect New England would still be able to supply at least one-half of its energy needs with petroleum in 2000. Increased domestic natural gas production, gas imports from Mexico, Canada, and other countries, and the development of synthetic gas from coal, wood and wastes should supplement existing gas supplies. This, combined with reduced boiler fuel use of natural gas nationwide should allow an increase in gas consumption in New England.

Third, all energy sources which will be available will also be very expensive. (See Figs. 2(a), 2(b), 3(a) and 3(b).) Even the alternative energy sources will not come cheaply. All forms of alternative energy require various forms and degrees of subsidization to become cost competitive, just as fossil fuels and nuclear power have required. (See Table 1.) The most competitive alternatives today are hydropower, passive solar, solar hot water heating, wood, and solid waste. We believe significant penetration by these energy sources in the region will take more time than is deemed prudent unless the correct policies are pursued by the U.S. Congress and the various state governments now.

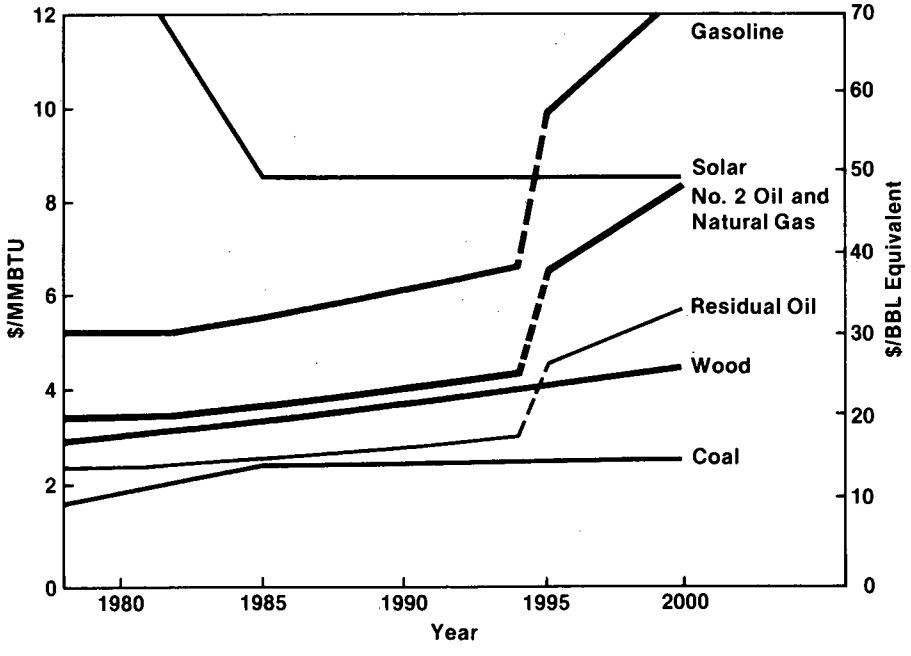
High energy prices will bear most heavily upon our nation's low and moderate income groups. We believe that a program should be established now to help these people pay for today's rising energy bills and tomorrow's much higher prices. This program should include a combined low income weatherization and solarization program, as well as a permanent energy assistance program. (See Recommendations 33-39.) Additional recommendations are made which must be instituted now to assist low and moderate income people in paying for their essential energy needs. This policy is considered a necessity by our committee since we are sure the price of all energy is going up in the future—and the poorer citizens are not able to pay their bills today.

FIGURE 2(a)
Projected Fuel Costs to Consumer to the Year 2000
(Current Dollars, All Prices Inflated at 6% Per Year)



The committee examined prices for the 3 years: 1978, 1985, and 2000.

FIGURE 2 (b)
Projected Fuel Costs To The Consumer
To The Year 2000 In 1978 $



The committee examined prices for the 3 years: 1978, 1985, and 2000.

FIGURE 3(a)
Bus Bar Cost of Electricity by Fuel Type*
(Current Dollars, All Prices Inflated at 6% Per Year)

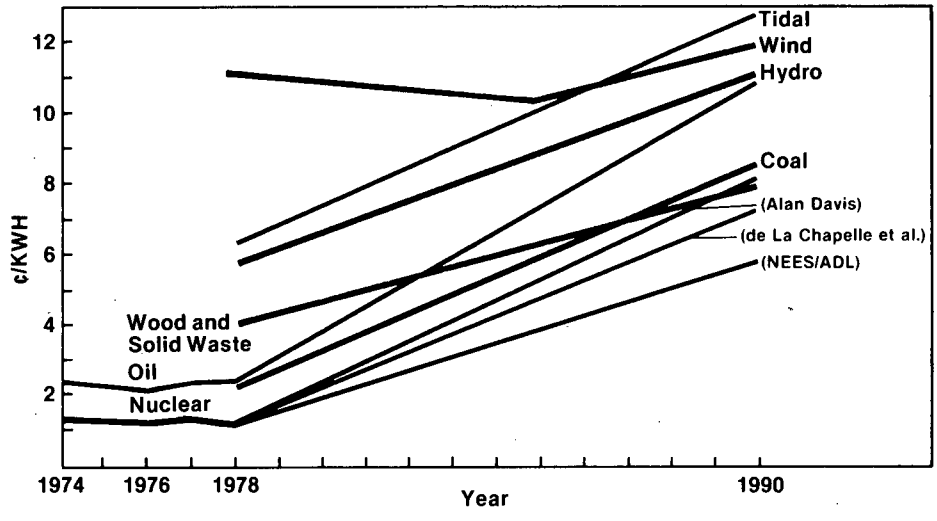
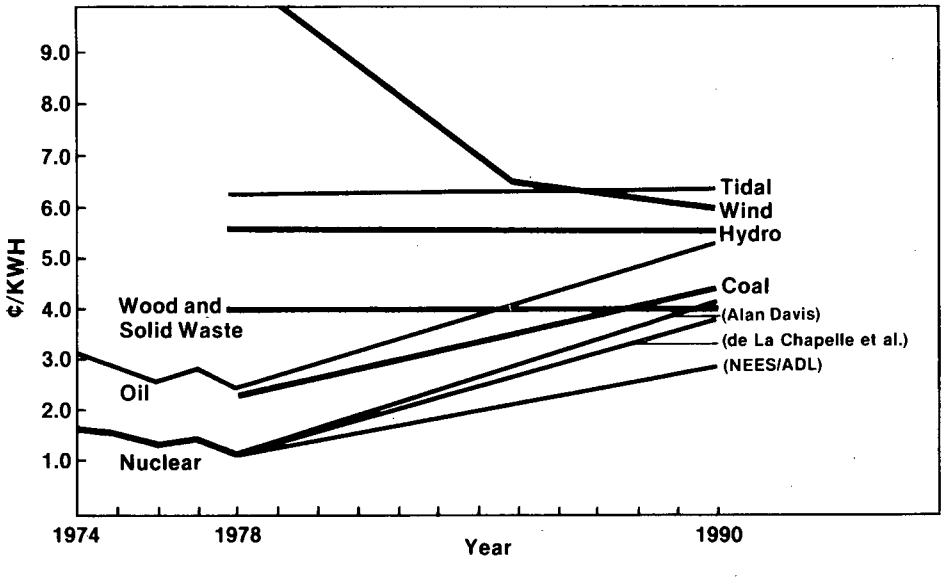


FIGURE 3(b)
Bus Bar Cost of Electricity by Fuel Costs*
(In Constant 1978 $)



*** The committee only looked at bus-bar costs to the year 1990.**
Historical data represents actual cost (before 1979).
Future cost projections represent estimated costs of a new unit.
Delegate Alan Davis has registered a dissent to Figures 3(a) and 3(b), for his explanation, see page 134.

Table I

Additional New England and U.S. Federal Financial Requirements for Alternative Energy Projects: 1980-1985
(In Millions of Dollars)

A. Additional Budget Outlay for New England and U.S.: 1980-1985

Fuel	Program Expansion		Grant		Study		TOTAL	
	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.
Wood	**5**	*25*				*10*	**5**	*35*
Solar			**165**	*3460*			**165**	*3460*
Solid Waste		*.5*	**40**	*200*	**.5**		**40.5**	*200.5*
Wind	**50**	*500*					**50**	*500*
Hydro								
Tidal			**2**		**.25**		**2.25**	
Peat and Others[1]			**.25**		**.75**		**1**	
	55	*525.5*	**207.25**	*3660*	**1.5**	*10*	**263.75**	*4195.5*

TOTALS

Total Additional Outlay Over 5 Years for New England	**$263.75**
Average Annual Additional Outlay for New England	**$ 52.75**
Total Additional Outlay Over 5 Years for U.S.	*4195.5*
Average Annual Additional Outlay for U.S.	*839.1*

B. Additional Loan and Loan Guarantees for New England and U.S.: 1980-1985

Fuel	Loan		Loan Guarantees		TOTAL	
	N.E.	U.S.	N.E.	U.S.	N.E.	U.S.
Wood			**200**	*600*	**200**	*600*
Solar						
Solid Waste			**160**	*800*	**160**	*800*
Wind	**75**	*750*			**75**	*750*
Hydro		*330*				*330*
Tidal						
Peat and Others[1]			**10**		**10**	
	75	*1080*	**370**	*1400*	**445**	*2480*

TOTALS

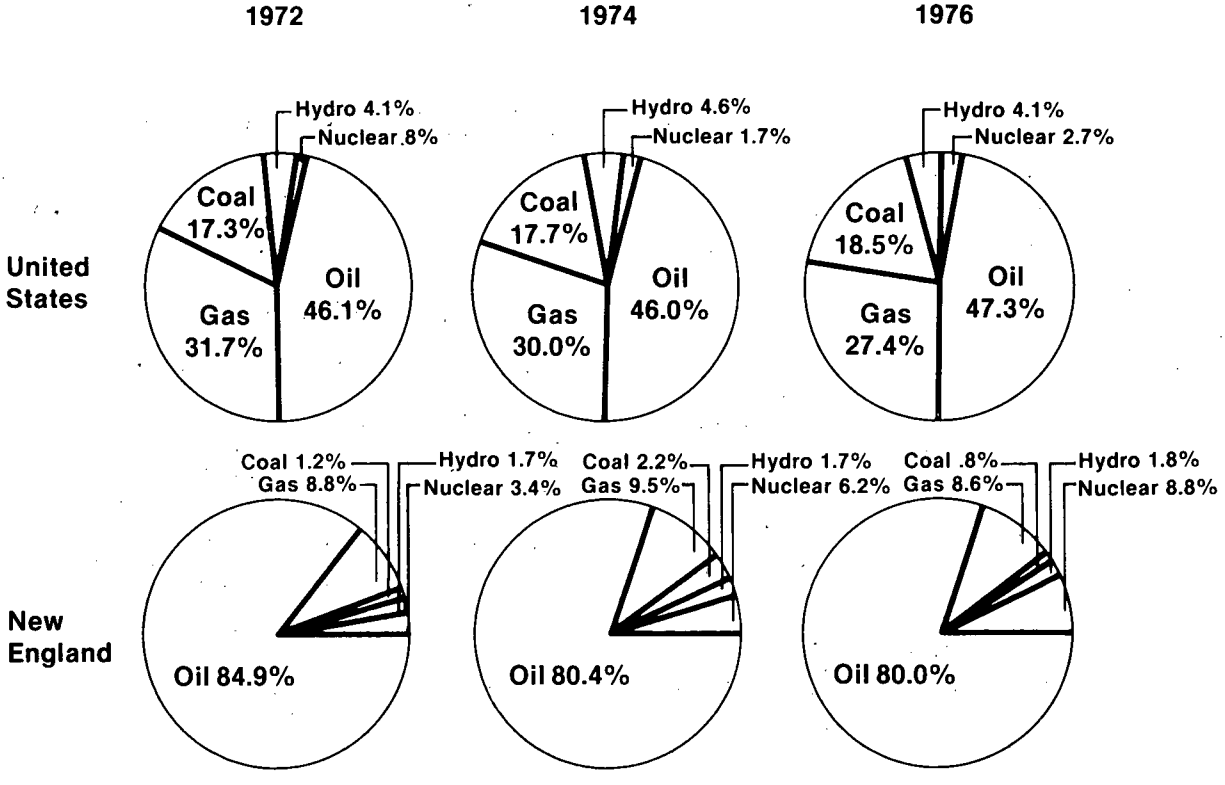
Total Additional Loan and Loan Guarantees for New England	**$445**
Average Annual Additional Loan and Loan Guarantees for New England	**89**
Total Additional Loan and Loan Guarantees for U.S.	*2480*
Average Annual Additional Loan and Loan Guarantees for U.S.	*496*

Suggested New England numbers shown in **bold**.
Suggested U.S. numbers shown in *italic*.

[1]Includes Methane and Alcohol.

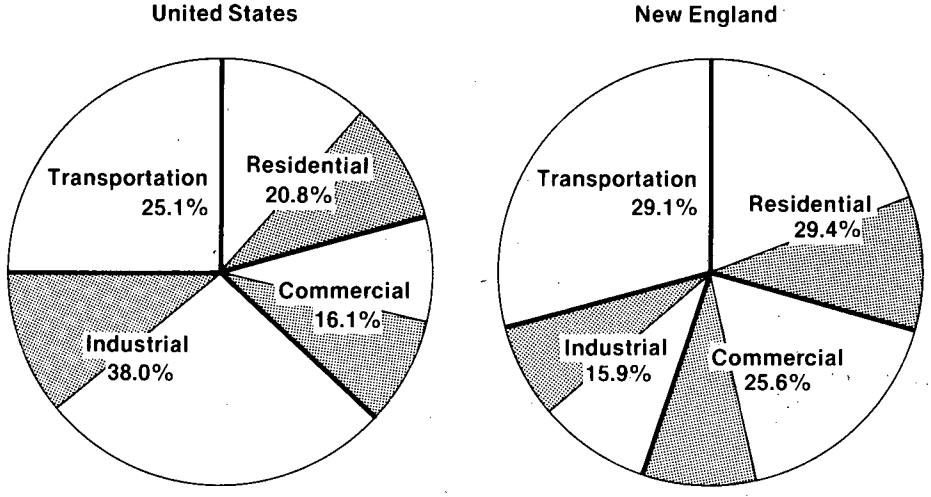
In striving for an optimal energy mix, the committee agreed that price as well as environmental and social impacts should be given weight in our recommendations. Moreover, complete agreement was reached that by the year 2000 oil consumption in New England should be reduced from 80% of the total energy supply to less than 50% (about the national average) in the year 2000. (See Figs. 4, 5, and 6.) Realizing therefore that even our near-term energy prices will be very high, we are committed to implementing a program now to help the low and moderate income people pay their energy bills.

FIGURE 4
Total Energy Consumption By Source
United States and New England - % Of Total



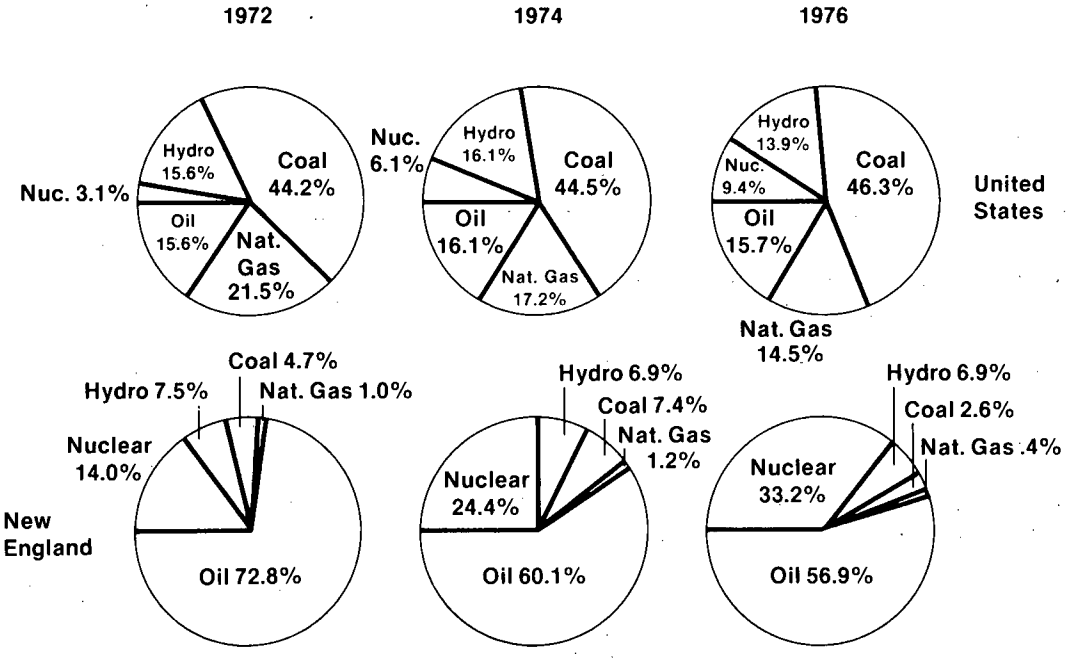
Sources: U.S.-DOE Monthly Energy Review
N.E.-DOE Boston

FIGURE 5
Energy Consumption In 1975
By Sector



Source: DOE-Federal Energy Data System-February 1978
Electricity, U.S. 28.9% and N.E. 26.2%, including generation and transmission losses, allocated to end use sectors as shown by shading.

FIGURE 6
Fuel Sources for Electric Power
United States and New England-% of Total



Source: DOE Boston

Demand

From data communicated to us from the Demand Committee, we adopted an average 1.5% annual overall growth rate and an average 2.2% annual electric growth rate as planning objectives for the purposes of our supply mix. The committee made its projections with the full understanding that energy growth rates do not always conform to the desires or even to the best guesses of forecasters. If we have guessed too low, we must compensate with an increased reliance upon oil, coal, or nuclear fuels. If we project more than will be required in 2000, oil, nuclear, or coal may be reduced in the mix.

Natural Gas

As seen from the bottom line in Figure 1, the committee has recognized the potential which natural gas has for relieving New England's heavy dependence on foreign oil. An increase from the equivalent of about 120,000 bbl/day (8% of total energy in New England) in 1978 to 270,000 bbl/day (13% of total) in the year 2000 is indicated for the region. This would represent about 30 percent of New England's requirements in the year 2000, exclusive of fuel for electric power generation and transportation fuel. While such uage would represent a substantial increase, it would still be less than nationwide levels, expressed as a percentage of total energy use. Recommendations 1-4 pertain to natural gas.

Coal

The second line from the bottom of Figure 1 shows that the committee does not place a great emphasis on coal. Ten million tons of coal per year are projected for the year 2000. This assumes the conversion of three boilers at Brayton Point, the construction of a Sears Island coal burning plant in Maine, and the coal boilers in use in N.H. There is a commitment to probably no more than one or two additional coal burning electric plants by the end of the century. High costs due to transportation, health and environmental considerations are major reasons why we do not expect a greater increase in coal consumption in New England. However, if significant and economically viable reserves are discovered in the Narragansett Basin of Massachusetts and Rhode Island, prospects for increased coal-burning in the region after 1990 could brighten. Recommendations 5-6 pertain to coal.

Nuclear

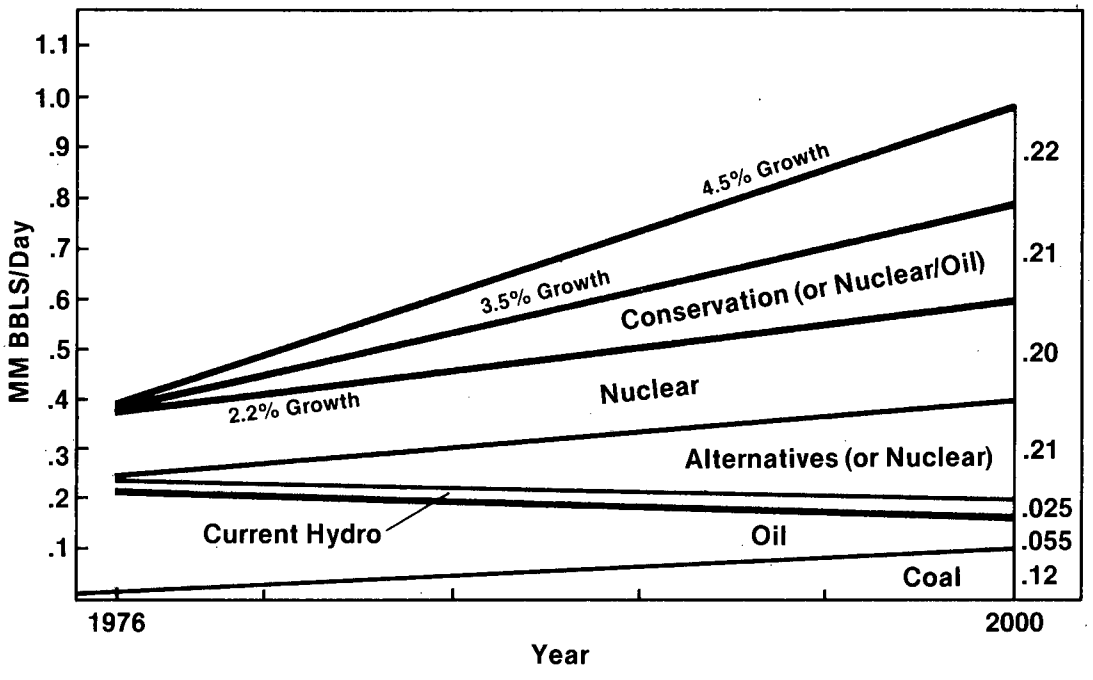
The third line from the bottom of Figure 1 indicates that the committee has agreed that in addition to the nuclear generating capacity operating in 1979, 3450 MW of new capacity will be required by the year 2000, even if all the projected alternative fuels proposed are developed. In addition, the committee has agreed that nuclear energy could supply another two hundred and ten thousand barrels per day of oil equivalent by the year 2000 in the event that the alternatives considered do not fulfill their total projections. In the event that conservation does not reduce the electricity growth rate to 2.2% or less, more nuclear or coal plants may be required as seen on Figure 7.

Consensus was reached within the committee that the shorter the time required between the decision to build a nuclear or coal plant and its completion, the longer the time available to develop the alternative energy sources and to demonstrate conservation. Recommendations 7-10 pertain to nuclear.

Alternatives

As seen from the fourth line from the bottom of Figure 1, the projected contribution of the alternative energy sources range up to the equivalent of more than 500,000 barrels of oil per day, or

FIGURE 7
New England Electric Utility
Energy Mix 1978-2000



Projection calculated for the single year 2000.
Growth rates are represented as a straight line between point estimates for 1976-2000.

25% of the region's needs in 2000. To develop this large and diversified energy source will require significant financial incentives and investments as well as a large R & D program similar to that afforded present day fuels during their development phase. (See Table 1.) The alternatives total reflects a commitment to double the contribution of hydroelectric energy by the turn of the century. It projects the equivalent of a 10 percent increase in woodburning every year from now until 2000. This represents about 250,000 barrels of oil per day equivalent, or ½ the total alternative contribution by 2000.

Solid waste electricity production and cogeneration is counted upon to provide 740 MW by the year 2000. Wind power is expected to become cost competitive in the mid-eighties, delivering over 3% of electricity by the year 2000. Tidal power will be a uniquely New England resource, with 2 to 3 demonstration projects undertaken along Maine's coast. Photovoltaics is projected to provide as much as 10% of our electricity needs by the year 2000.

The direct solar contribution to space and water heating is calculated with the assumption that an increasing percentage of new housing, reaching 50% in the year 2000, will utilize solar energy. Nearly one-half of existing units are assumed to be retrofitted with solar hot water heaters by the year 2000. The programs, policies, and studies recommended constitute an intensive stimulus to spur alternative energy use as a substitute for nonrenewable energy use in New England. They are focused on the achievement of specific significant levels of utilization by 1985. We believe a "critical mass" level of funding for alternative energy sources must be achieved in New England if this program is to make a significant impact on New England's energy future. Recommendations 11-25 pertain to alternative energy sources; they appear in the recommendations of the Joint Committee on Alternatives on page 135.

Oil

Oil is counted upon to provide 970,000 barrels per day, or less than half the total energy requirements for 2000. (See Fig. 1.) This represents a significant drop (from 1.3 million barrels per day in 1976) in New England's reliance upon oil, and reduces our present 80% dependence upon oil to 47% by the year 2000. Thus, while the region's percentage reliance on oil declines, oil will still remain the single largest source of energy for the year 2000. The availability of this oil presupposes that steps will be taken by the U.S. and foreign governments to reduce the demand for and stimulate the supply of oil worldwide. Measures should be implemented to deal with periodic supply interruptions. Exploration programs should be encouraged in as many countries as possible; international trade policies should establish an environment to encourage producing countries to make oil exports available to meet world demand.

The utility requirements for residual fuel oil for New England by the year 2000, assuming a 2.2% electricity growth rate, will be less than 60,000 barrels of oil per day (See Fig. 7). With the Congressional prohibition against new oil burning boilers, utilities will be looking to meet future electricity demands through improved load management, alternative energy sources, cogeneration facilities, nuclear generating facilities, or coal-fired boilers. Recommendations 26-32 pertain to oil.

Conclusion

Recommendations 33-42 pertain to low and moderate income policies, utility rates, or other matters that do not pertain to a particular energy source; however, it is clear that these recommendations must be acted upon concurrently with the other recommendations if we are to achieve consensus on energy policies within New England. After nine months of working together our committee has reached a consensus on what should be done. The task is large and the price is high. Yet we recognize that agreeing on what to do is much easier than making it happen. Periodic energy crises remind us all too vividly that our citizens pay a high price for not solving our energy problems. We think the time to act is now.

RECOMMENDATIONS

Natural Gas

The New England Energy Congress supports the aggressive development of natural gas use in New England as indicated below. Furthermore, the Energy Congress believes that New England's gas distribution facilities are underutilized in comparison with the rest of the country as a result of the late introduction of natural gas to the region. In consideration of these factors and in the interests of economic efficiency, environmental quality and supply security, it is proposed that efforts be made to substitute gas for the nonrenewable fuels that would otherwise be used, consistent with energy conservation and appropriate pricing considerations. Energy conservation in this context means steps that can be taken to reduce end user consumption. The Energy Congress advances the following specific recommendations:

1) Regional, State and Local Initiatives

   A) *Encourage use of gas as a substitute for oil and electricity, when economic, to the extent that additional present and future gas supplies can be obtained.*

B) *Maintain flexibility in the marketing of natural gas, particularly with regard to interruptible and other such sales which can improve system operating and economic efficiency.*

D) *Reduce overlapping and duplicative regulation of gas facilities and adopt federal standards where possible.*

D) *Improve formal administrative procedures within state regulatory agencies to allow for a more open forum for discussion of company, agency, environmental, and customer problems.*

E) *Increase level of contact between and among state regulators and federal regulators in order to better define state responsibilities in connection with the administration of the National Energy Act as it applies to natural gas.*

2) Federal Initiatives

A) *The committee believes that the present gas deregulation legislation may or may not fully accomplish the objective of increasing domestic gas supplies, and therefore it is recommended that the issue be reviewed periodically to determine whether further action is required.*

B) *Expedite purchases of Mexican and Canadian gas and planning for an Alaskan gas transportation system.*

C) *Determine a federal policy for the import of liquified natural gas, including siting and safety standards.*

D) *Remove limitations on the availability of feedstocks for synthetic gas manufacture, thereby permitting their use where economically efficient.*

E) *Establish a mechanism whereby New England's gas companies would be guaranteed pipeline transmission of gas supplies which they develop outside of the region.*

3) *Proceed with the orderly exploration and development of North Atlantic potential oil and gas reserves. Prior to so proceeding, the Department of Interior (DOI) shall acknowledge the importance and uniqueness of Georges Bank as a fishery and shall implement administrative actions to coordinate consideration and design of a leasing program on Georges Bank with the Department of Commerce and New England Regional Fisheries Management Council. A Georges Bank Lease Sale shall be subjected to all sections and requirements of the Outer Continental Shelf Land Sales Amendments recently enacted, and all regulations necessary to fully implement the Amendments shall be finally adopted prior to the Lease Sale.*

4) *Natural Gas - New England should support measures which increase the safety and lower the cost of both LNG and the construction of major international pipelines.*

Coal

5) *Incorporate in the DOE budget a program to evaluate the Narragansett Coal Basin. A 7-year program at an approximate cost of $10 million is proposed for 650 drill holes to an average depth of 1,000 feet supplemented by related downhole and surface geophysical studies. This program would establish whether commercial development of this potential resource is feasible.*

6) *The following recommendations are designed to minimize the public health dangers associated with coal burning:*

   A) *Encourage the speedy development of National Air Quality Standards for fine particulates, sulfates, and acid nitrogen particulates.*

   B) *On new coal plants require the application of Best Available Control Technology (BACT) for sulfur and particulate controls.*

   C) *Encourage utility experimentation with fabric filtration for particulate control.*

   D) *Fund research to utilize the existing data base for determination of health and environmental consequences of coal combustion—then determine need for additional data.*

   E) *Focus international attention on CO_2 buildup in the atmosphere.*

   F) *Provide additional funding to research the relationship between the emissions from coal (e.g. NO_x) and photochemical oxidant pollution.*

Nuclear

7) *The goals of nuclear licensing should be to balance the twin considerations of shortening the process while at the same time assuring that there is a quality review concerning the decisions of whether to license the plant in the first instance. Heavy water and other type reactors should be given equal treatment in licensing procedures.*

8) *The nuclear and coal options for future electricity generation should not be foreclosed. Alternative energy sources and the technologies of conservation should be pushed to their maximum potential. To the extent that a nuclear versus coal choice must be made for a new generating station, all costs — environmental, social, and economic — should be calculated and applied to the decision-making process.*

9) *Establish a national waste disposal facility to be operational by the date recommended by the President's Interagency Review Group (1988-1992) for disposal of high level nuclear waste. If such a facility is not operational by 1983-1992, a moratorium on starting new nuclear power stations should be called.*

10) *Establish a federal program for exploration and evaluation of Conway (N.H.) and other uraniferous and thorium-bearing granites to determine the feasibility and steps necessary to their development as a fuel source. This program would establish whether commercial development of this potential resource is feasible prior to the time that any commitments are made to private development on federal lands.*

Alternatives

THE SUPPLY COMMITTEE RECOMMENDATIONS NUMBERS 11-25, DEVELOPED JOINTLY WITH THE ECONOMIC DEVELOPMENT THROUGH ALTERNATIVE SOURCES OF ENERGY COMMITTEE, APPEAR ON PAGES 135- 143.

Oil

The ability of oil to supply the remainder of New England's fuel requirements will depend upon the international oil supply/demand balance. The committee reviewed a wide variety of international oil supply forecasts for the period 1978 through 2000. It rejected the more pessimistic and optimistic forecasts and concluded that oil supply would be adequate to meet demands up to

the mid-1990's but that a gradual tightening of supplies would lead to a price increase of 2% a year (in constant 1978 dollars) from 1983 onwards. At some point in the mid-1990's, a more severe shortage could be expected to lead to substantial price increases of 50% or more. The committee recognized that the supply of oil is very fragile depending on the production of very substantial volumes of oil by some major exporting countries such as Saudi Arabia, Iran and Iraq and that political disturbances, such as the 1973 Arab embargo and the 1978 Iranian revolution, could result in supply interruptions and discontinuities in prices, e.g. sharp increases followed by slow declines in constant dollars (plateauing in current dollars). More permanent changes in production policies of major exporting counties could considerably affect the price and availability projection.

Given the above outlook, the committee recommends that every effort should be made by all countries (including the U.S.) to explore for and develop additional oil reserves and avoid policies which limit oil supply.

Specific recommendations follow.

26) *Imports of refined products into the United States are heavily concentrated in the New England region, particularly residual fuel. The committee supports a free market in refined products in which imports should be allowed to compete equally with U.S. sourced refined products. If on grounds of security or other reasons, federal policy protects or otherwise subsidizes U.S. refiners, the New England region should not be penalized. Exemption relief should be offered or a comparable subsidy made available to development of alternative energy sources in this region.*

27) *The development of additional refining capacity on the East Coast of the U.S., if economic, is desirable provided an environmentally acceptable site can be found. The committee notes that the Pittson Project, as presently proposed, may be inconsistent with the plans for a tidal power project.*

28) *Funds should be appropriated to restore the national strategic storage system to its originally proposed timetable. Steps should be taken to establish as a part of the total system residual fuel oil storage easily accessible to the New England region with adequate environmental safeguards.*

29) *The committee believes certain conditions must be present before consideration of the issue of setting domestic crude oil prices at competitive world levels in the future, phased in over a period of years. These include an adequate showing that: significant additional production would likely result; that effective competition in the refining industry exists; that any detrimental effects on the region's and nation's economy would be minimal; that financial safeguards for low and moderate income consumers are in place; that world oil prices reflect the true U.S. marginal replacement cost; that additional profits on existing production resulting from any such price increases be reinvested in exploration, development and production of domestic sources; and that a set of stand-by controls are available in the event of unexpected price increases. The committee further believes that any refinery protection policies which are or may be adopted should be considered in assessing whether any or all of the above conditions are met. The committee did not agree whether these conditions are presently met or when they would be met in the future. The committee agrees that if these conditions are met, the setting of domestic crude oil prices at competitive world levels, phased in over a period of years, would be desirable to increase U.S. crude oil supply, restrain demand for oil, stimulate competition from alternative energy sources and reduce oil imports. In the meantime, crude oil price controls should be simplified as much as possible consistent with the intent of those controls.*

International Policies

30) *Oil Sharing - Because of its dependence on imported oil, New England's representatives should support international programs designed to share available oil supplies during an international supply shortage. Particular attention should be devoted to the allocation of product supply during any shortage.*

31) *Non-OPEC Oil Production - The development of oil and gas in non-OPEC countries should be encouraged. In particular, the United States must avoid measures and regulations which place U.S. oil companies at a competitive disadvantage with foreign firms in the development of overseas oil deposits. For example, the U.S. should retain foreign tax credits and avoid constraints on foreign investment.*

32) *International Economic Integration - Sudden OPEC oil price increases which disrupt the world economy can be discouraged by integrating OPEC countries into the world economy. Increased OPEC foreign investment also has the potential for stimulating economic growth and should therefore be encouraged.*

Low-Income

There is a critical need to develop immediately federal programs to alleviate the financial burdens imposed by energy prices on low and moderate income groups. Therefore we recommend the following:

33) *A combined low-income weatherization and, where appropriate, solarization program should be passed by the Congress. This program should include provisions for labor, materials and administrative costs. The program should be administered by the Community Services Administration and operated by community action agencies. Cost: $1 billion annually.*

34) *Congress should establish an energy assistance program for low-income persons.*

   A) *Eligibility sbould be based upon 150% of federal poverty level guidelines.*

   B) *The initial appropriation should be $2 billion with annual increases tied to fuel and utility prices indices.*

   C) *Ten percent of the appropriation should be set aside for an emergency energy program for the heating season.*

   D) *Benefits should take the form of cash payments administered by IRS or HEW.*

   E) *Levels of individual payments should be based upon a formula which takes into account age, household income as adjusted for cost-of-living and regional residential energy consumption.*

35) *All public service or utility commissions in New England should adopt the following National Energy Act guidelines where not already approved.*

   A) *No gas or electric service to a gas or electric consumer may be terminated unless reasonable prior notice (including notice of rights and remedies) is given to such consumer and such consumer has a reasonable opportunity to dispute the reasons for such termination, and*

   B) *During any period when termination of service to an electric or gas consumer would be especially dangerous to health, as determined by the state regulatory authority (with respect to an electric or gas utility for which it has rate-making authority) or nonregulated electric utility, and such consumer establishes that:*

i) *He/she is unable to pay for such service in accordance with the requirements of the utility's billing, or*

ii) *He/she is able to pay for such service but only in installments, such service may not be terminated.*

Such procedures shall take into account the need to include reasonable provisions for elderly and handicapped consumers.

36) *Regulatory agencies should require electric rate structures which embody the following principles:*

A) *Minimize price increases associated with minimum and necessary basic consumption to the extent that such actions can be cost-justified.*

B) *Encourage conservation.*

37) *The Congress should earmark a special modernization fund which is used solely to weatherize and, where appropriate, solarize public housing units. Cost $500 million annually.*

38) *Through the McCormick Act, Congress has already authorized $1.5 billion for R & D and federal government purchases of photovoltaics. A portion of the federal government purchases should be utilized for demonstration projects on the multi-family assisted housing units.*

39) *Congress shall require HUD and DOE to study (a) the economic and institutional feasibility of weatherizing of private rental units without passing the costs on to low-income tenants and (b) community scale solar heating systems; and if feasible, to set up a demonstration program.*

40) *State Public Utility Commissions should require electric companies to consider cogenerated power, if deemed reliable and economical, as an alternative to new central station capacity. These cogeneration units should be counted towards the utilities' Capability Responsibility under the NEPOOL Agreement.*

41) *State Public Utility Commissions should encourage electric and gas companies to conduct studies of the effectiveness and the impact of load-control projects in their service area.*

42) *The committee supports in principle Time-of-Use rates for electricity, but believes that specific rate schedules must be carefully designed to insure protection for low and moderate income consumers who cannot modify their electricity consumption patterns.*

Supplemental Hydropower Recommendations—Alternative Subcommittee

The following recommendations have been designed by the Alternative Subcommittee to indicate in more detail specific steps which can be undertaken to develop hydropower in the region.

I. General Recommendations

1) *Improve the operating efficiency of old, existing installations in the form of replacements and modifications. This same concept can also be applied to retired plants in need of rehabilitation.*

2) *Increase the number of demonstration projects that include the following considerations:*

   a) *The use of high technology for fully automated facilities, control, storage, and monitoring,*

   b) *Use sound engineering expertise,*

   c) *Properly designed interface network.*

3) *Standardize hydroelectric generating equipment and develop simplified hydrology, reservoir yield, and power plant capacity analysis techniques.*

4) *Define the public utility commission's role and authority to affect wholesale prices of electricity. Streamline federal regulatory requirement and decrease institutional barriers (i.e , federal/state law, agency policies).*

5) *Classify project cost, especially from the results of pilot plants. Topics that should weigh heavily in this evaluation include the following:*

   a) *Life-cycle cost analysis,*

   b) *Cost of fishway; i.e., developer's or agencies cost.*

6) *Identify all New England rivers which are targeted for reintroduction of anadromous fish.*

7) *Relocate of DOE's Low Head/Small-Scale Hydro Program to a more appropriate division within DOE.*

8) *Mandate utility purchase of hydro power.*

9) *Exempt small-scale producers from classification as public utilities.*

10) *Prohibit price discrimination.*

11) *An economic study should be made to determine if and how a subsidy should be used.*

12) *The Department of Energy (DOE) should develop low-cost, low-power turbines/generators, power trains, and interface equipment.*

13) *Some demonstration projects should use high technology, such as storage systems.*

14) *An ecological/environmental study of major river basins should be made to determine the impact of fish ladders on the present fish and wildlife mix.*

15) *Provide low-interest development loans.*

16) *Establish a regional DOE hydropower office to offer technical assistance, to promote this type of development, to coordinate information transfer, and to offer economic assistance.*

II. Specific Measures to Aid Implementation of General Recommendations

Demonstration projects constitute the best means of developing the additional data needed to better assess the engineering and economic feasibility of a small-scale hydropower development program. At least a few of the demonstration projects should be at retired hydropower sites, since these dams offer the best opportunity to quickly and inexpensively construct prototype power houses and concentrate effort and funds on important technological considerations.

In addition to the demonstration program, a research program to develop small-scale hydropower planning, design, construction, and implementation techniques is needed.

17) *Develop and refine small-scale hydropower turbine technology.*

    a) *Direct federal research and development funds to the basic study of low-head turbine design.*

    b) *Direct federal R&D funds to the development of non-turbine based low-head hydropower technology.*

18) *Perform a state-of-the-art study to determine the most effective way to interface small-scale hydropower plants with existing and planned regional grids.*

19) *Conduct a short-term study of the relative economic efficiency of alternative electrical generation systems.*

20) *Special areas of concern include the following:*

    a) *Diverting reservoir storage from current use to hydropower production could be inefficient and cause significant economic stress,*

    b) *The ecological impacts of peak load power production by small-scale hydropower plants are possibly significant,*

    c) *The social effects of a small-scale hydropower program are numerous, diffuse, and largely unknown.*

21) *Conduct a study to identify and define institutional barriers due to existing federal law, regulatory processes, or agency policies.*

22) *Demonstration projects should use the latest state-of-the-art technology for automation, control, storage, and monitoring hydroelectric facilities. Emphasis should be on sites smaller than 5 MW. In those situations where energy storage by means of water storage is not possible, alternate forms of energy storage need to be explored. More data on low-cost flywheels and other energy storage systems need to be gathered.*

23) *Cost reduction should be sought by standardizing hydroelectric generating equipment. (i.e., using less completely site-optimized equipment). At the same time, the development of high-rpm power trains for possible cost-reduction potential should be explored.*

24) *The potential role and authority of state public utility commissions to affect wholesale prices of hydroelectric energy should be further documented.*

25) *More information about dam insurance availability and costs is needed. The availability of insurance must be assured by some means, if private firms cannot provide adequate and reasonable coverage.*

26) *The actual environmental impacts of raising and lowering reservoir levels need to be documented and made known to the general public.*

27) *Allocate appropriate funding to encourage the development of small dams, i.e., less than 15 megawatts.*

28) *The cost of fish ladders, when required, should be borne by an agency other than the small hydroelectric site developer.*

29) *Federal governmental regulatory requirements for these facilities should be streamlined to reduce cost and time.*

30) *Appropriate laws should be amended to permit life-cycle cost feasibility assessments.*

31) *Federal research and development funding should be made available to encourage the development of low cost, efficient, low-head hydroelectric power plants.*

32) *The development of the initial sites should be accomplished with sound conservative engineering expertise and in a responsible manner. It is recommended that initial demonstration funding be spent to maximize the sound development of these initial sites.*

33) *Federal funds should be made available to the states so that they may better define and streamline regulatory procedure.*

34) *Federal funding should be made available to develop suggested technical standards for low cost, effective interface equipment that meets the requirements of small hydroelectric facilities.*

COMMITTEE OVERVIEW

The Supply Committee delegated its fact-finding and preliminary recommendations-drafting work to three subcommittees: Fossil Fuels, Nuclear and Alternatives. Meeting at least once per month, the subcommittees considered in turn four central tasks:

1) Assessing the contributions their respective fuel sources are making to New England's current energy supply mix and the maximum potential contribution each source could make by 1985 and 2000;

2) Establishing current prices, and estimating end-use prices for 1985 and 2000;

3) Projecting a most desirable and feasible fuel mix for the year 2000, taking into account the environmental, social, technological and institutional constraints inhibiting the availablity of each fuel source.

4) Recommending legislative, financial and regulatory changes to Congress which facilitate the realization of the previously agreed to desirable fuel mix.

Meeting once per month, the full committee heard reports from the subcommittees, modified and accepted their findings and acted upon various recommendations. In August, the committee tentatively approved the availability projections from each subcommittee for the years 1985 and 2000. In September, the committee accepted some revisions in the availability estimates and approved the subcommittee projections of future prices to end-users. In October, the committee agreed to an optimal supply mix for 2000, and adopted six recommendations designed to aid the implementation of that mix.

In November over 100 additional recommendations pertaining to approximately 20 energy sources received full committee approval. The December public hearings and January public comments introduced new information which enabled the committee to modify, streamline and improve its recommendations. In February forty-two final recommendations were approved. Finally, in March the committee agreed to the "Executive Summary" of the report.

In the subcommittees' fact-finding efforts and in the committee's deliberations, many nationally recognized experts have been called upon to address the delegates. In addition to personal presentations from twenty "resource consultants" representing utilities, universities, hardware manufacturers, environmental and consumer organizations, energy delegates have consulted scores of knowledgeable experts in various energy areas by telephone, and scoured hundreds of governmental, public interest and industry reports and documents. On the committee itself sat no less than nine people with an extraordinary understanding of a particular energy area. Sixteen individuals have submitted more than twenty reports for the committee's consideration. Many of these appear in the documentation section of this report.

The decision-making process within the subcommittees and with the full committee has been one of consensus. Within the full committee, the agreements upon availability and cost projections, the optimal supply mix and recommendations to Congress have followed the same

procedure: subcommittee chairmen make reports, deliver findings, and make recommendations for full committee adoption. The full committee discussed, modified and agreed upon issues unanimously. Formal votes were not taken. Availability and cost estimates, optimal fuel mixes and recommendations were modified until everyone agreed. Very few subcommittee findings or recommendations were rejected because consensus could not be reached. In a few cases, as in the projection of future nuclear costs for newly constructed plants, different opinions have been expressed as a range or band of potential costs.

Major areas in which consensus was not been reached were remarkably few. Many difficult issues have undergone hours of discussion, reams of material, and a process marked by good will, trust and compromise. Developing the consensus process took months of hard work. Mutual trust, respect and friendships have been nurtured in an atmosphere punctuated by collegiality in subcommittee meetings and good will, patience, dedication and skilled leadership in the larger committee sessions. Without the extensive time commitments, the willingness to compromise, and the belief in the process shared by all the delegates, the consensus reached on a wide variety of issues could not have been achieved.

Three unanimously shared operating assumptions guided the committee's work: (1) the future supply mix should reduce the nation's 45% and New England's 79% petroleum dependence upon imported oil; (2) the future supply mix should enable our region to compete more economically with the rest of the country; and (3) consistent with (1) and (2), we should develop indigenous, environmentally acceptable energy sources wherever possible. It has been recognized that these premises may conflict with one another in specific instances. Agreeing upon the supply mix which optimizes the meeting of these criteria was a central charge of the committee.

AVAILABILITY AND COSTS FINDINGS

Each subcommittee has been charged with making availability and costs estimates for 1985 and 2000 for energy sources within their respective jurisdiction. Also they were asked to project an optimal supply mix for the year 2000. The optimal supply mix agreed to by the full committee formed the basis for the recommendations of the subcommittees, and ultimately, the full committee.

Fossil Fuels Subcommittee

I. Perspective

From the perspective of the Fossil Fuels Subcommittee, even an optimistic New England energy supply projection for 1985 will leave the region uncomfortably dependent upon imported oil (perhaps 80% of our petroleum requirements). In addition, the subcommittee agrees that no single conservation or fuel strategy will significantly improve this situation during the next seven years.

The subcommittee has identified the following factors as central causes of New England's disadvantageous energy situation: the regulation of natural gas, higher costs due to the region's location at the end of the transportation pipeline, the absence of developed economic indigenous fuels, and the vulnerability to an OPEC boycott of significant price increases.

The subcommittee organized its work by fuel sources: coal, oil, and gas.

II. Coal

A. Potential

We are in no danger of running out of coal in this century. President Carter's goal of doubling domestic coal production from 600 million to 1.2 billion tons by 1985 is,

however, an unrealistic objective, given the current and expected additional environmental constraints Congress has imposed on coal burning. Coal is America's richest existing energy source—accounting for 90% of all proven U.S. fossil fuel resources. Yet New England's coal utilization currently comprises only 1% of the region's energy consumption. During the last twelve years more than 20 N.E. utility boilers have switched en masse from coal to oil for oil's economic and environmental advantages. The Arab oil embargo prompted Congressional passage of the Energy Supply and Environmental Coordination Act in 1974, mandating utilities return to coal-burning boilers wherever feasible. In New England, no one has yet converted back to coal, but New England Electrical Systems (NEES) is planning conversions in two or three boilers at Brayton Point, Somerset, MA in the early 1980's.

In New England today 11 utility boilers are under Prohibition Orders from the Department of Energy to convert from oil to coal. According to a study by the New England Congressional Caucus' Energy Task Force, we can save 22 million barrels of residual oil annually if all eleven boilers do convert. This represents 30% of the total oil currently consumed by the utility sector. In addition, seven other boilers have received DOE issue notices of intent to issue prohibition orders. Should all 18 of these boilers convert to coal, coal use would increase by 6.9 million tons. This figure corresponds to a 37% saving of utility oil consumption, or a 7% saving in total petroleum consumed by the region.

There are also over 150 major industrial fuel burning installations in New England. They use about 50,000 barrels per day. At best the subcommittee feels 10% of these could be converted to coal, resulting in an additional ½ million tons of coal burned per year.

Currently nine steam-electric plants are projected to come onstream during the next 15 years in New England, but only one—Sears Island of Central Maine Power, a 600 MW unit—will be coal-fired. It would require at least 1.2 million tons of coal per year. Beyond the utility and industrial sectors, coal has no significant end-users in New England. By the late 1980's the most optimistic coal use scenario envisions coal comprising 6% of our region's total energy needs, amounting to approximately 8.4 million tons annually. It appears the most optimistic scenario will not be realized, since only three boilers will probably be converted in this time-frame, unless the nuclear option is eliminated.

By 1985 coal is expected to supply no more than 1-2% of the region's energy needs. Beyond 1985 coal consumption is more difficult to predict. Cost considerations loom critical to any long-term projection. The price of oil, prevailing environmental standards, the development of synthetic fuels from coal, the potential of the Narragansett basin, the demand growth rate and the future of nuclear significantly affect New England's need for coal after 1990.

B. Costs

The economics of coal conversion for both utilities and industrial customers in New England are at best only marginally attractive, even with coal-capable boilers. Existing sulphur emission standards are more rigorous than a decade ago, requiring the burning of more expensive low-sulphur coal and/or the addition of expensive flue gas desulphurization systems to treat high-sulphur coal. If 1.5 percent medium-sulphur coal can be burned without scrubbers, the fuel cost saving in burning coal might offset the additional costs of operation and investment in particulate control equipment. If scrubbers are required, a 150 MW plant may be forced to spend $20 million or more in pollution control equipment. The addition of scrubbers also reduces the unit heat rate of coal-burning, reducing the plant's efficiency. The fly ash and sludge wastes generated by pollution control's equipment create costly and difficult disposal problems for utilities,

many of which lack the acreage for even temporary storage. The failure to control the emissions would result in the release of harmful pollutants into the air.

In previous reports to the Supply Committee, our subcommittee has indicated that the U.S. coal industry will be able to meet any foreseeable demand for coal in New England. The limit to the use of coal will be set by demand not supply. The cost of coal is likely to reflect the cost of mining in the Northern Appalachian region. Beyond 1985 additional mining capacity requirements may cause an increase in current costs of some 10% in constant dollar terms. Because coal is not expected to be in short supply its price, unlike that of natural gas, it is not expected to reflect the cost of alternate imported oil fuel. Competition within the coal industry is expected to maintain stability of prices. However, action by the UMW in successive contract negotiations, action by the federal government on health, safety and environmental control regulations, and action by state governments on severance taxes could cut into the relative cost advantage of coal compared with other fuels and may not be offset by productivity increases. Some allowance has been made for these factors in the following projection but it is recognized that the projection may be on the conservative side.

Table 2
Coal Price Projections
($/MMBTU in 1978 Dollars)

Items	1985	2000
Mining	$1.15-1.35	$1.27-1.46
Transportation	.39-.51	.39-.51
Pollution Control	.40-.50	.40-.50
Labor and Regulation	.21-.34	.21-.34
Total	$2.15-2.70	$2.27-2.81

For the electric utility market, coal will remain an economic option in many parts of the country and cost pressures are not likely to make it a more expensive option than nuclear in areas close to the coal fields. Should nuclear no longer be economically viable in New England, it would mean that it has ceased to be a viable option in the rest of the United States, since it is in New England more than in any other region that coal will have the greatest difficulty in providing competition.

C. Synthetics

The technologies for coal gasification and liquefaction are developing rapidly, but the costs are still uneconomical. Present estimates indicate that synthetic fuels will cost $30-40 per barrel in current dollars by the late 1980's when they become commercially available. Before 1990 they could not contribute significantly to New England's energy consumption. The subcommittee agreed that the benefits of synthetics from coal are too distant and speculative to be counted upon as a major contributor to our energy supply before 2000.

D. Narragansett Coal

The potential reserves, quality and extraction costs of Narragansett coal are still largely unanswered questions. The Weston Observatory estimates that at least 90.5 million tons of mineable coal lie beneath 60 of the 600 square miles in the region. Such a find would represent a BTU value of 1.8 quads or 310 million barrels of oil—one-half of the estimated total of New England demand in 1985. Yet the estimates are based on inadequate data—only twenty holes have been drilled to date. The anthracite (high fixed carbon percentage, low moisture) coal has been found largely in steeply dipping seams difficult to mine. This pattern, if representative, indicates expensive, unconventional mining techniques.

The quality of coal ranges considerably in the experimental drilling to date. A Portsmouth, RI hole yielded an anthracite low-sulphur, low-ash (10%) 13,000-14,000 BTU/lb. coal. Another hole in West Mansfield, MA yielded a high-ash (48.5%) impure coal with a .7% sulphur content. The Weston Observatory estimates the mined coal would sell for $50 per ton and generate $4.5 billion. Mining could not generate significant quantities until at least 1990. Because of the uncertain volume, quality, and mining difficulties, Narragansett coal is not expected to contribute to New England's energy supply before 1990.

E. Contribution to 2000 Desirable Energy Mix

Coal is counted upon to provide about ten million tons per year for New England in 2000. While this is approximately ten times the current consumption level, it represents less than 25% of New England's future base-load electricity needs. Our region's reliance upon coal will be minimal compared to the future utilization of this fossil fuel elsewhere in the country. Beyond one New Hampshire plant, Brayton Point conversion, Sears Island, and one or two additional coal-fired electricity plants, the remainder of the coal utilization will be confined largely to industrial boilers.

III. Oil

A. Perspective

Diminishing our reliance on foreign oil is a priority. The weight of world opinion on the U.S. to cut our oil consumption in order to reduce the pressures faced by other countries competing for a limited OPEC supply, and our own difficulties generated by a worsening balance of payments situation militate for a strong policy redirection. The subcommittee is agreed that our reliance on foreign oil is a major hindrance to the region's improving its energy cost-competitiveness with the rest of the country. Oil represents 80% of New England's energy use versus 47% for the nation as a whole. Imported oil accounts for 79% of New England's petroleum use, versus 48% for the entire country.

The lack of cheap natural gas and coal are the primary factors responsible for making New England's energy costs 30% higher than the rest of the country, and explain our disproportionate reliance upon imported oil. The subcommittee is seeking to reduce our reliance on foreign oil without exacerbating our cost-disadvantage with the rest of the country.

B. Availability

In 1976 we consumed 401 million barrels of petroleum in New England, or about 1.1 million barrels per day. Congressional Research Service estimates of 1985 U.S. oil and natural gas liquids production range from 9.5 to 13 million barrels of oil per day. Today the U.S. produces about 10 million barrels per day. In 1970 the U.S. produced 11 million barrels daily.

The high 1985 figure assumes locating new fields in the frontier area of the lower 48 states and Alaska. Estimates of total oil reserves yet to be discovered range from a high of 590 billion barrels (USGS 1962) to a low of 72 billion barrels (Hubbert 1974). The oil companies' estimates range between 88 and 118 billion barrels. Higher than predicted price rises may increase the level of estimated economic reserves. The Department of Energy and Exxon estimate domestic oil production will be between 9 and 9.9 million barrels per day respectively in 1985; they estimate that 10.9 million barrels per day of imported oil will flow into the U.S. in that year. Last fall the figures were 9.5 million barrels domestic and 8.9 million barrels imported oil per day.

C. Costs

The subcommittee has reviewed a representative sample of international oil supply forecasts for the period 1978 through 2000. It has rejected the most pessimistic (CIA) and optimistic (Stanford Research Institute) of the forecasts. The remainder predict that oil supply will be adequate to meet demand at current price levels for at least a decade. Eventually the supply situation will tighten to force an upward movement in prices in constant 1978 dollars. (Prices in current dollars are expected to move upwards with inflation throughout the period.) The subcommittee recognizes that it is very hard to predict when this supply tightness will occur. It could be as early as the late 1980's and as late as the late 1990's. It considers the most likely scenario to be the average of the forecasts and typical of more recent forecasts which would indicate tightness developing in the mid-1990's.

Such a scenario would suggest a constant price for oil in 1978 dollars until 1995 with a substantial increase thereafter. However, the subcommittee believes that in order to avoid a sharp jump in prices in the mid-1990's, OPEC with the tacit consent of the U.S. and other consuming nations will begin to increase the real price of oil once the current glut created by initial supplies from Alaska and the North Sea has been absorbed and the balance of payments between oil producers and consuming nations have been brought into better equilibrium. The subcommittee believes that some increase in the price of oil in 1978 dollars is likely to occur from 1983 onwards.

Accordingly its price forecast is as follows.

Table 3
Oil Price Forecast 1978-2000
(In 1978 Dollars)

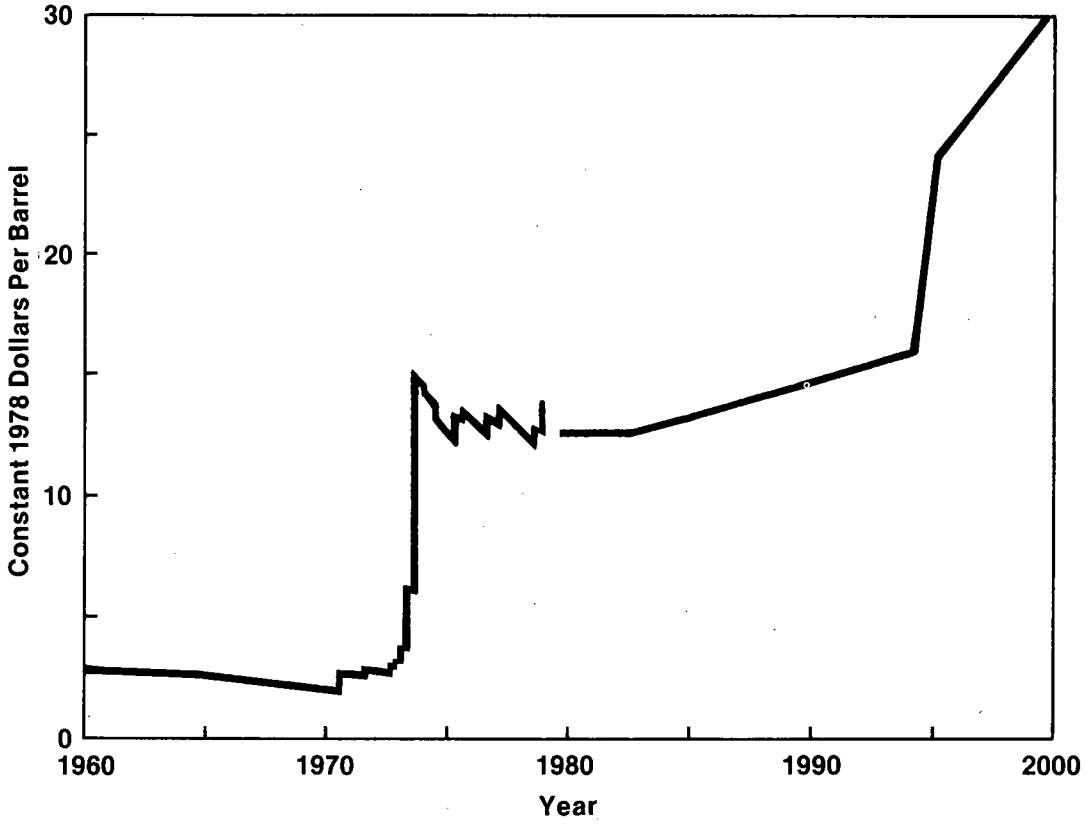
	Arabian Light		#6 Fuel Oil (.5% Sulfur)		#2 Heating Oil		Unleaded Regular Gas
	$/BBL	$MMBTU	$/BBL	$/MMBTU	¢/Gal	$/MMBTU	¢/Gallon
1978	12.70	2.19	14.88	2.37	48	3.46	65
1985	13.48	2.32	15.79	2.51	51	3.68	74
1990	14.88	2.57	17.43	2.77	56	4.04	81
1994	16.11	2.78	18.87	3.00	61	4.40	87
1995	24.17	4.17	28.31	4.50	91	6.56	129
2000	30.85	5.32	36.13	5.75	117	8.44	163

The subcommittee has a further caveat about the adequacy of supplies between now and 1995. Political disturbances, both internal and external, could disrupt supplies from one or more major producing countries at any time throughout this period. Our supply is very fragile depending as it does on the production of a very substantial volume of oil by Saudi Arabia and Iran which supply 30% of the total Free World availability. The subcommittee urges that policy recommendations to the Congress which include measures to reduce the impact of possible supply interruptions.

D. Contribution to Desirable 2000 Energy Mix

The committee has reduced oil's percentage of the region's total energy needs in 2000 from 80% to about 50% in its desirable fuel mix. Assuming a 1.5% annual growth rate, this still represents about one million barrels of petroleum per day. If the alternatives projected do not achieve their desirable potential, we could expect as much as 1.1

FIGURE 8
Past and Projected Price of Arabian Light Crude Oil
1960-2000



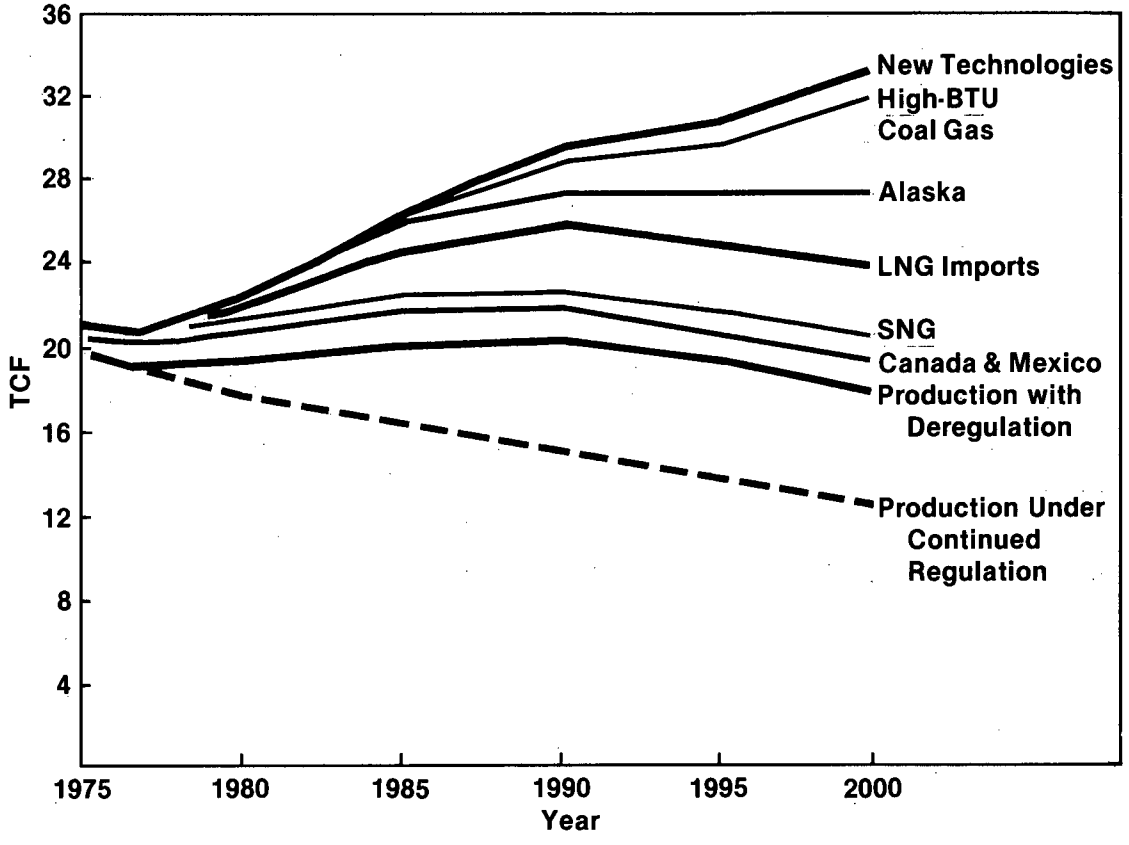
million barrels daily. Demand for residual oil is expected to decline considerably as we supply future electricity stations with nuclear, coal, and alternatives. Gasoline demand is expected to decrease slightly during the next twenty-two years. Slow population growth, the tougher EPA mileage standards, and higher gasoline prices provide the sources for this estimate. Distillate oil demand should remain close to current levels two decades from now. Conservation, direct solar, and natural gas are expected to fill many of the water and space heating functions now provided by distillate.

IV. Gas

A. Perspective

The action Congress has taken to change the regulated price structure of domestic natural gas determines to a great extent the potential availability and cost of this fuel to New Englanders in 1985 and beyond. The impact of price regulations upon natural gas has damaged New England more than any other section of the country. Two deleterious effects can be attributed to our legacy of regulated prices: (1) we have gone from a national surplus to a deficit supply situation since 1954; and (2) the allocation of newly discovered gas has been disproportionately channeled into the intrastate markets, worsening the shortage for many regions, particularly New England. Our region's inability to procure more than 1/3 of the national average consumption (9% vs. 27%) of the country's cheapest and cleanest burning fossil fuel explains more than any other single factor New England's disadvantageous energy position relative to the rest of the

FIGURE 9
Future Sources of U.S. Gas Supply



Source: American Gas Association, 1976

country. Farthest from well-head production, with substantial unused transmission and distribution capacity, New England also pays a great deal more for the scarce gas we do receive: residential consumers pay about 70% more than do consumers nationwide. Narrowing the region's energy cost differential with the rest of the country requires in part: 1) increasing the cost of gas; and 2) enabling our region to purchase more of it as long as it is economical to do so.

B. Availability

In the U.S. gas accounts for 36% of all energy produced today. Estimated U.S. reserves range from 700 to 1200 trillion cubic feet (TCF), enough to supply the country at our current 20 TCF/year rate for 35-60 years. Worldwide recoverable resources are estimated at 10,000 TCF, or 200 times current annual world production. The American Gas Association estimates that annual production of lower 48 states' gas under deregulation will be 24% higher in 1985 and 38% higher in 1990 than under continued FERC regulation. With appropriate federal subsidies unconventional gas resources—geopressured reserves, high BTU oil shale gasification, synthetic natural gas from biomass (SNG), liquefied natural gas (LNG) and others—can contribute 5.5 TCF by 1985 and 14 TCF by 2000. In the year 2000 the AGA estimates that conventional and supplemental gas resources could generate 32 TCF yearly in a deregulated market. This represents 33 quads.

Natural gas could triple its contribution to the region's supply by 2000. The existing transmission infrastructure (pipeline) can handle 30% more gas by merely adding more compressing stations to the current pipeline—from 900 million to 1.2 billion cubic feet per day. The 15% of the market which is now hooked up along existing mains can be expanded to 35%. Only 56% of all New England households with gas for stoves and water heating use gas for space heating, compared to an 80% average nationwide. Total New England consumption could increase from the 250 billion cubic feet annually to 760 billion cubic feet per year using the existing distribution infrastructure. This represents the energy equivalent of approximately 1/4 of our current energy consumption.

C. Costs

Today natural gas is expensive relative to the rest of the country: approximately $3.40 per million BTUs to residential consumers versus $2.00 nationwide. The wholesale costs to utilities average 40-65¢ higher than the U.S. average, historically closer to the lower end of this range. In 1985, in a deregulated market, gas prices should track #2 oil prices for New England. Assuming 2% infrastructure real cost increases yearly, prices to consumers should range between $3.66 and $4.26 per million BTUs, depending in part upon the expansion in the rate of gas usage in the region.

In a deregulated market, the well-head price of gas will rise; but if as expected additional availability results there will be savings in distribution costs from greater utilization of distribution facilities. Although the natural gas compromise was passed by the Congress, uncertainties remain as to the volume of additional natural gas that will be produced. If a substantial proportion of additional supplies has to come from LNG imports or synthetics from coal, incremental raw material costs will be significantly higher than projected.

D. Contribution to 2000 Desirable Energy Mix

Deregulation and favorable state regulatory actions designed to promote the use of natural gas in N.E. promise the desirable and feasible potential of the equivalent of 270,000 barrels of oil daily in 2000. This represents a doubling of natural gas's current contribution of 275 billion cubic feet per year. The committee felt a 3.2% yearly increase in natural gas consumption should be encouraged to diminish our reliance on foreign oil and allow the burning of the cleanest fossil fuel.

Nuclear Subcommittee

I. Perspective

The role of nuclear in the region is more extensive than in the rest of the country: one-third of our current electricity needs are now met by nuclear, versus 12% for the country at large. Our region's unique energy mix and future energy objectives encourage an even greater reliance upon nuclear from now until the end of the century. Yet nuclear's future is clouded by regulatory delays, cost escalations, perceived safety problems, and citizen opposition. The industry's recent trend of constructing very large plants (1000 MW and larger) also makes planning for new nuclear construction more sensitive to vacillations in energy demand, especially given the long lead time required for nuclear licensing and construction.

II. Availability

The Nuclear Subcommittee has agreed to nuclear's potential for N.E. in 1990 and 2000. (Table 4)

Table 4
Potential Nuclear Capacity
(MW)

Year	Capacity (MW)
1978	4,189
1985	7,569
1990	13,319
2000	15,619

III. Costs

Future costs have consumed most of the subcommittee's attention. The subcommittee estimated the future costs in constant dollars of a nuclear plant brought on line in 1990. Since the planning, licensing, and construction period for a nuclear plant requires twelve years, this exercise is relevant for today's planning. After three full days of discussion, hundreds of hours of research, and the active participation of several of the region's more knowledgeable people in this field, the subcommittee agreed on a range of bus-bar costs between 3.9¢ and 4.1¢ per kilowatt hour. In contrast, today's existing plant generating cost figures reveal that nuclear is the cheapest of the conventional fuels. A New England utility survey conducted by the Atomic Industrial Forum reveals these N.E. total generating cost figures for 1976 in 1978 dollars: coal 2.5¢; oil 3.3¢; and nuclear 1.7¢. In 1977, nuclear was 1.7¢ and oil 3.4¢.

The subcommittee positions on the cost issue reflects a general uncertainty about the future costs of nuclear facilities in New England. Two subcommittee reports, with differing assumptions and methodologies, are included in this report to indicate how the range of costs was determined. The greatest divergence occurs in the projection of capital costs and capacity factors. While one member believes nuclear construction costs have increased at a rate of 22% per year, including inflation, from 1970–1976, three members feel the real cost escalation will be less than 3% per year, or 8.2 % yearly, including inflation. Capacity factor estimates are 69% and 60% respectively.

IV. Contribution to 2000 Desirable Energy Mix

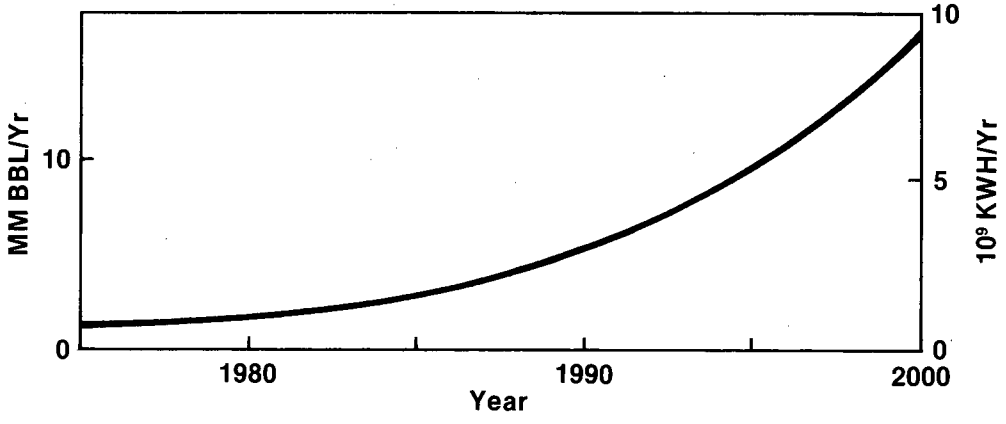
The full committee has agreed to a range of nuclear generation from approximately 7600 MW (200,000 barrels equivalent) to 15,000 MW for the year 2000. Our region's current nuclear capacity is 4189 MW. The percentages of baseload generation represented by these numbers are 33% and 66% respectively in 2000. The 7600 MW capacity assumes a 2.2% electricity demand growth rate and the achievement of the optimal contribution projected for the alternatives. If the growth rate is higher than 2.2% and/or the alternatives do not realize their potential, nuclear's contribution would be larger.

Alternatives Subcommittee

I. Perspective

The subcommittee feels that New England should receive a substantial infusion of federal financial incentives to support the development of renewable energy sources. Specifically, the region requires 7½-10% of the national funding allotted for research and development, demonstration programs, loan guarantees and grants for renewables—despite a population

FIGURE 10
Wood Electricity Contribution to Supply Mix
1975-2000



Assumptions: **Wood-electric generation is assumed to grow 12% per year from its estimated 1977 value of 0.7 × 10^9 KWH, mainly in the pulp and paper industry.**

	MW	10^9 KWH/Yr	10^6 BBL/Yr
1978	160	0.8	1.4
1985 add	200	0.9	1.7
2000 add	1600	7.8	13.9
Total	1960	9.5	17.0

Capacity Factor: 0.55

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comprising only 6% of the national total. The subcommittee considers this report both equitable and necessary for three reasons:

1) The national objective to reduce our reliance on OPEC oil must focus on New England, which consumes 20% more oil per capita than the rest of the country.

2) New England pays higher prices for energy than the rest of the country—26% higher in 1976 than the national average.

3) New England, which is resource deficient in fossil fuels, is relatively rich in untapped renewable energy sources. Our potential for wood, low head hydroelectric, solid waste, wind and tidal energy is as promising, or more promising, than in the rest of the country. Our economic disadvantage relative to the rest of the country makes direct solar an attractive alternative for the region.

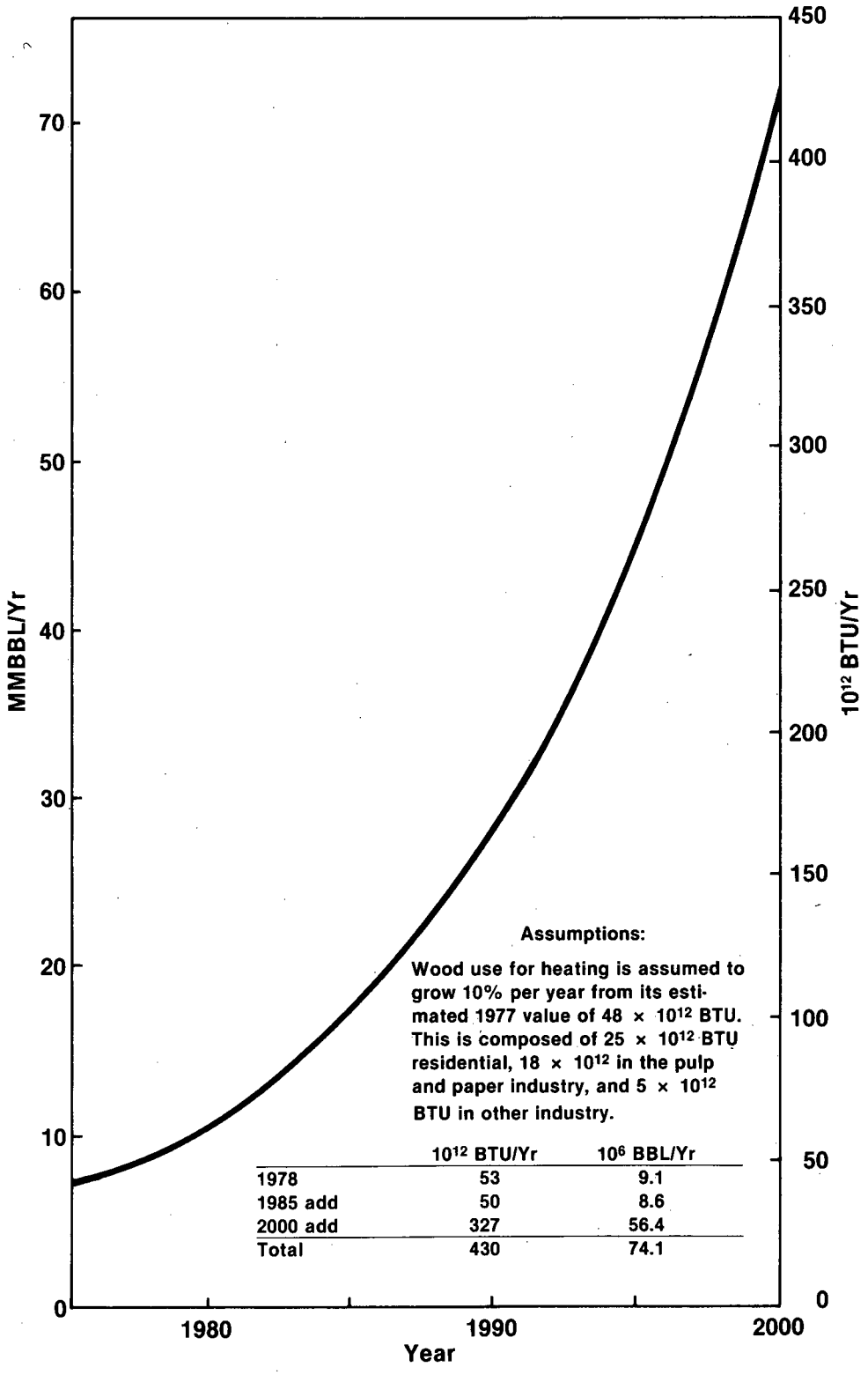
The subcommittee approached its tasks of estimating availability costs and desirable contributions of renewable energy sources with this premise paramount in their deliberations.

II. Wood

A) Availability

Wood may be New England's most promising renewable resource over the next 25 years. Over 80% of the region is forested. Most of New England forested land is classified as commercial forest (capable of producing more than 20 cubic feet of industrial wood per acre per year). New England has more than 32 million acres of commercial forest land, over 2/3 of which is not owned by forest industries. Wood can be used to generate

FIGURE 11
Wood Heating Contribution to Supply Mix
1975–2000



Assumptions:

Wood use for heating is assumed to grow 10% per year from its estimated 1977 value of 48 × 10^{12} BTU. This is composed of 25 × 10^{12} BTU residential, 18 × 10^{12} in the pulp and paper industry, and 5 × 10^{12} BTU in other industry.

	10^{12} BTU/Yr	10^{6} BBL/Yr
1978	53	9.1
1985 add	50	8.6
2000 add	327	56.4
Total	430	74.1

electricity, process steam, provide district heating, automobile fuel, and heat homes. Dry wood has an average value of 8500 BTU/lb.

The annual potential yield for the region's forest is impressive: by 1985, New England could provide over 650 x 10^{12} BTUs from wood heating and wood-electric sources. By 2000, the potential renewable yield rises to 860 x 10^{12} BTUs. Mill and logging residues, land clearings, diseased, dead, and undesirable standing trees, thinnings from overstocked pole-sized acreage, annual surplus growth of tree parts not merchantable and biomass plantations represent the energy sources from New England's wood. Except for the harvesting from land-clearings, overstocked acreage, and diseased, dead and undesirable standing trees—which are harvested theoretically over a twenty year period—the wood energy sources are sustainable. Yet the sustainable yield in the twenty-first century will decline steadily as the one-time yields are harvested. Therefore, wood energy must be looked upon as a major transition fuel for the remainder of this century, and not as a large contributor to the supply needs of the next century. Much of the wood energy available will provide space heating to the residential and commercial sectors, particularly in northern New England. Additionally, the forest industries, by moving towards energy self-sufficiency, could utilize wood to supply 90% of their needs and 4% of the region'total energy consumption.

B) Costs

Cordwood is delivered today for $45-$65 in northern New England; and $80-100 in metropolitan areas. Assuming 50% efficiencies for both wood stoves and oil boilers, northern New England wood is $2-4 cheaper than fuel oil per million BTUs, and $4-6 cheaper than electricity for space heating. In Boston, wood selling at $100 per cord is competitive with electricity, but it will not be competitive with fuel oil until its price approaches 75¢ per gallon (it was 60¢ per gallon in March, 1979). With a rapidly expanding market all over New England the regional differential should close somewhat in future years. A draft of a recent Maine study indicates that new wood furnaces in that state will cost the average homeowner the same as an existing oil furnace in annual costs ($474/yr.).

Burlington Electric's 10 MW plant costs 23 mills/KWH at the busbar on a 75% wood/25% oil over-fire basis. They expect their 50 MW boiler to generate electricity in 1983 at 34.7 mills (1978 dollars). Competition with the pulp industry may drive prices up, but the dimensions of real price increases are difficult to predict. The committee estimates 1-2% yearly real price increases in wood fuel.

C) Contribution to 2000 Desirable Energy Mix

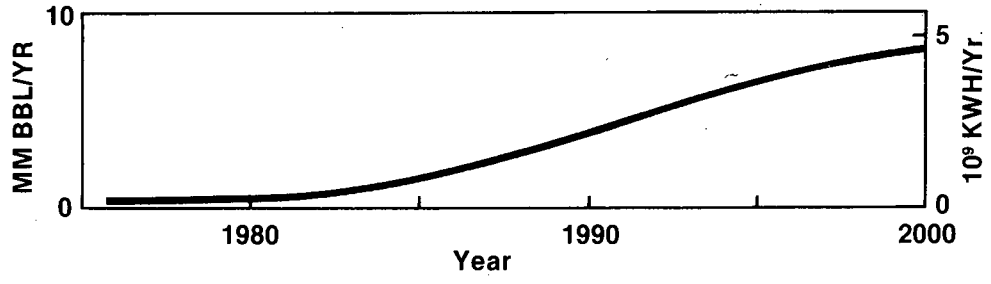
The expected desirable and feasible contribution of wood to our energy mix is 535 x 10^{12} BTUs, or the equivalent of 90 million barrels of oil per year, more than 20% of our current oil consumption. This represents 60% of our available yearly resource between now and 2000, and a 10% yearly growth from out present consumption of approximately 50 x 10^{12} BTUs per year. If the forest industry achieves 90% energy self-sufficiency, if appropriate financial incentives are offered wood producers and consumers, land owner attitudes become more favorable, and oil prices continue to escalate, this objective can be realized.

III. Solid Waste

A) Potential

Electricity generation from urban solid wastes is an economical proposition today. The 1978 market potential for electricity production is 480 MW. By 1985, 730 MW could constitute the market potential as the population increases, metropolitan concentration

FIGURE 12
Solid Waste Contribution to Supply Mix
1975–2000



Note: 1985 estimates refer to projects presently being planned or considered.

Assumptions:

	MW	10^9 KWH/Yr	10^6 BBL/Yr
1978	25	0.2	0.3
1985 add	95	0.8	1.1
2000 add	610	3.6	6.9
Total	730	4.6	8.3

Capacity Factor: 0.55

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continues, and smaller towns join together to plan regional facilities. This larger capacity represents 7.5 million barrels of oil. If all urban refuse in New England was used to fuel electric generating plants, utilities could cut their present day residual fuel imports by 22%. By 2000, 1100 MW, providing 58 x 10^{12} BTUs of electricity at a 55% capacity factor could be generated.

B) Costs

A currently operating 1200 ton per day Saugus, MA. plant cogenerates steam for $2.50 per million BTUs—a cost-competitive figure today. Building future installations which range between 100 (5MW) and 3000 (60MW) ton waste capacities, the region can build approximately 30 plants in the next decade which should generate electricity selling for the same rate as larger scale fossil fuel or nuclear plants. The capacity to cogenerate steam and the additional service performed by reducing community disposal and landfill dilemmas may promise an attractive economic potential for solid waste electricity generation over the next twenty-five years.

C) Contribution to 2000 Desirable Energy Mix

The solid waste contribution to the 2000 desirable energy mix is 48 x 10^{12} BTUs or 730 MW of capacity. This is a realizable target if the recommendations suggested are enacted. Such a role for solid waste envisions scores of small (5-10MW) facilities servicing medium-sized cities (50-100,000 population). Additionally, every city or metropolitan area with a population over 100,000 is projected to have a solid waste facility.

IV. Solar

A) Availability

Solar hot water and space heating has a large potential for New England's residential and commercial sectors, but federal financial incentives will have to be

Table 5
Total Potential
(10^6 BBL/Yr. Saved)

	Residential	Commercial	Total
Retrofits	5.9	3.8	9.7
1979-1985 new	7.2	4.7	11.9
1986-2000 new	19.0	12.4	31.4
Total	32.1	20.9	53.0

Assumptions:
A) Insulation: Demand per house is projected to decrease 25% in existing stock and 50% in hew housing due to improved insulation and passive solar designs.
B) Efficiency: Fuel saved is calculated on the assumption that fossil fueled furnaces are 65% efficient (80% in the commercial sector).
C) Retrofit-residential:
1) 48% of single family units can be retrofitted (1,050,000).
2) 10% of these can space heat with 600 sq. ft. (105,000).
3) 90% will water heat with 100 sq. ft. collectors (945,000).
4) 48% of duplexes will also water heat (490,000 units).
5) The collectors convert 25% of incident sunlight to heat.
D) New Housing-residential:
1) 100,000 units are built per year.
2) 75% install solar space and water heating.
E) Commercial/Industrial:
1) Penetration of the market will parallel residential.
2) Present fuel consumption for space and water heating is 80% as great as in the residential sector.

forthcoming and institutional barriers removed for that potential to be realized. Potential availability, expressed in millions of barrels of oil equivalencies, is estimated for several end-use categories and time periods. (Table 5)

B) Costs

Solar heating is competitive today with electrical resistance heating at $35/ft.^{2}. To be competitive with oil and gas by 1985, the price per square foot (construction, operation and maintenance, 25 year life) must decline to $10-$12/ft.^{2} to compete with #2 fuel oil. Presently the initial cost varies between $20 and $40. The Department of Energy projects collector costs at $8-20/ft.^{2} by 1985. Active solar cost comparativeness hinges on more separate factors than any other fuel. Inflation, fuel escalation and prevailing interest rates are three general factors which affect solar's cost competitiveness. Additionally, local taxation policy and meteorological conditions at building locations are site-specific factors which have large impacts on solar's economic viability. Although difficult to separate from building costs, passive systems are competitive today. Present estimates state that passive systems for space heating cost between $10 and $20 per square foot.

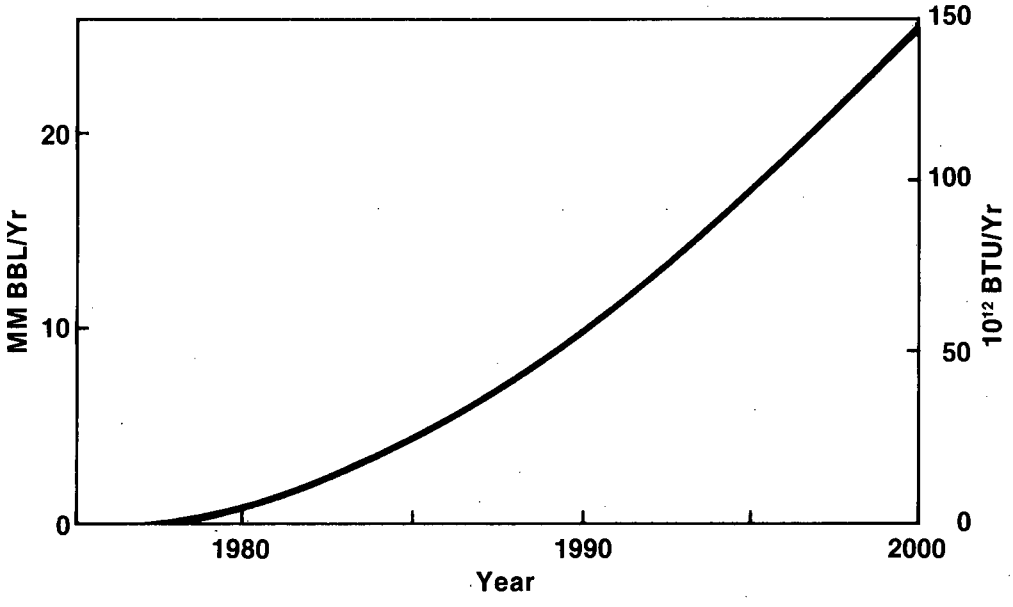
C) Contribution to 2000 Desirable Energy Mix

By the year 2000, 144×10^{12} BTUs of direct solar energy can be provided to the region based on the following five assumptions:

1) 1.4 million homes (almost 37% of the total) are retrofitted by 2000 for solar hot water; 105,000 homes are retrofitted by 2000 for space heating (600 square feet of collectors).

2) 500,000 new homes (25% of the total) will install solar hot water by 2000.

FIGURE 13
Solar Heating Contribution to Supply Mix
1975–2000
(in terms of conventional fuel displaced)



Assumptions:

A. Retrofit residential (15% installed by 1985)

	# of units	%	10^{12} BTU/Yr
Solar Water Heating	1,400,000	36	26
Solar Water and Space Heating	105,000	3	8

B. New Residential to the year 2000

Solar Water Heating	550,000	25	9
Solar Water and Space Heating	650,000	30	45

C. Commercial / Industrial — — 56

D. Summary:

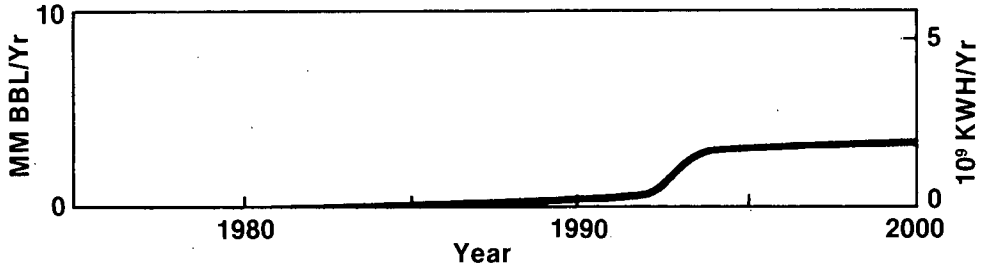
	Residential	Commercial	10^{12} BTU/Yr Total	10^{6} BBL/Yr Total
Retrofits	34	22	56	9.7
1979-1985 new	11	7	18	3.1
1986-2000 new	43	27	70	12.0
Total	88	56	144	24.8

3) 50,000 new homes (30% of the total) are fitted for solar space and water heating (600 square feet) by 2000.

4) Commercial and industrial sectors receive together 80% of the collector space which the residential sector receives.

5) Delivered heat divided by 65% to calculate in terms of fossil energy saved (80% in commercial sector).

FIGURE 14
Tidal Power Contribution to Supply Mix
1975–2000



Assumptions:

		MW	10^9 KWH/Yr	10^6 BBL/Yr
1985	Demonstration Project	12.5	0.04	0.07
2000 add	Cobscook Bay Project	500	1.18	2.14
add	along upper Maine coast	200	0.61	1.09
Total		712	1.83	3.3

Capacity Factors: 0.27-0.35

V. Tidal

A) Potential

By 1985 tidal power could provide a capacity of 12.5 MW of electricity, and by 2000 an additional 380 MW. This capacity could deliver .038 x 10^9 KWH in 1985, and 1.29 x 10^9 KWH in 2000. These figures represent .39 x 10^{12} BTU and 13.42 x 10^{12} BTU respectively, or .07 million barrels of oil in 1985 and 2.30 million in 2000. This potential is based on individual single-pool systems in Cobscook Bay (U.S. Corps of Engineers, All-American project, Half Moon Cove Demonstration Project, and other sites along Maine's upper coast).

B) Costs

Estimates of average power costs range from 49.6 mills/KWH to 62.5 mills/KWH ($4.77-6.01/MMBTU). Capital costs, expressed in 1976 dollars, could vary from $1797/KW to $3600/KW. Cost discussion requires closer examination of variables and assumptions indicated in Normand Laberge's paper in the documentation section of this report.

C) Contribution to 2000 Desirable Energy Mix

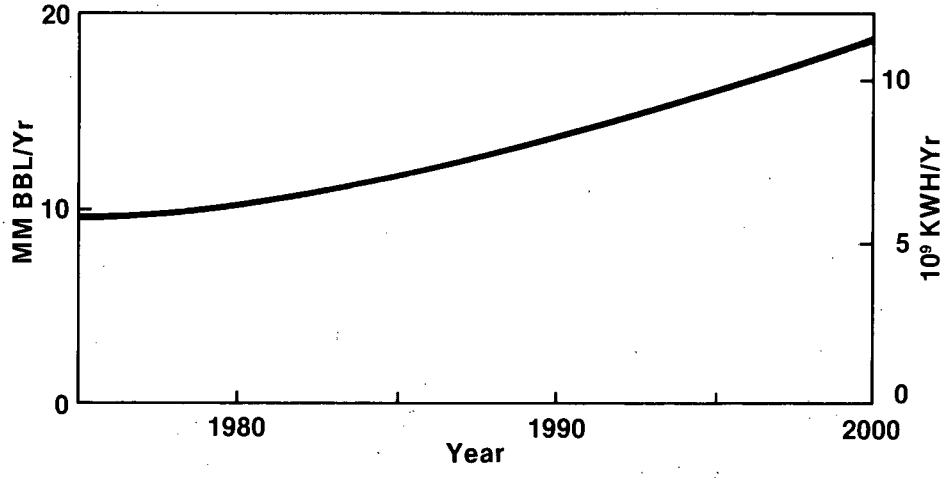
The desirable contribution for tidal power assumes that all of the planned projects will come on line. By so doing, 18.98 x 10^{12} BTUs can be generated in electricity from 792.5 MW capacity by 2000.

VI. Hydroelectric

A) Potential

The high scenario envisions 375 MW new additional installed capacity by 1985, and 1238 more new installed MW by 2000. This capacity could generate 1.13 x 10^9 KWH in 1985, and 5.32 x 10^9 KWH in 2000. These figures represent 11.75 x 10^{12} BTU in 1985 and

FIGURE 15
Hydroelectric Contribution to Supply Mix
1975-2000



Assumptions:		MW	10^9 KWH/Yr	10^6 BBL/Yr
1978	Present utility	1174	4.75	8.5
	Present non-utility	250	1.00	1.8
1985 add (4) "best sites"		195	0.42	0.8
and small scale		180	0.71	1.3
2000 add (4) "best sites"		195	0.42	0.8
and (3) "marginal sites"		193	0.42	0.8
and small scale		850	3.35	6.0
Total new hydro		1613	5.32	9.5
Grand total		3037	11.1	19.8

Capacity Factors: 0.245-0.46

55.33 x 10^{12} BTU in 2000, or the equivalence of 2.01 and 9.47 million barrels of oil respectively. This potential aggregates small-scale and conventional estimates. Capacity factors range between .19 and .50, depending upon specific sites and type of project. More detailed capacity and cost information is available in Laberge's paper. Existing capacity is 2695 MW.

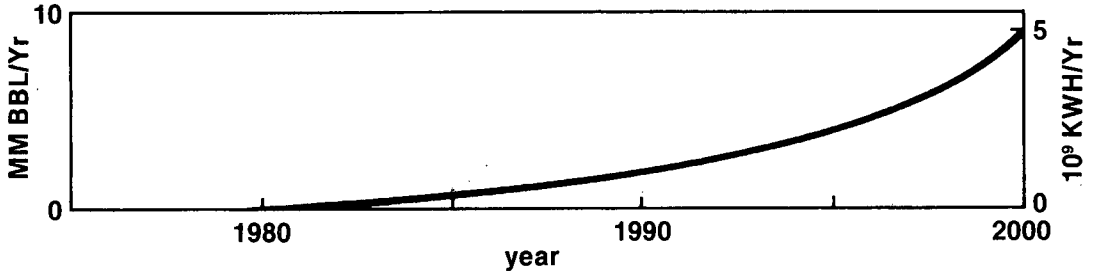
B) Costs

Proposed average power costs for a large project and a relatively small project (i.e. Black River) are 38.16 mills/KWH and 58 mills/KWH respectively. The cost of small scale hydro at existing sites is estimated to range from 35 to 50 mills/KWH in 1978 dollars.

C) Contribution to 2000 Desirable Energy Mix

The desirable contribution for new hydroelectric capacity assumes 1613 MW by 2000. (Today we have 1217 MW in conventional capacity and 1477 MW with pumped storage). This total does not include Dickey-Lincoln. It does include almost 400 MW from the best sites identified by the Army Corps of Engineers, and 1030 MW from small-scale sites where there are existing dams. The total also includes 193 MW from "marginal" locations. Hydroelectric would generate 55.3 x 10^{12} BTUs in New England, in addition to the 99.3 x 10^{12} BTUs of existing hydro.

FIGURE 16
Wind Contribution to Supply Mix
1975–2000



Assumptions:

	MW	10^9 KWH/Yr	10^6 BBL/Yr
1985	150	0.4	0.7
2000 add	1670	4.4	7.9
Total	1820	4.8	8.6

Capacity Factor: 0.30

VII. Wind Power

A) Potential

New England, because of its geography and climate, is in a uniquely favorable position to use the wind to generate electricity. Wind speeds tend to be highest in coastal and mountainous areas. The region's long coastline (several thousand miles) together with the mountain chains — Berkshires, Green and White mountains — in the north and west provide numerous sites for locating wind generation units.

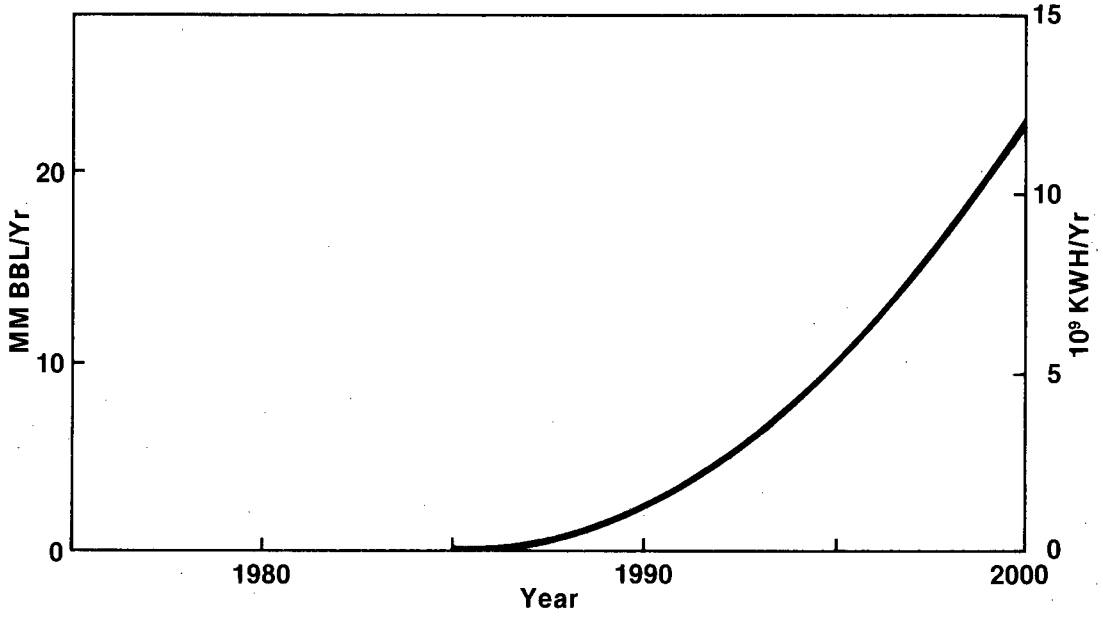
Wind generating facilities are normally divided into two categories, small wind energy conversion systems (less than 100 KW) and large systems (100 KW or greater). The small systems are most suitable for the residential market. The large systems will be utilized by utilities and industries. Large systems are only in the prototype stage, but small systems are now commercially available. It is anticipated that additional research end development will significantly improve both the design and economics of wind generating units and, as a result, the market for these units in the 1985-2000 period. The potential for 2000 is estimated between 5400 MW and 10,800 MW. With an average capacity factor of .3, annual electrical output could reach 14.28 million KWH, the equivalent of 160-320 trillion BTUs. This would displace 25-50 million barrels of oil annually.

B) Costs

There are only a limited number of wind systems in operation today and, thus, it is difficult to assess average costs. Estimates of current costs for wind generated electricity are 10-12¢/KWH for small systems and 10-20¢/KHW for large systems. DOE cost goals for both large and small units are 1-2¢/KWH by 1985. This goal is considered difficult to achieve but would allow these units to be effective competition in major markets.

Capital costs for small systems are now $2,000-3,000 per kilowatt of capacity. DOE predicts a $1200 per kilowatt cost by 1985 for newly designed systems and $750/KWH for mature systems. Larger systems are even more favorably priced: by 1985 prices are projected as $600-900 KWe for initial systems, and $400-600 KWe for mature systems.

FIGURE 17
Photovoltaic Contribution to Supply Mix
1975-2000



Assumption: **Will provide 10% of final electricity demand in the year 2000.**

2000 total: 4500 MW, 12.0 × 10^9 KWH/Yr, 21.5 × 10^6 BBL/Yr

Capacity Factor: 0.30

Subcommittee members recognized that the DOE projections might be too optimistic, but were unable to find independent evaluations.

C) Contribution to 2000 Desirable Energy Mix

Wind is targeted for 1820 MW by 2000, and 50 x 10^{12} BTUs of electricity. This total includes 1320 MW on-shore and 500 MW off-shore. The largest units are projected to be 2 MW, and most are expected to be much smaller.

VIII. Photovoltaics

The future deployment depends upon reducing the present $10 per peak watt cost to about $0.20-$1.00 per peak watt. Both the thin-film photovoltaic and the single crystal silicon technologies require further development and larger scale manufacture before costs can be reduced substantially. Small on-site application may be more feasible than large-scale power production, particularly because storage is a larger barrier to adapting this technology to use in power plants. While an American inventor, Stanford Ovshinsky, claims the development of inexpensive material for building photovoltaic arrays which could reduce the price to less than 10¢ per peak watt, and the Congressional Office of Technology Assessment released a recent study contending that small on-site photovoltaic facilities might be economically competitive with electric heating within 10-15 years, all estimates at this time are very unreliable. Joseph Loferski, Chairman of the Alternatives Committee and a national authority on photovoltaics, estimates that 10% of the region's electric requirements in 2000 can be met by photovoltaic systems. The subcommittee has accepted his prediction recognizing its speculative nature.

The committee projected an optimal contribution from photovoltaics of 12 x 10^9 KWH and 125 x 10^{12} BTUs for 2000. Rooftop systems would comprise most of that potential, with less than 100 MW estimated from central power stations.

IX. Peat

The subcommittee has not undertaken a comprehensive examination of this resource, but a preliminary report indicates that Maine in particular has a sizeable peat reserve. (See page 130.) Costs have not yet been estimated by the delegates, but the subcommittee does advocate the construction of prototype gasification and electric facilities. Based on their understanding of Ireland's successful experience with peat-electric stations, the subcommittee includes 1000 MW, or 50 x 10^{12} BTU, of peat-electric in their optimal supply mix for 2000.

X. Chicken Manure

The subcommittee has only taken a brjef look at this energy resource which promises to be an attractive venture for Maine chicken farms. A Des Moines, Iowa experiment in converting manure by anaerobic digestion to methane for 100 KWH of electricity generation and fertilizer has been very successful. Since Maine chicken manure alone offers the methane equivalent of 54.6 trillion BTUs, the subcommittee is committed to exploring this resource for the region. The committee includes in its optimal supply mix for 2000 1.0 x 10^{12} BTUs from chicken manure.

XI. Summary

The following tables and figures summarize the alternatives potential contributions and feasible contributions to the region's supply mix in 1985 and 2000. Table 7 is a projection of alternatives costs in this time period.

Table 6

Alternative Potential New Supply[1]

	1985	2000	MW	10^6 BBL/Yr	10^6 BBL/D
Non-electric (10^{12} BTU)					
Wood	580	760	—	130	0.36
Solar	125	307	—	53	0.14
Total	705	1067		183	0.50
Electric (10^9 kWh)					
Wood	6.7	9.6	2000	18	0.05
Solid Waste	4.6	7.0	1100	12	0.03
Tidal	0.04	3.0	1212	5	0.01
Hydro	1.1	14.5	3553	26	0.07
Wind	0.4	28.0	10800	50	0.14
Photovoltaic	0.0	12.0	4500	22	0.06
Peat	0.2	4.8	1000	9	0.03
Grand Total (10^{12} BTU)	840	1887		325	0.89

[1] This technical potential is generally considerably larger than the optimal supply chosen as a realistic target (see Table 8).

Table 7

Alternatives Costs in 1978 Dollars

	1978	1985	2000
Non-Electric ($/$10^6$ BTU)			
Wood	2.8-3.0	3.2-3.4	4.3-4.6
Solar[1]	15	8-9	8-9
Elecric (¢/KWH)			
Wood	2.1	3.5-4.5	4.1-5.2
Solid Waste	3.3-4.2	3.5-4.5	4.1-5.2
Tidal	5.6-7.1	5.6-6.7	5.1-6.3
Hydro	4.3-6.6	4.3-6.6	4.3-6.6
Wind	10-12	4.3-6.4	4.1-6.1
Photovoltaic	300	30	4.5

[1] Cost of delivered heat; not directly comparable to fossil costs.

Table 8

The Alternatives Optimal Contribution to the Supply Mix

	1978	1985	2000	MW	10^6 BBL/Yr	10^6 BBL/D
Non-Electric (10^{12} BTU)						
Wood	53	103	430	—	74.1	0.205
Solar	1	26	144	—	24.8	0.07
Manure	—	—	1	—	0.2	0.00
Total	54	129	575		99.1	0.275
Electric (10^9 kWh)						
Wood	0.8	1.7	9.5	2000	17.0	0.05
Solid W.	0.2	0.8	4.6	730	8.3	0.02
Tidal	0.0	0.04	1.8	712	3.3	0.01
Hydro	5.7	6.9	11.1	3037	19.8	0.055
Wind	0.0	0.4	4.8	1820	8.6	0.02
Photovoltaic	0.0	0.0	12.0	4500	21.5	0.06
Peat	0.0	0.2	4.8	1000	8.6	0.02
Total	6.7	10.0	48.6	13799[1]	87.2	0.235
Grand Total (10^{12} BTU)	124	233	1081		186.3	0.51

[1] Total MW is of limited significance because it conceals a wide variability in capacity factors and reliability.

FIGURE 18
Non-Electric Alternatives Contribution to Supply Mix
1975-2000

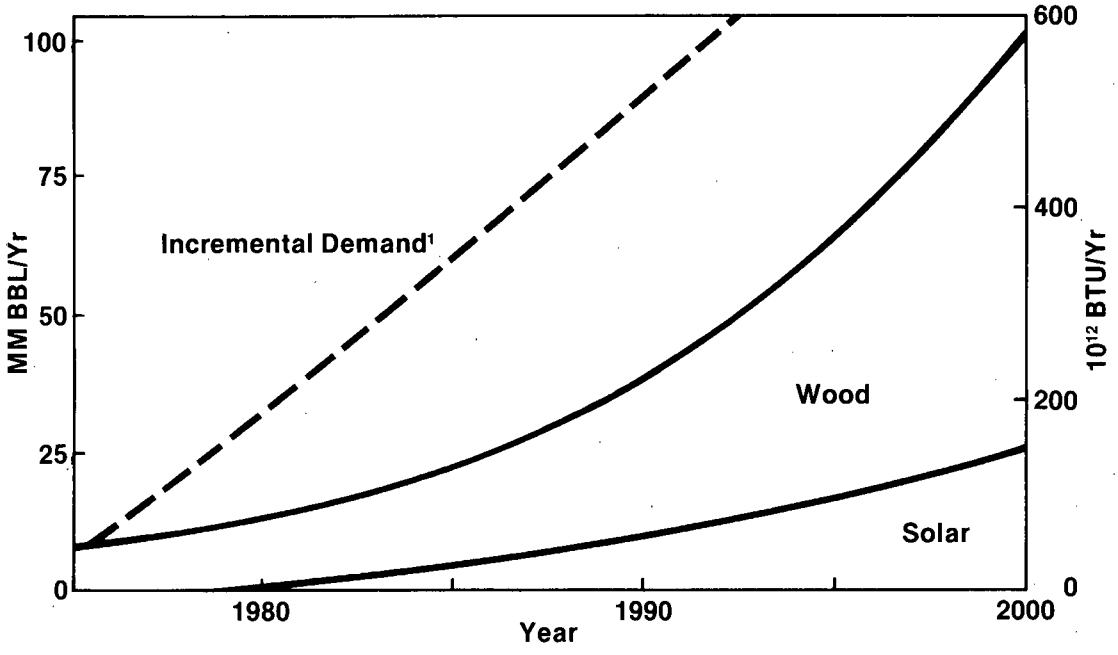
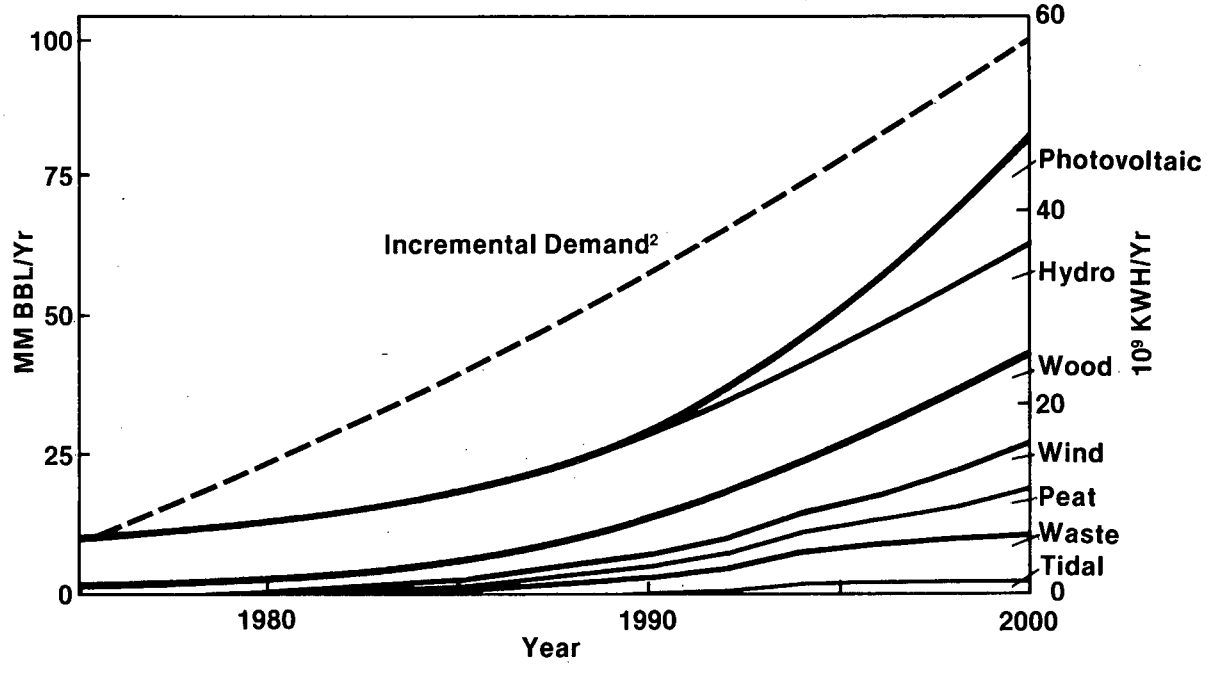


FIGURE 19
Electric Alternatives Contribution to Supply Mix
1975-2000



[1]Growth in total non-electric demand since 1976
[2]Growth in total electric demand since 1976

DOCUMENTATION

The following drafts have been submitted by delegates (there is one staff draft) as individuals or in small groups. These drafts formed the basis for availability and cost projections of each energy source. Some of the drafts also address environmental and institutional constraints, while others do not. Some of the documents also offer legislative recommendations, and others do not. They are included here to provide the explanation for the conclusions reached in the Availability and Cost Findings Section.

Coal in New England

(Submitted by Alan Cope)

Coal was once the leading source of energy in the United States and provided the dominant share of energy supplies to the six New England states as well. Today, although coal still accounts for some 90% of all proven American fossil energy resources, its share of the national energy market has dropped to below 20% of the total and in New England coal today accounts for less than 1% of total energy consumption in the region.

With proven, economically mineable reserves that are sufficient to provide coal for several generations, the prospects for a renewed growth in U.S. coal consumption are excellent. Last year, American bituminous coal consumption was 620 million tons and an additional 53 million tons were exported. Despite production lost during the UMWA strike last winter it is expected that 1978 coal production will approach 700 million tons.

Looking ahead to the mid-1980's it is likely that the U.S. can almost double coal production, approaching 1.2 billion tons per annum within 10 years. Certainly, the resource base and the technical ability to mine coal are present. Any limits to growth in coal use will come from public policy restricting coal burning for environmental reasons, or from consumer preferences for other fuels.

The decline in coal use that has now ended nationally, was due to the increased reliance upon less expensive and environmentally cleaner and easier to use substitute fuels, particularly oil and natural gas. Nationally, the electric utilities have become the dominant user of coal, with some three-quarters of total American coal output now going into electric generation. This market dominance is expected to continue for the foreseeable future.

However, in New England, the electric utitlities have shifted away from coal onto reliance upon imported residual fuel oil. As a result, the market for coal has almost disappeared. And, unlike other regions of the country, the prospects for a recovery in coal use in New England are not great.

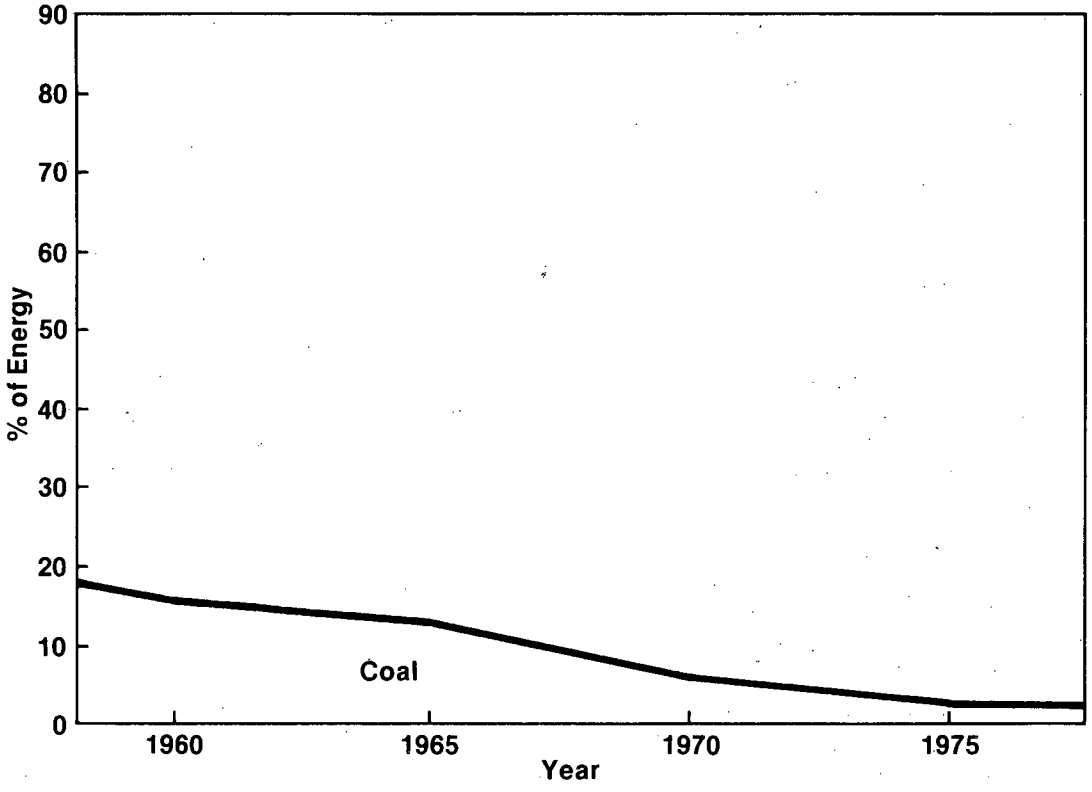
Consider recent history. As recently as 1966, coal was generating half of all New England electricity, and the direct burn by utilities in that year was 9.5 million tons. In 1966, an additional 1.4 million tons was used by other New England industries. Since then decline in coal has reached a point that it is used as the fuel for only 2.5% of the region's electric utility output and the total annual burn is below one million tons per year.

Whereas 24 utilities burned coal in 1966, today only the Public Service Company uses coal as a boiler fuel, at their Merrimack, New Hampshire plant.

The use of coal as a residential and commercial fuel has almost entirely ceased in New England. Certain industrial uses of coal remain, but coal accounts for only 0.6% of energy supplied to industries in the region at this time.

A loss of market share by coal can be attributed to the fact that other fuels are easier and cleaner to use and in most cases have been much cheaper as well. Demand for coal is not

FIGURE 20
Coal As A New England Energy Source



restrained by availability of supplies. All of the current demand for coal in New England could be met with the output of one medium-size coal mine.

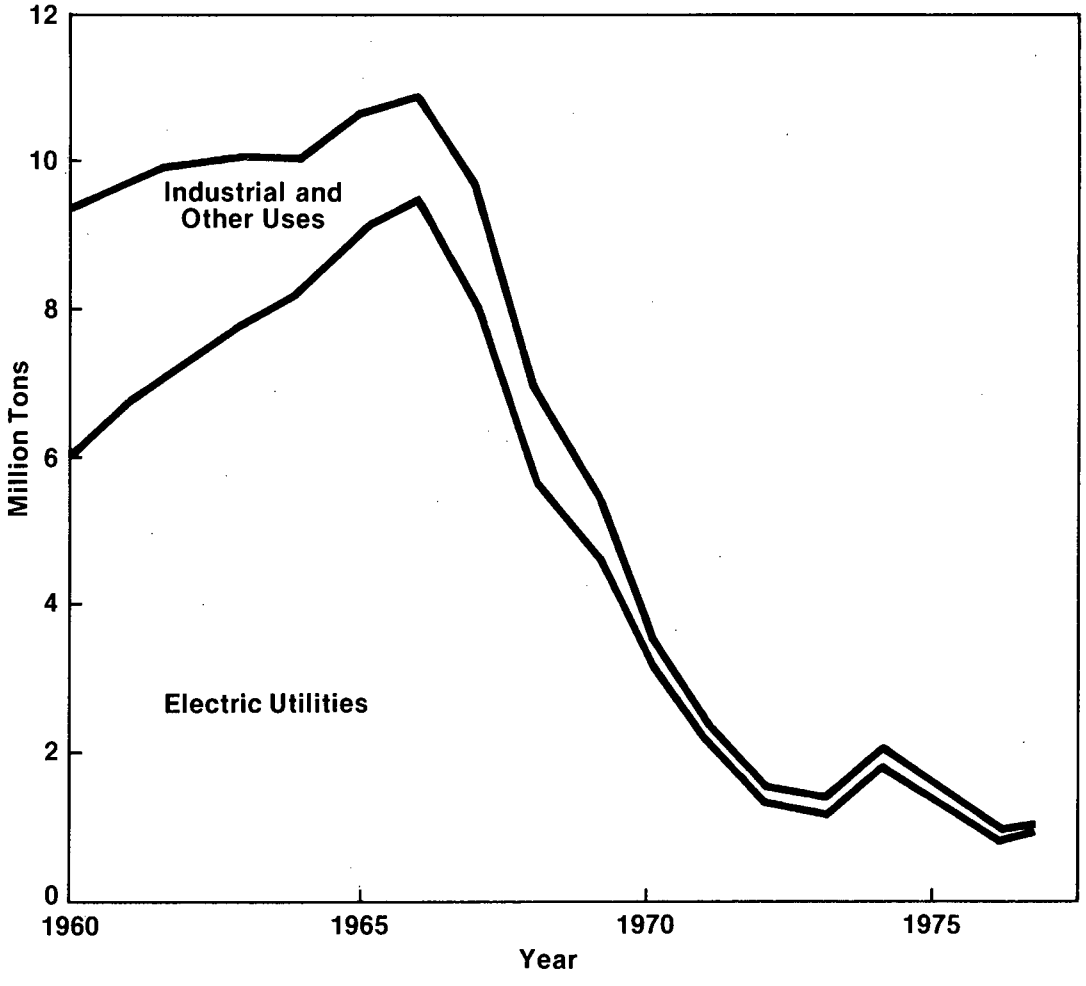
Instead of supply constraints, the outlook for increased use of coal in New England will be determined entirely by the attitudes of potential consumers towards coal as a potential source of energy. It is my opinion that we will find few consumers will be willing to voluntarily choose coal as their energy source in the future. Costs are likely to remain unattractive and the environmental and handling problems are certain to remain. Thus, I see no reason to anticipate that coal can ever make an important comeback as a fuel source in New England.

A maximum effort to reconvert those electric utilities capable of burning coal and to bring coal use in major fuel burning installations up to a significant fraction of total requirements could increase total coal consumption in the New England states by perhaps a factor of 10, but even that would mean that perhaps ten years from now, coal will be providing only 6% of regional energy supplies.

Today, almost all of New England's fossil fuel-based electric generating plants use oil. Yet at one time nearly all of them burned coal, and during the oil embargo it was possible for many of them to revert to coal use. The potential for substitution for imported residual oil by coal is significant, but the economic and environmental incentives are not there.

Several electric utilities have been ordered by the Department of Energy to convert back to coal from oil. Eleven utility boilers have been issued prohibition orders that would require this conversion. In addition, seven other boilers have had the Department of Energy issue notices of intent to issue prohibition orders. Should all 18 of these boilers switch back to coal, it would result in an additional coal market of some 7.0 million tons of coal per annum being generated.

FIGURE 21
Bituminous Coal Shipments to New England



There is another prospective industrial market for coal. According to Department of Energy statistics, there are over 150 major fuel burning installations in New England. Their use of oil at this time is about 50,000 barrels per day. This is a small proportion of total oil consumption. Should it be possible to convert, say ten percent of these major fuel burning installations to coal (and that is a somewhat optimistic observation) an annual market for coal of an additional 400,000 tons might be generated. Thus, combining the conversions of the 18 boilers and 10% of the major fuel burning installations with the present use of one million tons per year, we see that total New England coal demand might top 8.0 million tons per annum, about 6% of regional energy use, late in the next decade.

If New England possessed any coal reserves that might be mined if coal prices rose, one could hope that regional energy costs could be improved in the future. However, that is not the case. The only coal deposits in New England are those of the Narragansett Basin in Massachusetts. These anthracite coal seams were mined sporadically up to the early years of the last century, but the seam thickness and the other geological constraints on these deposits make them far too expensive to be cost-competitive with coals from elsewhere.

Despite the enthusiasm of some people about the Narragansett Basin as a prospective coal source for New England, it is the generally-held view in the coal industry that these coal beds are at present too serious an economic and technical disadvantage versus alternative coal sources to offer a means towards alleviating New England's high-cost energy situation in the near future at least.

Thus, it is my conclusion that coal has only a limited potential role to play in helping New England to get lower cost energy supplies, but despite that, coal could become quite a bit more important if certain social and political decisions were made.

If it was decided as a matter of social policy that the use of nuclear power in base-load electric generating plants was no longer acceptable, then it would become necessary for coal to take the place of nuclear in meeting future growth in electric demand.

It is most likely that coal use will not grow that quickly by reconversion, and there are few new big coal-burning projects underway.

At the present time, there are nine steam-electric plants projected to come onstream during the next decade in New England, only one of which is coal. That one, the Sears Island plant of Central Maine Power, a 600 megawatt unit, had originally been scheduled to be nuclear, but permit delays forced a switch in fuels to coal. If new steam-electric generating plants in New England were to substitute for uranium, then the picture would alter, although not dramatically, as New England electricity needs are not growing very quickly. Even a 1,000 megawatt plant would require only 2.5 million tons of coal per annum for its fuel.

The economics of coal conversion for both utilities and industrial customers in New England are at best only marginally attractive, even though the boiler may be coal capable in a physical sense. The cost of meeting present environmental laws is extremely high. Air quality standards relating to the removal of sulphur compounds impose requirements for expensive flue gas desulfurization systems that would involve outlays of tens of millions of dollars at each power plant. Capital investments on this order of magnitude quickly offest any potential fuels savings, and it is for that reason the utilities in New England have resisted strongly all federal efforts to force them to switch back to coal.

Unless nuclear is rejected for political and social reasons, I can see little likelihood that coal will matter greatly in the New England states. The locational disadvantages relative to the coal mines will remain a major cost deterrent, and the costs of overcoming environmental problems will remain prohibitive, although the transportation network of rail and barge links exists and the problems involved in unloading and coal storage areas could be resolved should purchasers come forward.

Manufacture of synthetic gas or liquids from coal could increase the use of coal as a New England fuel source. In the case of high-BTU synthetic gas, it would be less costly to make these synthetic fuels at the mine mouth and ship them into New England, than to build the synfuels plant in the region. Synthetic gas from coal, although more expensive than heating oil and conventional fuels today is in fact a less expensive source of energy for space heating than would be electric resistance heating derived from a newly-built coal-fired utility power plant. But at a cost of $5.00 per million BTU for high-BTU syngas, it is still more economic to use No. 2 distillate heating oil in New England as a space-heating fuels.

As regards the option of low or medium BTU syngas, these fuels could offer some modest economic advantage as a way to use coal at power plants, if work now in the pilot-plant stages proves out. However, gasification plants at utility sites, coupled with coal storage yards, could present a storage problem.

New England Coal Prices

I. Introduction

Estimates of economically recoverable U.S. coal reserves vary between 211 and 437 billion tons. Although these coal reserves comprise approximately 90% of the U.S. energy resource base, coal is used to supply only 1% of New England's energy requirements. This relatively low level of coal utilization in New England is the result of a number of factors.

1) *Energy Prices.*

After taking account of inflation, real coal prices increased between 1963 and 1972 by some 25%. During that same period, however, real oil prices fell by about 15%. This changing price relationship increased the demand for oil and decreased coal consumption in certain parts of the country.

2) *Transportation and Handling Costs.*

The costs of transporting and handling coal are considerably greater than the costs of transporting and handling oil. These cost differences increase the attractiveness of oil and decrease the attractiveness of coal.

3) *Environmental Regulations.*

Concern for the environment resulted in the passage of legislation in the late 1960's and early 1970's which set air quality standards. Coal capable of meeting these standards is expensive and the mechanical equipment capable of cleaning less expensive coal is costly to build and operate. These costs further handicapped coal in its competition with oil.

In addition to these historical factors which have helped to drive coal from the New England marketplace, a number of uncertainties loom on the horizon which could decrease coal's competitive position in the future. These factors include: Federal Mine Health and Safety Regulations, Federal Strip Mine Reclamation Regulations, Federal Miners Health Program Standards, United Mine Workers contract demands, and state severance taxes. While coal is no longer in direct competition with oil and gas in New England (oil and gas are prohibited as boiler fuels by current energy legislation), coal still must compete with nuclear power. Its ability to compete will once again depend on its price and the factors which influence that price.

II. Mining

A basic component of coal prices is the cost of mining the coal. Mining costs are influenced by such physical factors as the depth of the coal seam, the thickness of the coal seam and the amount of gas and water which must be removed to allow mining to take place. The bulk of the coal in the Eastern United States occurs in thin underground seams which are more expensive to mine than the relatively shallow, thick, western coal seams which can be mined by inexpensive surface mining methods.

The opening of a new underground mine requires a substantial capital commitment which is usually not made until the mining company has a firm long-term contract for the sale of the coal. Since the bulk of coal is sold under these long-term contracts, any substantial increase in coal demand would require the opening of new coal mines. The cost of these new coal mines can thus serve as a basis for estimating New England coal prices in the future.

The coal of choice for New England consumption is mineable in the region of Northern Appalachia, which extends through northern West Virginia into southern Pennsylvania. The coal in this region generally has a high energy content with low ash, both of which combined to minimize transportation costs. The sulfur content of the coal can range from medium to high.

Between now and 1985 there appears to be sufficient existing coal mining capacity to meet the demand for northern Appalachia coal at relatively constant prices. Depending upon sulfur content, this would mean coal prices in 1978 dollars between $30 and $35 a ton (for coal with 13 thousand BTUs per pound, the energy price is $1.15 to $1.35 per million BTU). Beyond 1985, increased demand and reserve depletion in existing mines may require that additional mining capacity be added in northern Appalachia. These newer mines would likely be higher-cost operations than the existing northern Appalachia mines and an increase in mining costs of approximately 10% by the year 2000 could take place. This mining cost increase could raise real northern Appalachia coal prices to between $33 and $38 per ton in constant 1978 dollars by the year 2000.

III. Transportation Costs

While the cost of coal at the mine is a major factor in coal prices, New England coal users must also pay to have the coal transported to New England. Because the cost of coal transport depends upon the location of the coal mine, the location of the power plant using the coal and whether the coal is transported totally by railroad, or via a combination of railroad and barge, there is no single cost of transporting coal to New England. A number of recent studies have examined the question, however, and they have all come to similar conclusions.

A Bechtel Corporation study done in 1975 estimated that the cost of a 600 mile unit train haul would fall between 1¢ and 1.4¢ per ton mile. The study determined that longer hauls were slightly less expensive with hauls of 1,000 miles costing between 0.9¢ and 1.1¢ per ton mile. These costs would appear to bracket New England's transportation costs because most hauls from the coal fields to points in New England would fall between 600 and 900 miles in length. These transportation charges would mean a delivery cost of $7 to $9 a ton on a 700 mile run.

A more recent study done by the New England Energy Policy Council in 1976 analyzed transportation costs to four power plants in New England.The study examined the options of shipping largely by rail with a short sea voyage by barge and compared this with a long barge voyage from ports in Virginia. The costs ranged from $9 to $12 per ton with the longer rail route being slightly less expensive. If these rates are applied to coal with the heat content of 13,000 BTUs per pound, they raise the price of coal by between 35¢ and 46¢ per million BTUs. If transportation charges are expected to keep pace with inflation throughout the forecast period, these transportation charges could be expressed as between 39¢ and 51¢ per million BTUs in constant 1978 dollars.

IV. Pollution Control Costs

A coal user also faces the costs of making coal use environmentally acceptable. The direct burning of coal releases large quantities of ash and sulfur dioxide into the atmosphere and environmental regulations strictly control the amount of each substance which can be emitted by coal-fired plants. In fact, new amendments to the Clean Air Act require that the best available pollution control technology be used on all new coal-fired plants even if relatively low sulfur coal is to be burned in the plant.

The costs of complying with these Clean Air regulations raises the costs of coal use in three ways: the costs of the pollution control equipment itself, the costs of operating that pollution control equipment and disposing of its waste products, and finally the costs associated with the lower electricity generating efficiency which occurs when the pollution control devices are installed.

Various studies have estimated that the direct capital costs involved in the installation of a flue gas desulfurization system (scrubber) capable of meeting today's standards range between $50 and $120 per kilowatt. Economies of scale make larger units less expensive per kilowatt than smaller industrial size scrubbers. Similarly new systems are less expensive to install than a system which

would have to be retrofitted on an existing installation. These capital costs can be combined with the cash operating expenses to produce a coal cost increase of between 40¢ and 50¢ per million BTUs in constant 1978 dollars.*

Since the new Clean Air regulations seem to require the use of scrubbers no matter what kind of coal is burned, there would not appear to be any premium associated with the use of low-sulfur coal. If the regulations (when they are finally issued) allow the use of low-sulfur coal in place of scrubbers, it would be reasonable to expect that low-sulfur coal prices would be 40¢ to 50¢ per million BTUs higher than high-sulfur coal prices.

V. Labor and Regulation Costs

A major element in the costs of underground coal mining is the cost of labor. Currently total labor costs average around $15 per hour or about half the price of a ton of northern Appalachian coal. The recently negotiated United Mine Workers contract contains provisions which allow for worker incentive programs designed to increase worker productivity. Hopefully, these productivity increases will offset future wage increase and result in no real coal price increase. Should productivity not keep pace with wage rates, however, either an increase in real coal prices or a decline in coal production could be expected.

A number of federal programs have also directly and indirectly affected coal prices. Recent federal strip mine legislation levies a tax on coal to fund a program designed to reclaim abandoned strip mines in the eastern states. Another federal program taxes coal to fund a program which treats miners with black lung disease. These taxes, when combined with the recent United Mine Workers contract agreement, are expected to raise coal prices in 1985 by between 21¢ and 34¢ per million BTUs in constant 1978 dollars. The increase in real prices in the year 2000 could be even larger if additional federal programs are enacted or if future UMW contract wage gains outstrip productivity.

VI. Outlook

Current federal energy legislation outlaws the use of oil and natural gas as boiler fuels in new base load utility power plants. Coal and nuclear power are thus the only fuels left to compete for the electric utility base load power plant market. Neither fuel by itself has such obvious cost advantages that it can drive the other fuel from the marketplace. Yet there are certain areas of the country which seem more likely to opt for a particular fuel choice.

Those areas of the country near the coal fields (east, central, and western) are likely to base their electricity generating systems largely on coal. Because they are located near the coal fields, they can minimize the transportation costs which form a major component in the costs of coal use. Similarly, by the time coal is transported to the coasts (Atlantic and Pacific), the costs of coal use in new plants tend to exceed the costs of nuclear power generation. These regions can therefore be expected to rely heavily on nuclear power. The dividing line between the regions will be the focus of the battle between coal and nuclear, and the boundary can be expected to shift depending upon the competitive nature of either fuel.

New federal legislation which raises the costs of either fuel will affect the region of coal/nuclear competition. A major new factor, however, could be the imposition of state severance taxes on coal as states in the mining regions attempt to gain for their citizens some of the

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**Forum Data Handbook for New England Energy Alternatives*, Volume IV, Supplement 4, Dec. '77, Mitre Corp., pp 39-45.

The Mitre Corporation study of coal prices in New England used projections of coal transportation and utility generating and scrubbing costs which generally parallel those used in this paper. The Mitre estimates of coal mining costs are a bit low, however, and probably stems from the fact that Mitre based its estimates on TVA contract prices. Since the TVA is the largest coal consumer in the nation, its market power is immense, and the prices TVA pays for coal may not be representative of the prices paid by other coal consumers. Therefore Mitre's estimates for coal prices should be revised upward to represent the types and volumes of coal which would be purchased by New England utilities.

perceived benefits of increased national coal use. Of direct concern to New England would be any effort on the part of either West Virginia or Pennsylvania to impose large new state taxes on coal produced in those states. If the coal states perceive the market for their coal to be the metropolitan area from New York to the south, they could attempt to raise their taxes to a level which would just make coal competitive with nuclear power in the New York metropolitan region. Because of transportation costs, such a tax would make coal non-competitive in New England.

A combination of state tax pressures, government regulations and United Mine Worker contract demands can therefore be expected to push coal use costs up to the level of nuclear power costs in many regions of the country. But while nuclear power costs may place a ceiling on coal prices, coal would be unable to limit nuclear power costs except by means of replacement. In fact, if coal ever gains a major market share in New England, one of the highest coal cost regions, it can be said that nuclear power is no longer economically viable anywhere in the U.S.

In summary, the following table compiles the various coal cost estimates for the years 1985 and 2000:

Table 9
Coal Price Projections
($/MMBTU in 1978 Dollars)

Items	1985	2000
Mining	$1.15-1.35	$1.27-1.46
Transportation	.39-.51	.39-.51
Pollution Control	.40-.50	.40-.50
Labor and Regulation	.21-.34	.21-.34
Total	$2.15-2.70	$2.27-2.81

While every effort has been made to evaluate the major variables which will affect prices in the future, the actual events of the next 21 years will undoubtly affect these projections. These events will therefore have to be incorporated into future analyses to keep the projections up-to-date. It should also be noted that the prices are in constant 1978 dollars and therefore future inflation must be added.

Natural Gas Availability and Cost Projections

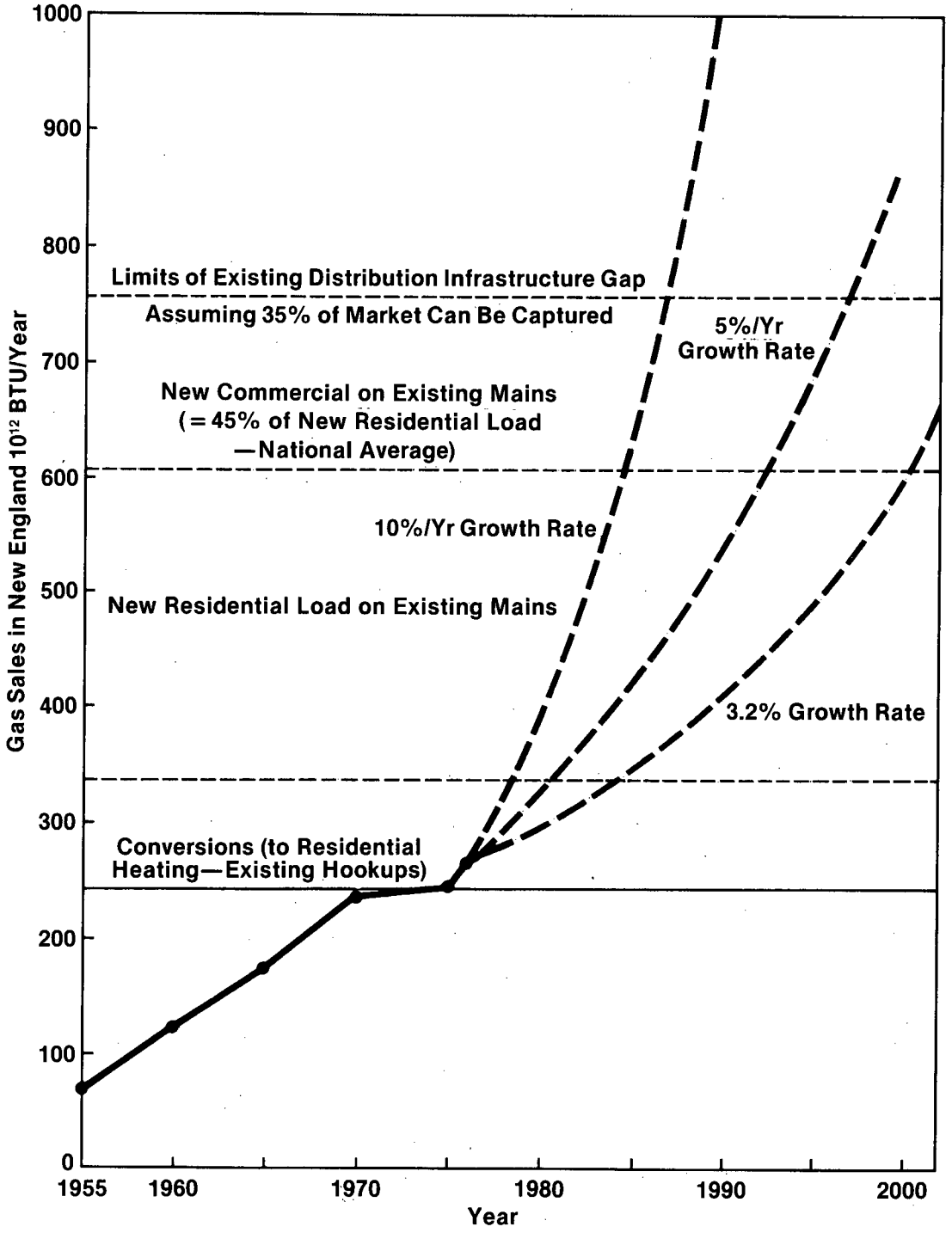
The graphs below and the AGA paper on U.S. gas price projections provide a preliminary assessment of the prospects for gas in New England. Basically, the conclusions are as follows:

1) Utilizing the existing gas distribution infrastructure in New England, a threefold increase in gas use is possible. Increasing the availability of gas to New England on a preferential basis will be required. Given the fact that gas is only 9 percent of our energy mix whereas it is 27 percent nationwide, such preferential treatment would not be unreasonable.

2) With a 5 percent per year growth rate in gas volumes marketed, gas prices to consumers should track imported No. 2 oil, based on an 8 percent per year oil price increase.

3) If gas availability were such that a 10 percent gas growth could be accomplished, gas costs could beat oil by a significant margin.

FIGURE 22
New England Potential Natural Gas Consumption
1978-2000

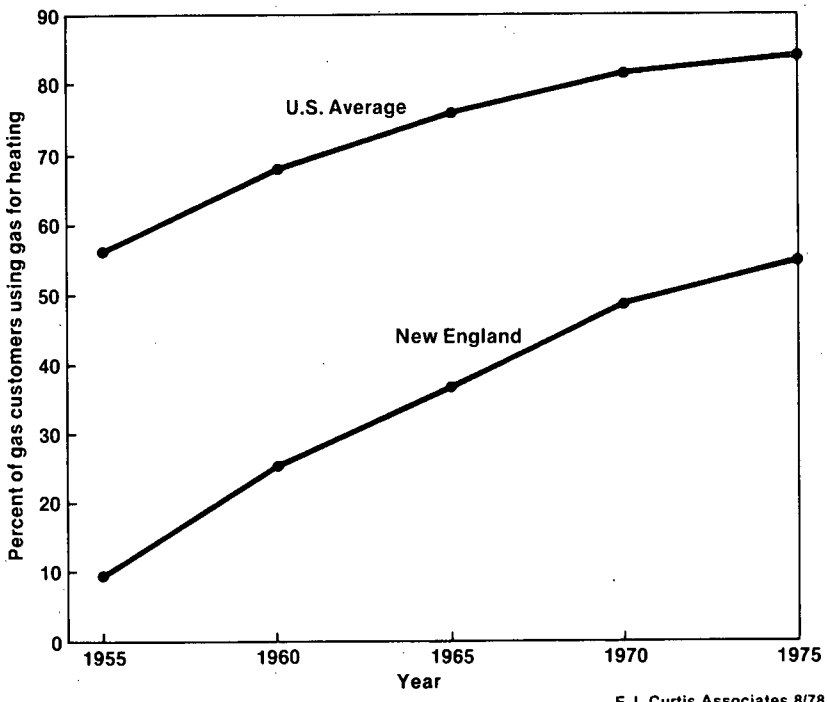


New England Gas Consumption Bases:
1. Existing Infrastructure
2. No growth in total energy needs in New England

E.J. Curtis Assoc. 8/78

FIGURE 23

Percent of Connected Gas Customers Who Also Use Gas for Home Heating

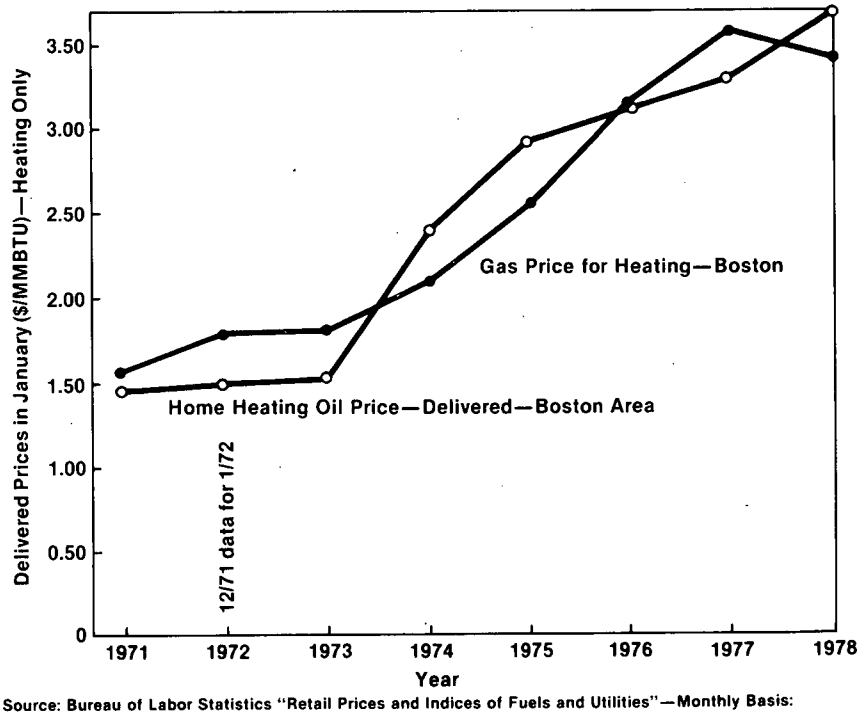


Source: "Gas Facts," 1977. American Gas Association, Table 60, pg 74

E.J. Curtis Associates 8/78

FIGURE 24

Cost of Home Heating Oil (#2 Oil) Compared to Cost of Gas for Residential Heating
(Boston SMSA)



Source: Bureau of Labor Statistics "Retail Prices and Indices of Fuels and Utilities"—Monthly Basis: Cost delivered to homes.

E.J. Curtis Associates 8/78

FIGURE 25
New England Energy Cost Forecast
Gas vs. No. 2 Oil Delivered to the Consumer

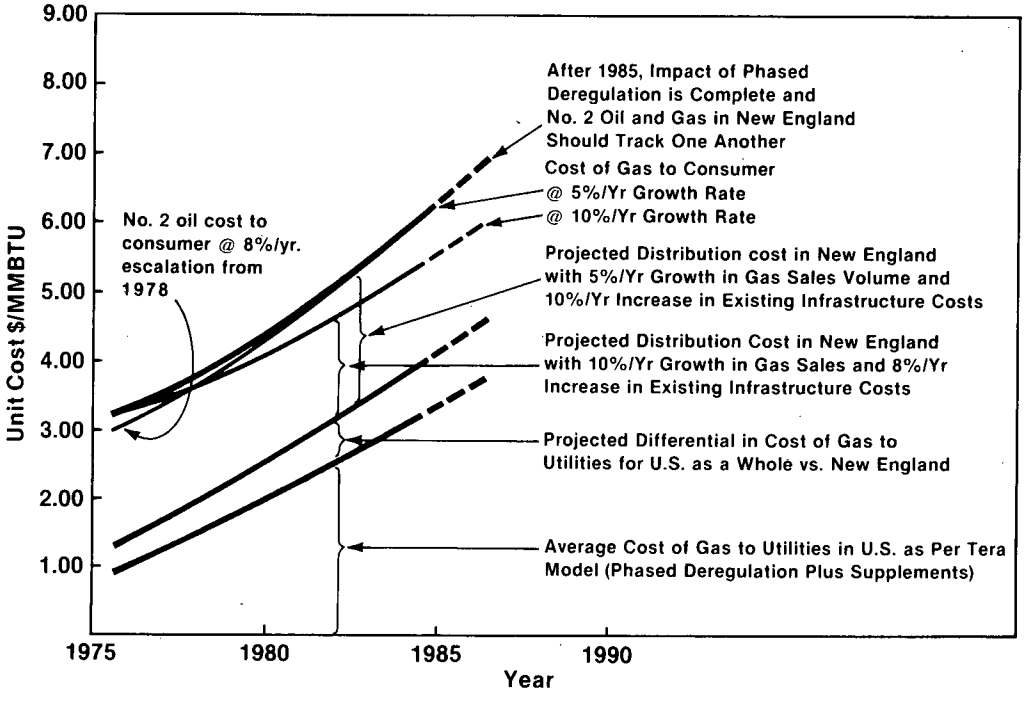
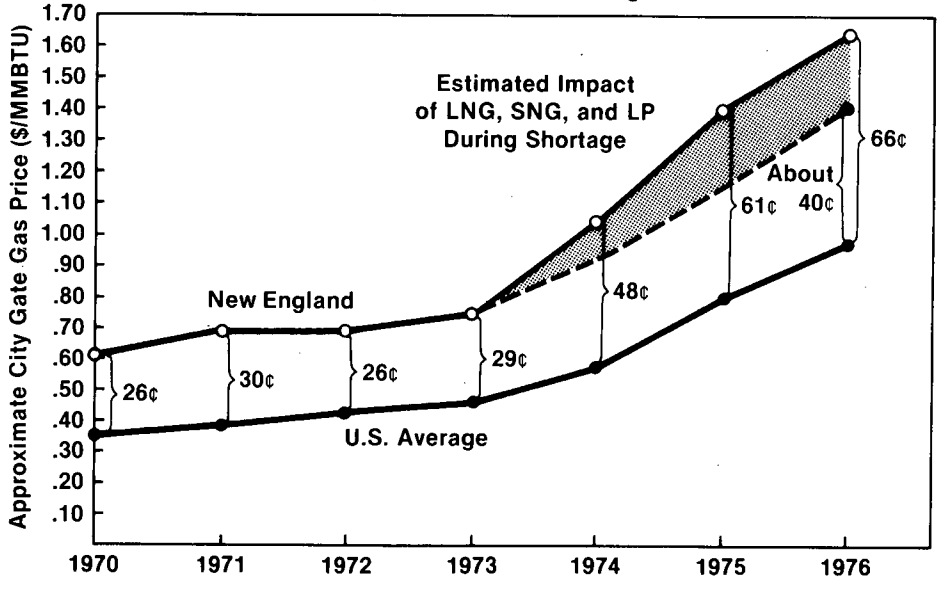
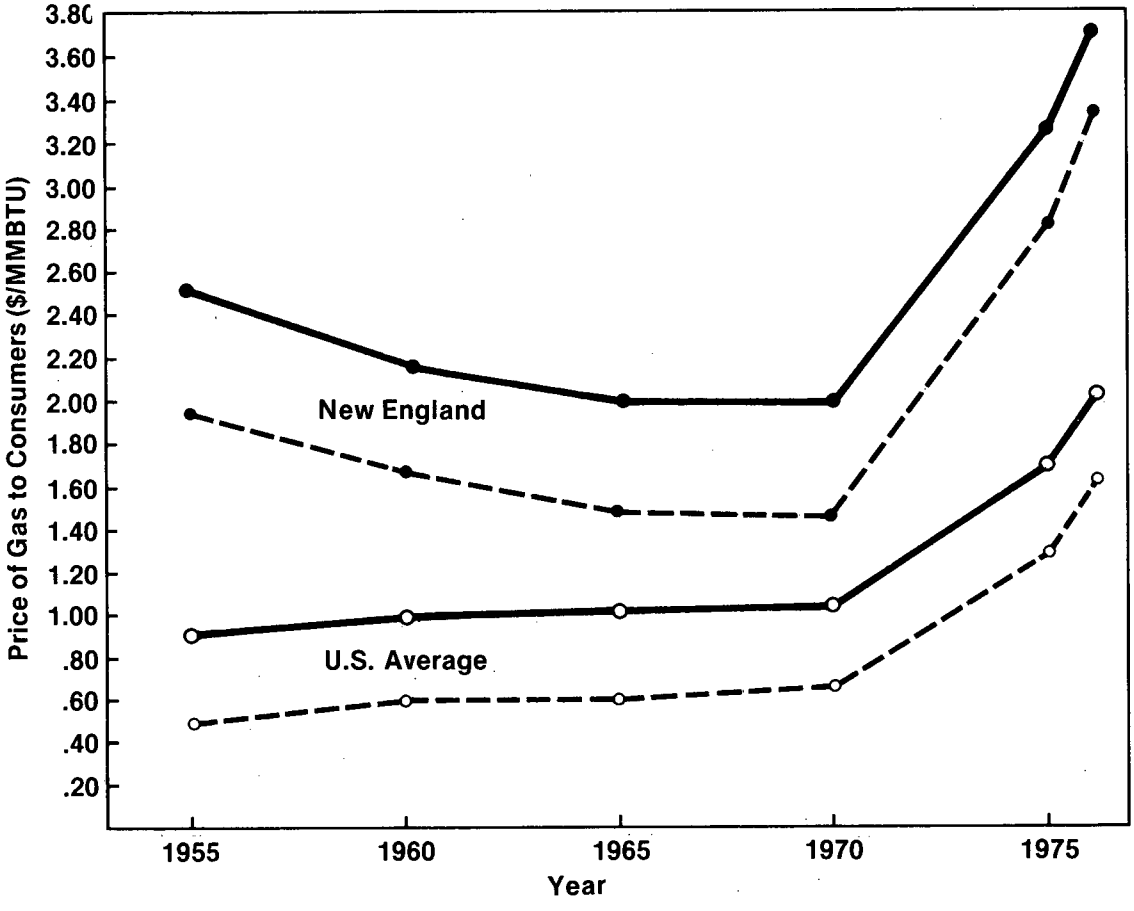


FIGURE 26
Historical Cost of Gas to Utilities
(Wholesale cost of gas)
New England vs. U.S. Average



Data Source: "Gas Facts," 1977 American Gas Association, Table 98, pg. 122

FIGURE 27
Composite and Residential* Average Gas Prices
New England vs. U.S. Average



Residential prices represented by dotted line.
Composite prices represented by solid line.
*Includes cooking and water heating uses as well as space heating.

Source: "Gas Facts," American Gas Association, 1977, Tables 93 and 94, pp. 116 and 117.

Nuclear Cost Projections: The Economics of New Nuclear Construction and Generation in 1990 (Alan Davis)

I. Introduction

The following text describes the assumptions and sources for a projection of nuclear electricity generating from a new station completed in 1990. The dollars are constant 1978. This analysis begins with a discussion of capital costs, and proceeds with capacity factors, fuel, operation and maintenance, decommissioning and related factors contributing to bus-bar costs expressed in Mills/KWH.

Table 10 contains a range of capital cost projections for a hypothetical 1,150 MW nuclear plant. Since nuclear plants are capital intensive (i.e., the bulk of the costs of their electric production arise from their construction rather than from their fuel and other operating costs), capital costs receive the greatest emphasis here.

Table 10

Hypothetical Nuclear Plant Cost Estimate

(In levelized current dollars for operation from 1990-2020)

	Mills/KWH	Levelized In Real 1978 Dollars[1]
Fixed Capital Costs		
High: $\frac{3753/\text{KWe} \times (.18) \times 1000 \text{ Mills}/\$}{8{,}766 \text{ hr/yr} \times (.6)}$	= 128.5	33.9
Mid: $\frac{2428/\text{KWe} \times (.18) \times 1000 \text{ Mills}/\$}{8{,}766 \text{ hr/yr} \times (.6)}$	= 83.1	21.9
Low: $\frac{1588/\text{KWe} \times (.18) \times 1000 \text{ Mills}/\$}{8{,}766 \text{ hr/yr} \times (.6)}$	= 54.4	14.3
Fuel Costs	56.6	14.9
Operation and Maintenance Costs	13.2	3.5
Total		
High:	198.3	52.3
Mid:	152.9	40.3
Low:	124.2	32.7

Assumptions:
- 6% General Inflation
- 18% Fixed Charge Rate (FCR)
- 60% Capacity Factor
- No allowance for decommissioning
- Does not include transmission and distribution
- Does not include line losses (only bus-bar, not delivered costs, are provided)
- Does not include capacity equivalency ratio for comparison purposes
- 0, 7 or 14% real escalation of plant costs
- 2% real escalation of fuel and O & M costs

[1] The levelized current dollar costs correspond to *declining* constant 1978 dollar costs. For instance, the middle estimate for the first year of operation is $152.9/(1.06)^{12} = 76.0$ mills/kwh in 1978$, whereas, for the thirtieth year of operation, the middle estimate is only $152.9/(1.06)^{41} = 14.0$ mills/kwh. If we follow normal utility operational practice of levelizing capital costs but passing through fuel costs as they are incurred, the corresponding 1978$ estimates are 55.6 and 32.2 mills/kwh for the first and last years. In order to obtain a single number for the real cost of electricity both fuel and annualized capital charges should be levelized in real dollars. This is done in the far right-hand column.

Table 11

Early and Recent Estimates of Nuclear Power Plant Costs

	U E & C		BECHTEL		EBASCO		S & L	
Year of Estimate	1967	1976	1965	1975	1969	1977	1969	1977
Year of Operation	1972	1986	1970	1985	1976	1987	1975	1986
Base Cost	115	535	115	540	160*	689*	158	482
Escalation	15	395	55	270	66	592	35	440
AFDC	10	205	10	220	–	–	33**	340**
Total	140	1135	180	1030	226	1281	226	1232
Percentage Change/Year	25		18		24		24	

* Includes AFDC ** Includes indirect costs

II. Capital Costs

A report last spring by the U.S. House Government Operations Committee[1] shows how estimates of capital costs for nuclear plant construction have borne little relation to the actual costs experienced by the industry. In 1967, the Atomic Energy Commission (AEC) was projecting capital costs of $134.00 per KW for plants beginning operation in 1973. The actual costs were between 50 and 280 percent greater. In 1974, the AEC said it would cost $700 per KW for plants to begin operation in the early 1980's. But utility companies were already announcing costs of $1000.00 per KW. In a 1975 study by economists at Harvard and M.I.T., the authors found that capital costs had risen more steeply than the costs for other high technology facilities.

Most utilities experienced at least 100 percent cost overruns. Boston Edison experienced a 267 percent construction cost overrun at one of its plants, while Vermont Yankee came in 178 percent above its original estimate. Table 11, taken from an exhibit in a recent Wisconsin case, shows comparative cost estimates by four well-known firms—United Engineers and Constructers, Bechtel, Ebasco Services, and Sargent & Lundy.[2] Final cost estimates have risen 25%, 18%, 24%, and 24%, respectively, on an annual basis.

There are a number of ways to project capital costs. One way starts with architect-engineer cost projections for labor and material for each year until completion. These cost predictions are based on the present scope of the project and are expressed in constant dollars. During the construction period, however, costs of factors not yet procurred may escalate (or, theoretically, may deescalate) due to increases in per unit costs for labor, materials, and services; and due to increases (or decreases) in the scope of the project and regulatory, environmental, and safety requirements. Hence the estimated direct construction costs are escalated, and taxes and allowance for funds used during construction (AFDC) are computed thereon for each year. The total expenditures for each of the years are then summed, giving a total capital cost in constant dollars.

This "brute force" method was not used here because: (1) there is no architect-engineer cost expenditures schedule to use a a starting point; (2) the apparent sophistication of the method is less impressive than it seems because most construction expenditures schedules are generated from standard curves, not detailed engineering plans (This is especially true of nuclear units.); (3) simpler methods are available which predict construction costs with accuracy.[3]

[1] *Nuclear Power Costs*, U.S. House of Representatives Committee on Government Operations, April 26, 1978, P. 31.
[2] Testimony of Lawrence Bertschi before the Wisconsin Public Service Commission, Docket No. 05-EP-1.
[3] *Ibid.*

Table 12
Nuclear Power Plants Costs

Commercial Operation Date	Number of Units	Year of Order	Capacity Cost MWe	Millions	Average Cost $/KWe	% Change
(1)	(2)	(3)	(4)	(5)	(6)	(7)
1971	5	1965-1966	3,406	$ 578	$170	
1972	8	1965-1967	5,525	1,341	243	43
1973	7	1965-1967	5,235	1,297	248	2
1974	10	1966-1967	8,977	2,777	309	25
1975	10	1966-1967	8,206	3,450	420	36
1976 (Est.)	8	1966-1968	7,823	3,648	466	11

Percentage Increase 1971-1976:

Total	174
Average	22

Source: FPC, *Factors Affecting the Electric Power Supply 1980-1985,* Dec. 1, 1976.

Wilfred Comtois, a Westinghouse Corporation consultant, developed a simpler method of estimating capital costs which he presented to the American Power Conference in April 1976.[1] His is one of two methods used here. (See Table 13 on the following page.)

One starts with a base capital cost. We selected $711/KWe, the base used by W. W. Brandfon in a paper presented to the Atomic Industrial Forum at an April 1978 conference.[2] Brandfon, who is responsible for estimating nuclear costs at Sargent and Lund, was estimating the costs of a comparably sized, hypothetical reactor to come on line in 1990, and his is the most recent such figure of which we are aware. Since Brandfon's base cost (which does not include AFDC or, obviously, escalations during construction) was based on a commitment beginning on January 1, 1978; we have adjusted it upward for each of the high, middle, and low cases, to a base time of January 1, 1979 to more closely correspond with decision-making in late September, 1979.

Having selected a base starting date and base cost, it is necessary to determine the appropriate time period. Here, eleven years, on the low side of commonly discussed periods, is employed.

The most controversial factor is the appropriate annual escalation rate. We have chosen a range of 6% annual escalation, representing escalation at the projected (and agreed upon) overall general inflation rate, to 20% escalation. The mid-point between these escalation ranges is 13%.

An 8% AFDC rate, corresponding to present AFDC rates, was also assumed.

Using the three escalation rates and the other factors in the Comtois formula yields a range of construction costs expressed in mixed current dollars. The construction cost estimate based on 6 percent general and 14 percent real escalation (high case) under this method is $3753/KWe. The low case, which assumes no escalation in costs above the general inflation rate (no real escalation case) is $1589/KWe. And the mid-point case between the two shows $2428/KWe.

Why was the 20% "high" escalation used? The answer is that it reflects recent historical averages and thereby attempts to capture the uncertainty of projecting nuclear construction costs. Table 12 shows FPC data on actual increases in cost per KW for plants coming on line in 1971 through 1976—an average annual increase per KW of 22 percent over the period.[3] One analyst has

[1] *Power Plant Construction Schedules, Escalation, and Interest During Construction,* by Wifred Comtois, April 1976.
[2] "Comparative Costs for Central Station Electricity Generation," by W.W. Brandfon. Paper presented to Atomic Industrial Forum Conference on Energy for Central Station Electricity Generation, April 18, 1978, Exhibit 1.
[3] *Factors Affecting the Electricity Power Supply 1980-85,* Federal Power Commission, December 1, 1976.

Table 13
Comtois Formula

A. For Calculating Future Capital Costs

$$P_C = P_O \frac{(1+e)^N - (1+i)^N}{N\, I_N\left[\frac{1+e}{1+i}\right]} \quad \text{(if } i \neq e\text{)}$$

$$P_C = P_O (1+e)^N \quad \text{(if } i = e\text{)}$$

where:

P_C = cost of the project at completion (C. O. date)
P_O = cost of project at the start exclusive of escalation
N = number of time periods to complete the project
e = rate of escalation per time period expressed as as a decimal fraction
i = rate of interest per time period expressed as a decimal fraction
I_N = natural logarithm

B. Comtois Formula—High Range

$$P_C = 853.20 \times \frac{(1+.2)^{11} - (1+.08)^{11}}{11 \times I_N\left[\frac{1+.20}{1+.08}\right]}$$

P_C = 3753 in rate base in 1990
P_O (base cost) = \$711/KWe × 1.20 = \$853.20/KWe as of 1/1/79
Assumptions: 6% general inflation
14% real escalation
8% AFDC

C. Comtois Formula—Mid Range

$$P_C = 803.43 \times \frac{(1+.13)^{11} - (1+.08)^{11}}{11 \times I_N\left[\frac{1+.13}{1+.08}\right]}$$

P_C = \$2,428/KWe in rate base in 1990
P_O(base cost) = \$711 × 1.13 = \$803.43/KWe
Assumptions: 6% general inflation
7% real escalation
8% AFDC

D. Comtois Formula—Low Range

$$P_C = 753.66 \times \frac{(1+.06)^{11} - (1+.08)^{11}}{11 \times I_N\left[\frac{1+.06}{1+.08}\right]}$$

P_C = \$1,588.34/KWe in rate base in 1990
P_O (base cost) = \$711/KWe × 1.06 = \$753.66/KWe
Assumptions: 7% general inflation
0% real escalation
8% AFDC

Table 14
Mooz Projected Capital Costs

CPIS*	N**	Cost (1976$/KWe)
1975	39	1334
1980	53	2019
1985	68	2718
1990	83	3417

suggested that the 22 percent annual increase reflects 6 to 7 percent in general inflation, 3 to 4 percent real change in construction costs over and above the general inflation, and 12 percent additional escalation attributable to design changes, including safety-related and environmental adders.[1]

Electrical World, an industry publication, cites 18 to 20 percent capital cost increases "in the early seventies, and now breaking through the 25% per year increase level." The *Electrical World* numbers are based on reactor vendor studies.[2]

An important primary problem in projecting future capital costs is the uncertainty associated with increasingly stringent regulatory requirements which have added significantly to costs.[3] Since the pace of additional and costly regulatory requirements shows no signs of abatement, realistic capital costs projections should attempt to capture this and other uncertainty by providing a range of estimates.

Another approach to projecting capital costs was recently released by the RAND Corporation last summer. The author, William Mooz, examines actual costs for all nuclear plants completed through 1977 in the U.S., excluding plants completed under "turnkey" contracts. (Under the early turnkey contracts the builder or the government directly bore portions of the construction costs in order to stimulate the development of the industry. Hence, the costs paid by the reactor owner did not reflect the true costs of the plant.) Since actual costs[5] were reported in mixed current dollars, Mooz converted the totals in 1976 dollars for comparison purposes.[6] The result is a series of capital costs for 39 nuclear units expressed in 1976 dollars. Mooz then performed multivariate regression analyses to determine which factors most heavily influenced costs up or down.

By far, the dominant variable was a time variable, expressed in terms of the date on which the construction permit was issued (CPIS). Other important variables were reactor size, builder (architect-engineer) experience, presence of cooling tower, and location in the Northeast (defined as location in FPC Region 1, which includes the New York and states north of Virginia).

Because of the high level of sophistication in the analysis, Mooz's data and regressions may be used in predicting future capital costs. Table 14 shows Mooz's projections for capital costs expressed in 1976 dollars for the dates of the construction permits shown.[7] Mooz assumes an 834

[1]"Comparative Cost Analysis" (Supporting Document No. 9 to the California Energy Resources Conservation and Development Commission AB 1852 Report to the California Legislature), Appendix A, pp. 21-22.

[2]*Electrical World*, September 1, 1978, P. 3.

[3]Indeed, the U.S. Nuclear Regulatory Commission has identified some 133 generic, unresolved safety issues in a January 1, 1978 report to Congress. In the past, resolution of one safety problem has often spawned new issues. See *NRC Program for the Resolution of General Issues Related to Nuclear Power Plants*. Report to Congress, January 1, 1978.

[4]*Cost Analysis of Light Water Reactor Power Plants*, by William Mooz, prepared for the U.S. Department of Energy, R-2304-DOE.

[5]Mooz did not have actual, final cost figures on plants completed in 1977 because of reporting lags; however, the 1977 units were close enough to critically permit him to use estimates of final costs. For these 7 plants (out of 39 in the data base). "... most of the cash flow is over and the slope of the cash flow curve has tapered off. Consequently, estimates of their costs should be reasonably close to the actual expenditures if the estimate has been made recently." Mooz *Op. Cit.*

[6]This was done by multiplying the expenditures for each of the construction years by the ratio between 1976 volume of the Hardy-Whitman steam plant index and the value of the index in those years.

[7]Mooz, *Op. Cit.*

MW reactor (the mean size in his 39 plant sample), all new plants constructed by the same, experienced architect-engineer (a cost-minimizing assumption), and a construction rate of 15 plants every five years.

"These costs reflect the effect of (a) the temporal cost increases due to the coefficient of CPIS and (b) the smaller offsets that result from the cost-learning process. As can be seen, the estimate is dominated by the temporal cost increases."

Since these results are expressed in constant 1976 dollars, rather than mixed current dollars, it is not identical to the amount which will actually be paid by the hypothetical utility. However, an attempt to undo Mooz's year-by-year inflation correction showed that the $2019 figure for a plant started in 1980 implies about $4000 in mixed current dollars for an 832 MW plant completed in 1990, or slightly *more* than the high case considered here.

III. Fixed Charge Rate

Though we understand through conversations that fixed charge rates of as high as 20% are being used for planning purposes in New England, we have used an 18% FCR, which compares with other recent estimates.

IV. Capacity Factor

The best independent work in this area appears to be Charles Komanoff's in his *Power Plant Performance, Nuclear and Coal Capacity Factors and Economics (1976), Nuclear Plant Performance/Update: Data Through December 31, 1976, (1977),* and his most recent *Nuclear Plant Performance Update 2: Data Through December 1977 (1978).* We have been impressed not only with the depth of his analysis, but also with his detailed responses to critics[1] and his use of explicit assumptions and regression analysis based on actual plant performance.

Komanoff's latest update predicts a 10-year, levelized capacity factor for an 1,150MW pressurized water reactor (PWR) at 58.9% (The projections for 1,150MW boiling water reactors (BWR's) are much lower—43 to 46%.).[2] To be conservative, we have assumed that the hypothetical unit is a PWR—the better performer—and we have raised Komanoff's projection from 58.9% to 60%. In comparison to utility projections of 70% and higher, Komanoff's 58.9% is on the low side, but his estimate seems far more reasonable in light of these factors.

1) The larger reactors have experienced lower capacity factors, the natural result of being more complex to control, having a greater number of components that can fail, and requiring longer lead times.

2) He has explicitly taken into account reactor maturation and the so-called "learning curve," which he calls reactor "vintage," based on actual experience. PWR performance peaked around age five and leveled out thereafter, with a slight, though not statistically significant, decline after year five.

> "In addition, the low capacity factor indicated in ages 6, 9 and 10, although not statistically significant, are evidence of a conclusion to the improving capacity factor trend evident from age 2 to 5.[3] This evidence matches the pattern shown by the three "pre-commercial" 200-MW class units, Yankee Rowe, Dresden #1, and Indian Point #1... and also resembles the maturation pattern of BWR's."[4]

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[1]See, for example, his exchange with nuclear industry spokesperson Lewis Perl, in *Nuclear Power Costs*, hearings before the Subcommittee of the Committee on Government Operations, U.S. House of Representatives, pp. 1198-1203, 1249-1255, April 26, 1978.

[2]Charles Komanoff, *Nuclear Plant Performance Update 2: Data Through December 1977* (1978), P.17.

[3]A separate regression found a decline in PWR capacity factors starting at age 6, significant at the 93% confidence level. The decline rate is very gradual, however—only 0.3 percentage points per year. Thus PWR capacity factors after age 5 follow a plateau rather than a sharp decline.

[4]Komanoff, *Op. Cit.* P.40

3) Komanoff's 10-year averages are frequently used as surrogates for 30-year projections in economic analyses. According to Komanoff, this practice downplays potential performance problems at aging reactors due to performance buildup of fission and corrosion products which may cause component failures and inhibit repairs.

4) There have been shortcomings in typical industry analyses: for example, redefining maximum capacities used for calculating capacity factors after reactors are derated, redefining maximum capacities in terms of "maximum dependable capacity," etc., which dilute the objectivity of an analysis, or, simply ignoring data on plants which have not performed well.

5) Despite the optimism reflected in many industry assumptions concerning nuclear plant performance, even certain well-known industry consultants are utilizing capacity factors in the 60% range. For example, the capacity factor for the nuclear cost estimate advanced by Brandfon, cited above, is 60%. National Economic Research Associates (NERA), well-known nuclear consulting firm, utilized a range of capacity factors of 50% to 65% in a recent description of its "supply optimization model."

In light of the historically erratic performance of nuclear plants, the numerous outstanding uncertainties which could affect their future performance (e.g., the effects of requiring new designs in response to "generic" safety issues) and the sensitivity of nuclear plant economics to fluctuations in plant performance (due to the capital-intensive nature of the nuclear plant), a more realistic approach, such as the Komanoff approach, seems to be warranted in projecting capacity factors.

V. Fuel, Operations and Maintenance Costs

Fuel and operations and maintence costs were based on the detailed testimony and exhibits of Ronald L. Knecht, presently Special Advisor to the California Energy Commission, who provided a full-fledged analysis of nuclear power costs to the Wisconsin Public Service Commission earlier this year. That analysis and others are found in *Methodology for Power System Cost Assessment: A Report to the California Energy Commission*.[1] Knecht's analysis was used as a starting point because it is recent, detailed, and comparable to the hypothetical situation here (For example, Knecht assumes a 60% capacity factor on an 1100 MW plant.). In addition, there are a number of conservative assumptions in his analysis which lend weight to his conclusions. He has, for example, included costs for permanent waste disposal, costs which we believe are entirely speculative at this time because of various analyses indicating that the technology is simply unavailable at the present time. Knecht's calculation assumes 0.64 Mills/KWH for waste disposal.[2] He assumes fuel "burn-up" rates of 30,000 megawatt-days (thermal) per metric ton of uranium, an optimistic assumption compared to experience with PWR's.

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[1]*Methodology for Power System Cost Assessment: A Report to the California Commission*, by Ronald L. Knecht, Contract 300-010 (7/8—, Attachment D, pp. D-2 through D-24.

[2]Recent government studies have conflicted with industry statements that the technology for permanent waste disposal exists. As we indicated in our July 14, 1978 Memorandum to the Nuclear Subcommittee:

1) A 1977 U.S. Government Accounting Office report, entitled *Nuclear Energy Dilemma: Disposing of Hazardous Waste Safely*, warns that a solution of the problem "is critical to the continued growth of nuclear energy." Yet the report states: "The technology for safe disposal has never been demonstrated and a satisfactory site has not yet been determined."

2) More recently, a report released earler this year by the U.S. Geological survey claims "some key geologic questions are unanswered and answers are needed before the risk associated with geologic containment can confidently be evaluated."

3) The Boston Globe (July 12, 1978) reported on the results of a study by the President's Office of Science and Technology Policy. The report cast doubts on the long-range suitability for storing wastes underground.

Knecht calculated 15.9 Mills/KWH for fuel costs (in *current* dollars) for a unit coming on-line in 1985, and 3.7 Mills/KWH for operation and maintenance. He assumes a 7% overall fuel and operation and maintenance (O & M) escalation, including 6% inflation to 1985 and approximately 5% thereafter.[1]

With *our* assumption of 6%/year inflation throughout, the fuel escalation rate becomes 8% after 1985, so the fuel and O & M costs in 1990 are 23.4 and 5.4 Mills/KWH respectively.

Knecht next applies a levelization factor to make the fuel costs directly comparable to the annualized capital charges. He finds the fixed current dollar fuel charge for each year of the 30 year life of the plant that has the same value (at 10%/year discount) as the actual escalating fuel charges. For 8%/year escalation, this levelization factor is:

$$\frac{(.10)\ (1.08)}{(.10 - .08)} \times \frac{1 - (1.08/1.10)^{30}}{1 - (1/1.10)^{30}} = 2.425$$

So the levelized costs are 56.6 for fuel and 13.2 for O & M.

VI. Decommissioning

No decommissioning costs have been included in the cost calculations because of the wide disparity in present predictions and the vast uncertainty of certain aspects of the technology. According to the April 26, 1978 report of the U.S. House of Representatives Committee on Government Operations, *Nuclear Power Costs*, dismantling a nuclear plant may cost anywhere from $31 million to $100 million in 1977 dollars, or 10% of the cost of a $1 billion plant.[2] But even higher figures do not include the costs of "perpetual care" for rubble from the plant. "The radioactive nickel may remain hazardous up to 1.5 million years. The committee found that "...from the lowest to the highest (decommissioning cost estimate), ...no one really knows how much it will cost or who will pay the bill to decommission this nation's nuclear reactors."[3]

VII. Comparative Factors

An analysis of nuclear power costs in New England is useful only to the extent that nuclear costs can be compared to alternative forms of electric generation, alternative energy sources, or energy efficiency (conservation) investments. In keeping with the hypothetical case, we have attempted to look at bus-bar costs for nuclear generation *in vacuo*. But to the extent nuclear generation is compared to other forms of electric generation or to other energy sources, additional costs must be borne in mind. Nuclear generation costs calculated on a bus-bar basis do not by definition take into account the substantial amounts of electricity lost in transmission. Nor have we added to capital costs any of the additional capital costs which are required as a result of expansion of generation capacity. Without estimating costs in these areas, comparison of nuclear or other forms of electric generation with competing alternatives would be incomplete. Moreover, the nuclear bus-bar costs discussed above will be inadequate in comparing the hypothetical nuclear unit with other forms of electric generation because of the sheer size of the hypothetical unit. More incremental system capacity is necessary to achieve a given level of reliability for an electric utility network if the incremental capacity is added in the form of large, rather than small, units. This is true not only because large units tend to break down more frequently than small ones, but also

[1]Knecht does not explicitly list the general inflation rate after 1985. However, in previous hearings in California he used 2% real escalation for fuel which implies 5% inflation. Since he used the same discount rate and annual fixed charge rate througout, the rate of inflation must stay in the 5-6% range.

[2]*Nuclear Power Costs*, supra P. 22.

[3]*Ibid*,: P. 29.

because an outage for any reason by a large unit creates a greater gap in the system. Dr. Edward P. Kahn, a scientist at Lawrence Berkley Laboratory, has found that, for the power pool serving Pennsylvania, New Jersey, Maryland, and the District of Columbia, roughly every three megawatts of nuclear capacity (for units comparable in size to our hypothetical unit), could be more economically replaced by two megawatts of coal capacity in medium sized (375MW) units.[1] Thus, the capacity equivalency ratio between large nuclear and small coal units, according to Kahn, would be 3:2. In the Wisconsin case mentioned above, the Wisconsin PSC Staff used 5:4 and Knecht used 7:6. The end result of taking capacity equivalency ratios into account for comparison purposes would be to increase large nuclear unit capital costs substantially. If the ratios above were used, the nuclear capital costs per KWe would be increased by 50%, 25%, or 16 2/3%, depending upon the ratio selected.

Finally, the cost of nuclear electricity can be compared with the cost of direct consumption of conventional fuels. In 1978, the busbar cost of nuclear electricity was 17 Mills/KWh in New England (1978 dollars). Crude oil was $12.70/BBL. Thus, per BTU *delivered*, nuclear electricity was 2.3 times as expensive as oil. The levelized real price of crude for 1990-2020 will be about $36/BBL assuming the 1995-2000 trend adopted in our oil price forecast continues. Thus the projected prices for nuclear electricity are 2.4, 1.9, or 1.5 times the price of oil. Thus, nuclear electricity from plants completed in 1990 will be at least as competitive as it is today if uranium escalates at the 2%/yr. estimated by Knecht while oil escalates at the 5%/yr. estimated by us (both in real dollars).

Projected Capacity and Economics of New Nuclear Construction and Generation in 1990 Dick de La Chapelle, Ken Picha and Frank Sahlman

Table 15
Summary of Projected Capacity, Costs, and Relevant Data

	Year	Fission No Breeding	Fission W/Breeding	Fusion
MW capacity –	1978	4189 (1)	0	0
BBL Oil equivalency —		39.7mil (2)	0	0
Projected capacity –	1980	4189	0	0
Projected capacity –	1985	7569(3) (4)	0	0
Projected capacity –	1990 (6)	13319 (3) (5)	0	0
Projected capacity –	2000 (6)	15619 (3)	?	?
Projected capacity –	2000+	?	unlimited	unlimited
"Bus Bar" Cost –	1976	1.5¢/KWH (7)	NA	NA
Projected Cost – in 1978 $s	1990	3.9¢/KWH (8)	NA	NA

(Continued on following page)

[1]*Methodology for Power System Cost Assessment*, Attachment O, pp. O-1 through O-4.

Table 15
(Continued)

	Fission No Breeding	Fission W/Breeding	Fusion
Impact on Human Health and Other Environmental Impact	Short term impact is minimal-long term impact is unknown and scrutiny should continue. See comparative risk data, Note 9.	?	?
Social Impact	Centralization		
Problems	Regulation and other delays. Changing requirements. Regulation pricing - political consideration. Utility commission knowledge. Citizen opposition. Technical & political problems of waste disposal. Technical problems of decommissioning. Threat of catastrophe.		

Notes:

1) The 4189 MW nuclear capacity generated 33% of electrical power used in 1976.
2) Barrels of oil which would have been required to generate same amount of electricity.
3) NEPOOL figures - see Table 16 for reactor schedule: assumes fuel availability. Does not assume alternate technology or increase in schedule. Regulatory delays are not assumed but should be expected.
4) Assume Seabrook I and II, Pilgrim II which are under attack through regulatory and court procedures - questions raised are need, comparative economics, environmental considerations and financing.
5) Assumes Millstone III, Montague I and II, Nepco I and II. Millstone III and Montague I and II have been indefinitely postponed as of July, 1978.
6) Will be influenced by demand growth. Since nuclear is only satisfactory for base load generation at this time, it can not provide more than 70-80% of the total power required. A 2% growth rate in demand and 15619 MW capacity in 2000 would mean that about 77% of NE's electric power would be nuclear generated.
7) This cost compares favorably with oil at 2.9¢/KWH and coal at 2.2¢/KWH. Nuclear costs do not include cost of decommissioning and cost of waste disposal.
8) See Figure 28 for cost break down and sensitivity to range of cost estimates. Calculations are shown in the appendix. The capital cost component of the total estimated cost (29.8 mills out of 38.6 mills) was not levelized according to normal practice. 38.6 mills therefore represents the highest consumer cost which would occur during the first year of operation. A 15 year levelized cost would be 29.2 mills per kilowatt-hour; a 30 year levelized cost would be 23.3 mills per kilowatt-hour.
9) Two independent assessments of risk to human life from various methods of generating power includes occupational exposure, mining, transportation, fabrication, pollution, radiation, accidents, etc. and disease from them. The studies, one by the American Medical Association, and one by Rothchild for the British Advisory Council on Science and Technology, estimates that the total risk to human life for mining, transport, pollution, accidents, radiation, etc. are substantially greater for coal and oil than for nuclear and gas per unit of electricity generated.

Table 16
Current Status of New England Nuclear Base Load Plants
(Megawatts)

State	Site	Operational Date	Status	Current Capacity	Planned Added Capacity 1977-1986	Planned Added Capacity 1986-2000
CT	CT Yankee	N/A	Operational	575	-	-
	Milestone I	N/A	Operational	652	-	-
	Milestone II	N/A	Operational	828	-	-
	Milestone III	1982	Construction Permit	-	1150 MAY 86	
ME	ME Yankee	N/A	Operational	790	-	-
	Richmond I	1991	Ordered	-	-	1150
	Richmond II	Ukn.	Letter of intent	-	-	1150
MA	Yankee Atomic	N/A	Operational	175	-	-
	Pilgrim I	N/A	Operational	655	-	-
	Pilgrim II	1984	Ordered	-	1180 JUNE 85	-
	Montague I	1986	Ordered	-	-	1150
	Montague II	1988	Ordered	-	-	1150
NH	Seabrook I	1982	Construction Permit	-	1150 DEC 82	-
	Seabrook II	1984	Construction Permit	-	1150 DEC 84	-
RI	NEPCO I	1984	Ordered	-	1150 NOV 86	-
	NEPCO II	1986	Ordered	-	-	1150
VT	VT Yankee	N/A	Operational	514	-	-

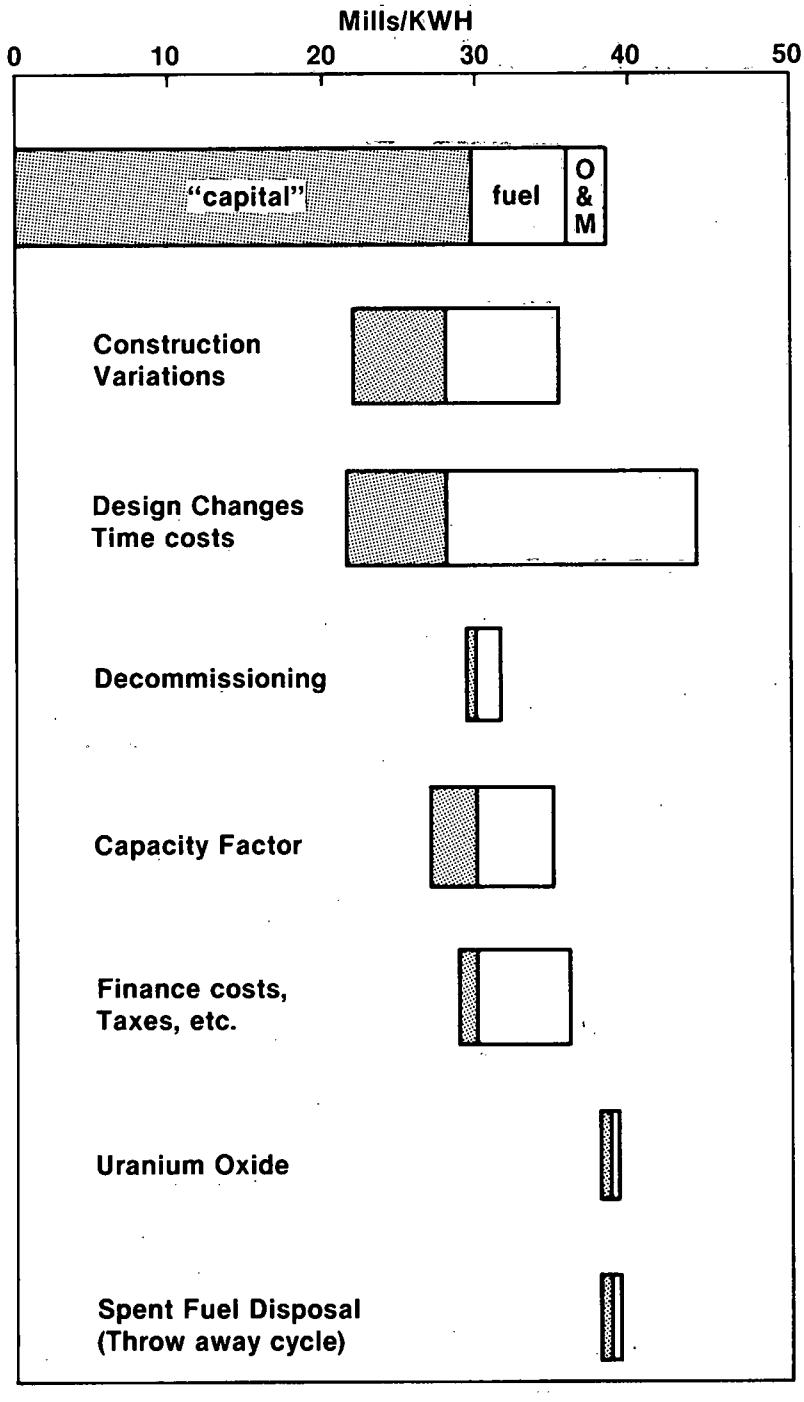
Totals
(MW Capacity)

Current Status	Operational	Construction Permit	Ordered	Letter of Intent
1977	4189(7)**	3556(3)	7030(6)	1150(1)
1977-1985	10125(12)			
1985-2000	15925(17)			

*Currently only one base load fossil fuel plant is planned in the 1985 stage (ME - W.F. Wyman - 600 MW, operational - 1978). Several fossil fuel plants in the 600 MW range are being considered as a result of nuclear construction delays.

**(Number of Plants)
N/A Not available
Source: Steam Electric Factors 1976
Atomic Industrial Forum Info News Release July 20, 1977

FIGURE 28
Estimated Cost of Electricity from Nuclear Plant
Started in 1978, Completed in 1990 (in 1978 $'s)



Appendix

Estimate of Nuclear Facility Started 1978 and put into Commercial Operation in 1990

1. Plant and Equipment Costs

1978 Estimate - $711/KW ± 25%

Given 6% inflation rate, projected rate of increase per year.

Low	6% or $1431 in 1990 $'s, $ 711 in 1978 $'s
Expected	8.7% or $1935 in 1990 $'s, $ 962 in 1978 $'s
High	12.8% or $3017 in 1990 $'s, $1499 in 1978 $'s

Low Estimate

- assumes no change in length of time to build plant; no significant changes in design/operation requirement; no improvements due to economies of scale, learning curve.

Expected estimate

- assumes no change in length of time to build plant; significant changes in design/operation requirements; no improvements due to economies of scale, learning curve.

High estimate

- assumes further increase in length of time to build plant and significant changes in design/operation requirements, etc.

The ± 25% reflects geographic location, specific design, type of cooling, and many unknowns. All numbers are amounts put into rate base which is made up of mixed dollars plus AFUDC.

2. Decommissioning Costs (add to capital costs)

For an 1150 MW Pressurized Water Reactor, the following estimates were used.

Low estimate	$25 million or $22/KW - 1978 $'s
Expected estimate	$45 million or $39/KW - 1978 $'s
High estimate	$100 million or $87/KW - 1978 $'s

The expected estimate assumes complete dismantling and removal. The low estimate would cover mothballing/perpetual care taking and/or entombment. The high estimate would cover unforeseen problems in permanent disposal of low level waste after dismantling and/or unforeseen complications in dismantling.

3. Capacity Factor

Low Estimate	60%
Expected estimate	69%
High Estimate	77%

New England nuclear plants have averaged 74.3 % capacity factor after four years of "break-in/start up" or 76.6% after five years operation. Other parts of the country have not done as well.

The 69% estimate is made up of ±75% for mature units, less 4-5 % allowance for start up, less 1-2% for going to larger units.

4. AFCR %

This is the amount multiplied by the initial book value of plant and equipment to cover finance costs, federal, state and local taxes, etc. The assumption is that nuclear plants will be financed through private utilities. There is a considerable difference in the cost of capital depending upon the method of financing. — For example:

Private:

51% bonds @ 9.5%
13% preferred stock @ 9.5% before tax, 19% after tax.
36% common stock @ 15.5% before tax, 31% after tax.
Weighted average 18.48%

Public:
100% tax free bond @ 7% = 7.00%

Low Estimate	17%
Expected estimate	18%
High Estimate	21%

5. "Captial Cost" (including allowance for decommissioning)

$$\text{"Capital Costs"} = \frac{(\$/\text{KW plant cost}) \times (\text{AFCR \%}) \times (1000 \text{ Mills}/\$)}{(8760 \text{ hours/year}) \times (\text{capacity factor})}$$

$$= \frac{(962 + 39) \times (.18) \times (1000)}{(8760) \times (.69)}$$

= 29.8 Mills/KWH – 1978 $s

(Note: Variations around expected value will be shown graphically)

6. Uranium Oxide Cost

Anticipated $50/# in mid '80's (1985), perhaps as high as $58/as low as $40.

Low estimate	$27/# or 2.00 Mills/KWH
Expected estimate	$29/# or 2.54 Mills/KWH
High estimate	$39/# or 3.08 Mills/KWH

(assuming .0584 Mills/KWH direct, .0178 interest, .0771 total)

The U.S. Government estimates there are adequate domestic supplies of U_3O_8 in the ground to cover foreseeable needs. There are, however, individuals who disagree with the government estimates — some saying they are too high — some saying they are too low.

An extremely large find of ore of high quality has been just been made in Canada.

There may develop a milling capacity problem in the late 1980's.

7. Enrichment Cost

$88/SWU now anticipated to rise @ 5 - 6% a year or 1.95 Mills/KWH (assuming .0179 Mills/KWH $1 SWU direct, .0043 interest, .0222 total).

Supply adequate through at least 1990 with 40,000 SWU stockpile — centrifuge going on line.

8. Fabrication Costs

Per NEES — current cost is 0.55 Mills/KWH direct plus 0.1 Mill/KWH financing for time of fabrication or 0.65 Mills/KWH.

9. Waste Disposal Costs

   Based on literature search only, ulitmate technology has not been proven in practice. Wide range reflects uncertainty.

Low estimate	0.5 Mills/KWH
Expected estimate	1.0 Mills/KWH
High estimate	1.5 Mills/KWH

10. Stabilize Mine Tailings

    One estimate only – at 8¢/# = .05 Mills/KWH.

11. Total Fuel Costs

Uranium Oxide	2.54 Mills/KWH
Enrichment	1.95 Mills/KWH
Fabrication	0.65 Mills/KWH
Waste Disposal	1.00 Mills/KWH
Mine Tailings	0.05 Mills/KWH
Total Fuel	5.19 Mills/KWH (1978 $'s)

    (Note: Using 7% general inflation, the following are other estimates of total fuel costs corrected to 1978 $'s: MEPO – 5.7, AEC Wash 1/74 – 4.3, A.D. Little - 5.3, NERA – 4.3)

12. Operating and Maintenance Costs

    Use 2.60 Mills/KWH – 1978 costs for four Yankee operating plants (This is somewhat higher than AEC, Boston Edison, and MEPO estimates).

13. Total Nuclear Costs

Capital Costs	29.8 Mills/KWH
Fuel Costs	6.2 Mills/KWH
Oper/Maint. Costs	2.6 Mills/KWH
	38.6 Mills/KWH (1978 $'s)

The Arthur D. Little/New England Electric Systems Cost Derivation for Nuclear Construction and Operations

The Arthur D. Little/New England Electric Systems (ADL/NEES) nuclear plant costs are derived approximately as follows. Construction of two units in 1986 and 1988 respectively is contemplated. The capital cost of the pair is derived from $713/KW base estimate for 1978 by escalating at 7% per year for nine years to the 1987 midpoint. This process calculates a $1311/KW in the rate base in 1987 dollars. These units are expected to operate at 70% capacity factor for the first three years and 75% thereafter. With a fixed charge rate (AFCR) of 17.5%, one derives a 37.4 Mills/KWH capital charge in 1987, 34.9 after 1989. The fuel costs are estimated to rise at an increasing rate after 1987 starting at 8.8 Mills/KWH in 1987 and rising to 17.7 Mills/KWH by 2001. Maintenance (O & M) costs rise at 4% per year from 2.9 Mills/KWH in 1987 to 5.0 Mills/KWH by 2001.

The first year of operation costs total 37.4 + 8.8 + 2.9 = 49.1 Mills/KWH. However, the data are not presented in terms of first year costs, but rather in terms of 15-year levelized costs with a 11.6% discount rate. Therefore the annual costs in each of the first 15 years were averaged, but early years are given more importance than later years. These average capital charges are 35.8; fuel-10.9; and O & M-3.5, for a total cost of 50.2 Mills/KWH.

Table 17
Arthur D. Little/S.M. Stoller Capital Cost Assumptions

	Nuclear (2-1150 MW)
High	1468
Reference	1311
Low	1154
	Coal (3-800 MW)
High	1289
Reference	1172
Low	1055
	Oil (3-800 MW)
High	831
Reference	777
Low	722

Note: Nuclear, coal and oil installed on 1986/88 time frame.

Source: Arthur D. Little/S.M. Stoller Preliminary Draft, dated 9/78.

Conversion of the first year costs to 1978 is a straightforward exercise. ADL assumed an inflation rate of 6% during 1978, 5% during 1979, 1980 and 1981 and 4% therafter. ADL assumed an inflation rate different from the constant 6% per year assumed by the Supply Committee. The total rise in the price index from mid-1978 to mid-1987 is therefore 1.479. The first years costs are 49.1 divided by 1.479, or 33.2 Mills/KWH in 1978 dollars.

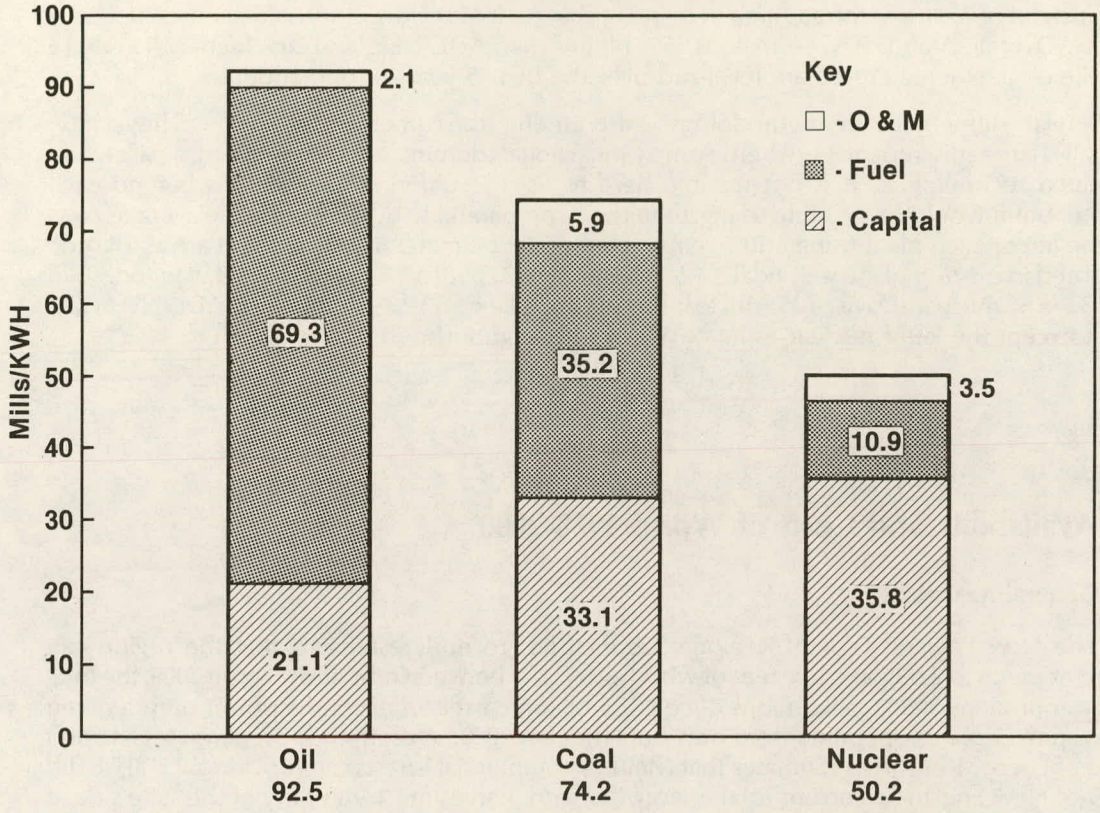
Conversion of the 15-year levelized cost to 1978 dollars is less straightforward. The "brute force" approach is the least confusing, so it is utilized: (1) calculate the current dollar costs in each of the 15 years 1987-2001; (2) convert each of these costs into 1978 dollars using the price index consistent with ADL's derivation; (3) average these 1978 dollar prices using an appropriate discount factor.

The second year costs are 49.2 Mills/KWH ; the third year, 49.5 Mills/KWH ; and the fourth year (with a higher capacity factor) 47.6 Mills/KWH . Thereafter the capital charges remain constant, while fuel and O & M costs yield 32.0 Mills/KWH in the second year; 31.0 in the third; 28.6 in the fourth; and 22.5 in 2001. A simple average of the values is 26.6 Mills/KWH, and a discounted average is 27.9 Mills/KWH.

This final value is the levelized cost in 1978 dollars for a plant completed in 1987. In order to calculate costs for a plant completed in 1990, one must move the capital, fuel and O & M costs forward by three years. The O & M costs are assumed to continue to rise at the 4% per year inflation rate after 2001. The fuel costs are assumed to continue rising at the 6.3% per year rate projected for the period. These two assumptions will have a minor impact on the costs. The major new assumption required is the rise in capital costs from 1987 to 1990. The same 7% (3% real) rate assumed from 1982 to 1987 is extended for this purpose to 1990.

Extrapolating to 1990, the capital, fuel and O & M costs total 60.5 Mills/KWH . Finally, converting each year's current costs to 1978 dollars yields a range from 35.2 Mills/KWH in 1990 to 24.2 Mills/KWH in 2004, for a levelized average of 29.9 Mills/KWH (See Figure 3(b) on page 6).

FIGURE 29
Projected 15-Year Levelized Generating Costs by Components
Reference Case*



***Current Dollars 1987-2001**
Inflation Rate 5% 1979-1981 and 4% thereafter.

Source: Arthur D. Little/S.M. Stoller
Preliminary Draft dated 9/78

An Analysis of the Differences in the Nuclear Cost Estimates (Robert Elgin, staff)

The de La Chapelle et al. estimate incorporates most of the same assumptions as the ADL/NEES estimate. The major difference is that ADL/NEES calculated average costs over 15 years whereas the former calculated only first year costs. The first year costs of the ADL/NEES estimate are 35.3 Mills/KWH or only 9% below the other estimate. This residual difference results mainly from a 30% difference in the estimate for O&M costs, a 9% difference in fuel costs, an addition of $39/KW for decommissioning, and a 1% difference in capacity factor. Levelizing the de La Chapelle et al. estimate over 15 years of operation would lower it to about 32 Mills/KWH.

The Alan Davis estimate is levelized over 30 years. This lowers capital costs and raises fuel costs without significantly affecting the total costs. The important differences are a 7% per year real escalation of capital costs instead of 3% (which raises total capital costs by 25%), a 60% capacity factor instead of 70%, and the addition of carrying charges for fuel inventory (which raises fuel costs by 80%). Overall, Alan Davis' estimate is 35% higher than ADL/NEES and 20% higher than de La Chapelle et al. when all three are levelized over the first 15 years of operation.

Similar differences in methodology exist among the other technologies. They cause especially large discrepancies when comparing capital dominated technologies against fuel dominated technologies. It is not feasible here to list the different assumptions behind each estimate, but it would be possible to improve their comparability by estimating the average costs over the life of each plant using a 10% real discount rate. Estimates in 1978 ¢/KWH are as follows: Oil burned in *existing* plants 4-5; tidal 3.4-5.2; wind 2.9-4.3; hydro 3.1-4.6; coal 3.9-4.9; wood/solid waste 3.5-4.5; nuclear (Davis) 4.35; nuclear (de La Chapelle et al.) 2.7-3.8; nuclear (ADL/NEES) 2.5-3.5. *All* except the latter nuclear estimate are in the neighborhood of 4.0¢/KWH.

The Availability and Costs of Wood 1978-2000

I. General Availability

The New England Federal Regional Council has recently estimated that the region can harvest as much as 2 billion cubic feet of wood every year between now and the year 2000, the total energy equivalent of 540 million tons of coal, 2.3 billion barrels of oil, or the power output of ten nuclear power plants operating from now until the year 2000.[1] A draft study prepared for Maine's Office of Energy Resources estimates that Maine's commercial forests can provide .62 x 10^{15} BTUs or 1/5 of New England's current total energy demand, harvesting 1/20 yearly of the state's dead trees, thinning overstocked acreage of 50% of its excess, and utilizing residues of current logging operations.[2] A wood availability estimate prepared by a Mitre Corporation researcher predicts that at least .3 x 10^{15} BTUs can be generated from New England's forests from mill and lumber residues, culling of undesirable wood, selective cutting of annual surplus growth, and minimal production of biomass plantations.[3]

New England has a vast energy reserve in its forest lands. Table 18 reveals the extent and distribution of the region's potential wood energy resources.

The state of Maine dominates the region, with better than 50% of New England's commercial forest land. Forest density ranges considerably from one state to the next, from New Hampshire's 1586 cu. ft. per acre, to Rhode Island's 1029.

II. Possible Sources of Wood Energy

Mill and logging residues, land clearings, diseased, dead, and undesirable standing trees, thinnings from overstocked acreage, annual surplus growth of tree parts not merchantable and biomass plantations represent the energy sources from New England's wood.

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[1]New England Federal Regional Council, *The Potential of Wood as an Energy Resource in New England*, September 1977. p. 23

[2]T.von Foerster, *On the Use of Wood as an Energy Resource in the State of Maine (Draft)*, January 31, 1978. p. 42

[3]Abbie Page, "Wood Energy Overview", speech for the Second Annual Conference of the New England Solar Energy Association, September 8, 1977.

Table 18
Forest Land Use in New England[1]
(thousands of acres)

	Commercial Forest Land	Productive Reserved	Unproductive[2]	Density* (cu.ft./acre)	Total Forest Acreage As % Total Land A
Connecticut:	1,806	30[3]	25	1,394	59.7
Maine:	16,894	221	634	1,424	89.7
Massachusetts:	2,798	104	50	1,395	58.9
New Hampshire:	4,692	55[3]	238	1,586	86.2
Rhode Island:	395	9	-	1,029	60.2
Vermont:	4,430	44[3]	20	1,333	75.7
Total N.E.	31,015	463	967	1,426	80.5

1. Source: *USDA Forest Service Resource Bulletins* NE-26, NE-36, NE-43, and NE-46. Based on merchantable bole concept and accounts for only commercial species
2. Incapable of producing 20 cubic feet per acre per year of industrial wood (all round wood products except fuel wood).
3. Includes some acreage used for Christmas tree production.

Table 19
Possible Sources of Wood and Bark for Energy in New England.

Source	From	Consisting of
Manufacturing residue	Pulpmills	Bark screenings.
	Sawmills	Bark, slabs, edgings.
	Veneer Plants	Bark, cores and clippings.
	Other	Bark, shavings and trimmings.
Logging residue	Timber stand improvement and commercial harvesting.	Tops, limbs, twigs, leaves, needles, stumps, and roots.
	Mortality (disease, insect, fire, and other causes).	Dead trees (down and standing).
	Nongrowing stock material	Cull (sound and rotten) and noncommercial species.
Land clearing	Forest land use change.	Trees not recovered for industrial wood.
Surplus of net growth over timber removals.	Commercial timber stands.	Entire growing-stock trees.
Biomass plantations	Dedicated acreage.	Trees dedicated for production of energy crop (usually thought of as all parts of the tree above the stump root system).

Source: F. Bryan Clark, USDA Forest Service, 1978.

RENEWABLE YIELD

A) Annual Growth - Undesirable Wood

Large quantities of wood are diseased, crooked, rough, rotten, or of a commercially undesirable species (e.g. grey birch). Often called "cull", this wood is the largest category available annually for energy use. Between 25 and 32 cubic feet/acre of this wood could be harvested each year.[1]

Table 20

Cull Increment Yearly

State	Cu. Ft./Acre	10^{15} BTU
ME	25.6	.13841
NH	25.6	.03844
VT	32	.045367
MA	25.6	.02292
CT	25.6	.014796
RI	25.6	.003236
TOTAL		.26317

Very extensive stands of existing cull may also be harvested. This one-time energy potential is estimated in the "nonrenewable yields" section which follows.

B) Annual Mortality

Cull wood which dies is another category which can be harvested. Calculated as .8 - 1.6 cubic feet per acre per year, the following estimates are based on a harvest of 1/10 the annual mortality.

Table 21

Annual Mortality

State	Cu. Ft./Acre	10^{15} BTU
ME	5.6	.00054
NH	5.6	.00015
VT	7	.00014
MA	5.6	.000089
CT	5.6	.000058
RI	5.6	.000001
TOTAL		.00978

[1]The estimates are based on data from the U.S. Forest Service, Charles Hewitt's "The Availability of Wood for a 50 MW Wood-Fired Power Plant in Northern Vermont," and the calculations of Alan Turner, Vermont Energy Office. Vermont's biomass estimates were adopted by Hewitt in light of Duxbury experiment and others demonstrating large underestimates of Forest Service surveys. For other New England states the author has multiplied Vermont's renewable estimates as calculated by Hewitt and refined by Turner, by 80% (25 cu. ft./acre - above). Vermont has a higher than usual percentage of overstocked acreage. Derivations of existing and future cull potentials, annual mortality, and existing and future thinning potential are rooted in similar calculations from the Forest Service data, Hewitt and Turner.

C) Annual Growth — Thinning of Pole-Sized Stands

Second growth stands of wood account for 1/3 to 1/2 of the region's forest acreage. These stands are dominated by timber whose diameter at breast height is 4" to 10", and therefore not useful as sawtimber. While the paper and pulp industries harvest these stands routinely, the timber industry thins these stands to allow room for some of the poletimber to grow to sawtimber size. By harvesting 1/4 of the annual growth in these stands, the following is yielded:

Table 22
Annual Thinning, Poletimber Stands

State	Cu. Ft./Acre	10^{15} BTU
ME	5.6	.009568
NH	5.6	.004245
VT	7	.00341
MA	5.6	.00299
CT	5.6	.00209
RI	5.6	.000417
TOTAL		.02272

The next section estimates the potential from harvesting existing pole-sized stands.

Harvesting this potential may be more costly than harvesting other categories of wood. The dense growth in many pole-sized stands requires smaller machines, careful felling and difficult skidding. Although smaller harvesting machines are on the market, the machinery most commonly utilized for wood harvesting is too large for this task. The process for pole-timber stands is today more labor-intensive and expensive than in sawtimber stands which are not overstocked.

D) Mill Residues

The wastes generated by saw mills and the pulp industry have been calculated as follows:

Table 23
Use of Mill Residues In New England

State	Million Cubic Feet: Used as Fiber	Used as Fuel	Other Uses	Percent Used	Content Unused 10^{15} BTU
ME	26.7	8.4	13.8	82	.00255
NH	8.9	1.3	6.3	85	.000690
VT	4.5	1.8	4.4	84	.000476
MA	2.6	0.7	2.4	77	.000405
CT	0.3	0.3	1.2	86	.000069
RI	0.1	0.1	0.1	86	.000012
				Total	.004202

Source: Abbie Page. Basic Data from James T. Bones, "Residues for Energy in New England," *Northern Logger and Timber Processor*, June, 1977.

E) Logging Residues

Abbie Page has calculated the parts of the tree left behind by loggers—everything but the merchantable bole (trunk and commercially desirable sections of wood) and the stump-root systems. It is important to recognize that logging operations take place on only a very small fraction of commercial forest land each year. In Maine, for example, where the forest industry owns almost half of all the commercial forest acreage, only 5.5% of the industry's land, and less than 3% of the state's commercial land, is harvested each year.[1] The industry's portion of the commercial land outside of Maine is considerably less, with a 32% total for the region (excluding Connecticut).[2]

Page cautions that her data is full of assumptions which cannot be easily tested. The Maine study estimates a total threefold that of Page's.[3]

Table 24
Annual Logging Residues In New England Forests
10^3 DTE Total Log Residues

State	Softwood	Hardwood	BTU x 10^{15}
ME	1509	1047	.043452
NH	91	215	.005202
VT	96	229	.005525
MA	69	137	.003502
CT	5	43	.000816
RI	2	8	.000170
TOTAL			.058803

Source: Abbie Page. Basic data from *Outlook for Timber in the United States*. Calculations based on methods found in MITRE/METREK *Silvicultural Biomass Farms*. Vol. VI.

NON-RENEWABLE YIELD

These categories of wood harvesting cannot be counted upon to generate wood energy into the 21st century. Land clearing, cutting existing cull, and thinning existing overstocked acreage in pole-sized stands are one-time yields. After the year 2000 the annual energy yield from land clearing should decline as the population stabilizes. If the one-time twenty-year harvest of existing cull and overstocked stands takes place, there will be no yield from these two categories after 2000.

A) Land Clearing

Table 25
Potential Wood Energy from Land Clearing

State	10^{15} BTU
ME	.00787
NH	.00520
VT	.00158
MA	.01409
CT	.00967
RI	.00145
TOTAL	.03986

[1]von Foerster, *Op. Cit.*, p. 17.

[2]USDA Forest Service Resource Bulletins, NE-26, NE-36, NE-43, and NE-46, tabulated on p. 13, N.E. Federal Regional Council, *Op. Cit.*

[3]von Foerster, *Op. Cit.*, p. 18. Includes cull and thinning as well as tops of trees, branches.

B) Existing Cull

A very sizeable yield, harvested over a twenty year period is possible from existing cull trees. Between 18 and 22.5 cubic feet/acre per year can be generated between now and 2000 from standing cull.

Table 26
Existing Cull

State	Cu. Ft./Acre	10^{15} BTU
ME	17.9	.096776
NH	17.9	.026878
VT	22.4	.031757
MA	17.9	.016028
CT	17.9	.01346
RI	17.9	.0022627
TOTAL		.187162

C) Thinning

Thinning the present pole-sized stands over a twenty year period similarly offers a generous energy harvest potential for the region:

Table 27
One-Time Thinning Overstocked Pole-Sized Stands

State	Cu. Ft./Acre	10^{15} BTU
ME	25	.04271
NH	25	.01895
VT	31	.012193
MA	25	.013353
CT	25	.009345
RI	25	.00186
TOTAL		.1817162

D) Total Wood Energy Potential

Adding together the one-time only and renewable yields from existing and yearly increments of cull; from thinning existing and yearly increments in pole-sized stands; from land clearing; and from mill and logging residues; we have available .68 x 10^{15} BTUs, or about 7 times present wood energy consumption, between now and 1985. This potential represents 25% of the total energy demand for New England in 1975, 87% of the residual oil consumption, and 108% of the distillate consumption for that year.

Table 28
1985 Total Wood Energy Potential

State	10^{15} BTU
ME	.341874
NH	.00520
VT	.100443
MA	.073195
CT	.050348
RI	.0094087
TOTAL	.684047

Additional Wood Energy Potential: 1985-2000

Wood harvests between 1985 and 2000 should improve as existing cull is removed, forest management practices are implemented more intensively and extensively, and logging and milling residues increase.

A) Logging and Mill Residues

By the year 2000, assuming a 3.5% yearly harvesting growth rate for the timber, pulp and paper industries, the yields from logging and mill residues could double:

Table 29

Potential Logging and Mill Residues: 2000

State	Logging Residues 10^{15} BTU	Mill Residues 10^{15} BTU
ME	.0869	.0051
NH	.0101	.0014
VT	.0110	.00095
MA	.0070	.00081
CT	.00163	.00014
RI	.0034	.000024
TOTAL	.1176	.00840

B) Biomass Plantations

Page's estimates can be converted into 1/10 of the tillable land defined as Class IV: "fair land with severe limitations caused by soil, slope or drainage...Suited only to occasional or limited cultivation."[1] Page's best guess of what can be harvested from biomass plantations are:

Table 30

Potential Wood Energy from Biomass Plantations on 1/10 of the S.C.S. Class IV Acreage in New England

State	Acres	10^{15} BTU
ME	123,341	.0150
NH	9,662	.00082
VT	23,784	.00219
MA	10,385	.00083
CT	27,807	.00236
RI	8,968	.00076
TOTAL	179,616	.01751

Counting upon a large estimate from this potential resource would be hazardous. The pattern of dispersed small land-holdings in southern New England, the prevalance of slopes on Class IV lands, the slower growth rates in comparison to southern biomass plantations, and the erosion risks are barriers to successful implementation of biomass plantations on a large scale for the region.

[1]Abbie Page, *Op. Cit.*

The potential of this virtually untested venture should await a final demonstration to determine its long-term feasibility for New England.

C) Biomass Productivity Increase

Today, European forests are much more intensively managed than those in the U.S., and forests with characteristics similar to ours have productivities better than 10 times as large.[1] Instead of New England's annual yield of 1 and 1/2 - 2 tons per acre, they routinely harvest 15 tons per acre per year of which 2/3 is suitable for energy purposes. By removing cull, thinning, planting, and undertaking careful soil maintenance practices, the region could increase its biomass productivity considerably by 2000. To be conservative, we estimate that the wood energy harvest from annual growth thinnings, logging and mill residues could increase 20% from additional biomass growth by the year 2000.[2]

Table 31

20% Biomass Productivity Increase

State	10^{15} BTU
ME	.02119
NH	.00315
VT	.0031
MA	.00216
CT	.00772
RI	.000156
TOTAL	.0305

D) Total Wood Energy Potential

In the year 2000, the potential increases to almost .86 x 10^{15} BTUs, but declines after that date. The high proportion of the 2000 total comprising one-time yields promises smaller harvests after 2000. Wood energy should be looked upon as a transitional fuel to the 21st century.

Except for residential and commercial space heating, especially in northern New England, and for the sizeable energy needs of the forest industries, wood energy is limited in its long-term applications to our region's unique energy needs. But between now and the end of this century, wood offers an attractive source for indigenous energy.

Table 32

Potential Wood Energy: 2000

State	10^{15} BTU
ME	.4700
NH	.115223
VT	.117688
MA	.084045
CT	.05525
RI	.010688
TOTAL	.858

[1]von Foerster, *Op. Cit.*, p. 30 (Rich and Bauer, 1975).

[2]von Foerster estimates a 100% increase in surplus annual growth.

Table 33
New England Wood Energy Potential
10^{15} BTUs

	ME	NH	VT	MA	CT	RI	N.E. (Total)
Renewable Yield							
Cull Increment	.13841	.03844	.045367	.02292	.014796	.003236	.26317
Annual Mortality	.00054	.00015	.00014	.000089	.000058	.000001	.00978
Annual Thinning Poletimber Stands[1]	.009568	.004245	.00341	.00299	.00209	.000417	.02272
Mill Residues	.00255	.00069	.000476	.000405	.000069	.000012	.004202
Logging Residues	.04345	.00520	.005525	.003502	.000816	.00017	.058803
Non-Renewable Yield							
Land Clearing	.00787	.00520	.00158	.01409	.00967	.00145	.03986
Existing Cull	.096776	.026878	.031757	.016029	.01346	.002207	.187162
One-Time Thinning	.04271	.01895	.012193	.013353	.009345	.00186	.09841
1985 TOTAL	.431874	.099753	.100448	.073195	.050348	.0094087	.684047
Post-1985 Renewable Yield							
Logging Residue Increment	.0869	.0101	.0110	.0070	.00163	.00034	.1176
Mill Residue Increment	.0051	.0014	.00095	.00081	.00014	.000024	.00840
Biomass Plantations	.00150	.00082	.00219	.00088	.00236	.00076	.01759
20% Productivity Increase	.02119	.00315	.0031	.00216	.000772	.000156	.0305
2000 TOTAL	.4700	.115223	.117688	.084045	.05525	.010688	.858
Barrels of Oil Equivalent	80,967,000	19,866,000	20,291,000	14,490,000	9,525,000	1,842,000	147,951,000

[1] Pole-sized stands acreage: Maine: 5339; New Hampshire: 2369; Vermont: 1524; Massachusetts: 1669; Connecticut: 1168; Rhode Island: 233.

II. End Use and Costs—Today and Tomorrow

A) Home Heating

Residential use of wood for space heating has risen dramatically since the Arab oil boycott. While no accurate data is available for residential wood-burning in past years, an official of the Vermont Energy Office estimates that residential wood burning has increased five-fold since 1975.[1] Today, 18% of Vermont homes use wood as their primary heating fuel; 63% burn wood to some degree. The Vermont Energy Office reports that 300,000 cords of wood, or 6.7 x 10^{12} BTUs were burned in households last year. A 12% increase is projected for 1978 in Vermont. The New England total for 1977 is in the 1.1—1.2 million cords range, or 23—25 x 10^{13} BTUs.[2] In 1977 prices, wood is delivered today at $60-80 per cord, or $2.80-3.70 per MMBTU. No. 2 fuel oil is priced at $3.40 per MMBTU. Electricity is $11-15 per MMBTU (in Maine). In the northern New England states, the price is closer to $50 (assuming trucking of 25 miles); in the southern states, $80, with frequently higher prices for delivered wood. With a rapidly expanding market all over New England, the regional differential should close somewhat in future years. The Maine study indicates that new wood furnaces in that state will cost the average homeowner the same as an existing oil furnace in annual costs ($474/yr) and a new wood stove $60 more per year. A wood furnace add-on would be only $365/yr., the cheapest of all heating alternatives.

B) Commercial Heating

Today commercial heating with wood is insignificant. Yet the Maine study indicates that commercial wood heating systems would be cheaper than conventional heating today.

[1]Telephone interview with Alan Turner, Vermont Energy Office, September 6, 1978.

[2]Telephone interview with Curtis Mildner, NERCOM, September 7, 1978. NERCOM surveyed the region's state energy offices for wood heating data in the residential and industrial sectors.

Table 34
Fuel Costs to Residential Consumers

Firewood			#2 Oil		
$/Cord	45% Stove Efficiency $/MMBTU	60% Furnace Efficiency $/MMBTU	$/Gallon	50% Furnace Efficiency $/MMBTU	60% Furnace Efficiency $/MMBTU
40	3.51	2.67	.50	7.24	6.05
50	4.40	3.34	.55	7.96	6.64
60	5.26	4.00	.60	8.68	7.25
70	6.16	4.67	.65	9.40	7.85
80	7.05	5.35	.70	10.14	8.47
90	7.92	6.02	.75	10.86	9.07
100	8.80	6.68	.80	11.60	9.69
120	10.56	8.02			

Conversion factors: Wood: 25 MMBTUs/Cord
#2 Oil: 5.8 MMBTUs/Barrell

Table 35
Annual Costs of Commercial Heating Systems in Maine

	Furnace			Fuel		System
	Initial Cost $	Annual Cost* $/yr	Efficiency	Unit Cost $/$10^6$ BTU	Annual Cost $/yr	Annual Cost $/yr
GAS	600	100	0.6			
residential				3.0	2500	2650
L.N.G.				3.5	2900	3050
OIL	1500	250	0.6			
residential				3.4	3400	3650
industrial				2.8	2800	3050
WOOD CHIPS	6100	950				
green, local			0.5	1.4	1400	2350
dried, distant			0.6	2.0	1650	2600
dried, delivered***			0.6	2.3	1900	2850

* 0.158 times the initial cost.
** including $5/ton for handling & delivery

All prices are estimates for 1977.
All costs rounded to nearest $50.
Fuel Costs based on annual heating demand of 500 × 10^6 BTU.

Source: T. von Foerster, *On the Use of Wood as an Energy Resource in the State of Maine*, (Draft).

Commercial wood-burning should increase considerably in the years to come, particularly in new buildings, and particularly in northern New England. Estimates of the extent of conversion are difficult; much will depend on the rate of increase of oil prices.

C) Utility Electricity Generation

Burlington Electric is today operating a 10 MW wood-burning plant costing 21 mills/KWH at the busbar on a 75% wood/25% oil over-fire basis. The wood portion costs 18 mills/KWH at the busbar. The wood is delivered as chips at $12.00—12.50 per ton and arrives from within a 50 mile radius. Saw mill residues and whole tree chippers provide the wood for burning. A 10 MW boiler will soon be converted to almost 100% wood. A

third boiler (30 mills/KWH) is 55-45% coal-oil over-fire. Burlington Electric is planning a 50 MW 100% wood-fired plant for completion in 1980, to cost consumers 51 mills/KWH in 1983 dollars or 34.7 mills in 1978 dollars.[1] Two other studies forecast a range of 40-60 mills in 1976 dollars.[2] This is competitive with future coal and nuclear generation. The boiler will require 2 and 1/2 years to build and cost an estimated $80 million in current dollars. They expect delivered wood chips to cost $19-20 in 1983 dollars. A Dartmouth feasibility study[3] predicts that delivered wood chips will cost from $10.88 to $17.56 in 1978 dollars. In 1983 dollars this range is $15.26 to 24.63, well in line with Burlington Electric's projections. The boiler will burn 550,000 green tons per year of 1500/tons/day. Currently they burn 200-250 tons per day. The Dartmouth College study concludes that there is plenty of wood available and feasible for procurement within a nine county area in northern Vermont. In fact, Vermont can most probably support three 50 MW wood-burning plants, generating 20% of the state's current electricity demand.[4] An energy consultant and principal author of another study examining the feasibility for generating electricity from wood testified at licensing hearings for the Seabrook nuclear plant that all of New Hampshire's electricity needs could be met with wood-fired boilers stocked by instate wood chip purchases.[5] Adopting the most conservative written feasibility estimate for electricity generation and applying its parameters to Maine, Vermont and New Hampshire, 1,000 MW wood-fired plants could be built. This estimate takes into account the inaccessibility of millions of acres at greater than 15° slope, farther than 1/2 mile from a road, and/or protected by owners unwilling to allow harvesting. It assumes only low quality wood would be harvested for electricity generation purposes. This 1000 MW capacity for New England's northern tier represents 23.5% of its current electrical capacity and almost 5% of the region's current capacity. With better than a 95% demonstrated capacity factor, wood-burning has proved to be a much more efficient electricity source than historical projections indicate.

D) Industry—Electricity

There are only incomplete figures on the extent to which industry burns wood for heat and electricity generation. The Maine study estimates that 35-50% of the forest industry's total energy needs are now met with wood. The Vermont Energy Office estimates that Vermont industry uses $.33 \times 10^{12}$ BTUs in wood today and will burn 1.6×10^{12} BTUs by next year. A NERCOM official reports that 20 industries in the region cogenerate at least 1/2 MW of electricity, a large potential market for wood-burning. Since this electricity has not been sold off the premises to date, no price data is available. The cogeneration potential for wood-burning is substantial, particularly in northern New England.

E) The Forest Industries' Use of Wood

The lumber, pulp and paper industries consume approximately 5% of the region's total energy today. Almost 15% of this total, or $.025 \times 10^{15}$ BTUs is consumed in wood energy.[6] This represents 3/4 of total wood energy consumption in the region. If the forest industries can become 90% energy self-sufficient by 2000, better than 4% of the region's

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[1]Telephone interview with Bob Young, Burlington Electric, August 29, 1978.

[2]Kathleen T. Segerson, *Estimating the Cost of Wood-Generated Electricity:* A Broader Perspective, Dartmouth System Dynamics Group; and Allan J. Schultz, *Feasibility of a 50 MW Generating Plant Using Wood for Fuel,* study for the Vermont Public Service Board, January 1977.

[3]Charles E. Hewitt, *The Availability of Wood for a 50 MW Wood-Fired Power Plant in Northern Vermont,* a report prepared for the Vermont State Energy Office, Dartmouth College, Hanover, N.H., June 1978.

[4]Interview with Phil Rich, J.P.R. Associates, September 7, 1978.

[5]Carl H. Reidel, *The Yankee Forest: A Prospective,* Yale School of Forestry and Environmental Studies, 1978, P. 13.

[6]1972 Census of Manufacturers, (Department of Commerce), SR 6: pp. 98, 99.

energy needs would be consumed by wood—and this total does not include residential or commercial heating or industrial and utility cogeneration.

The escalation in oil and electricity costs, cogeneration opportunities, and recent wood chip technology innovations are propelling the forest industries closer to self-sufficiency. If certain financial incentives—investment tax credits, accelerated depreciation on new equipment, and/or low interest loans are made available by Congress, this trend may accelerate.

F) Future Costs

The lack of data available anywhere within the industry and within the federal government testifies to the hazardous enterprise of estimating future wood energy prices. Two different markets will largely shape future prices of wood fuel. First, the prices commanded by the pulp, paper, and emerging particle board industries will have a large impact on the price and supply of firewood and wood chips. Although today the competition is quite limited, and careful forest management should provide an ample supply for the energy and non-energy industries utilizing the same low quality wood, past experience does not indicate that careful forest management will result (see Competitive Uses section for more discussion of these issues).

The other market pressure affecting the price of wood energy is the price of the most common fossil fuel alternative: home heating oil. Many foresters predict that wood energy will track #2 oil prices, hovering just below to compensate for the inconvenience associated with the labor requirements of burning wood. Predicting the future prices of #2 oil, however, is equally a speculative venture. The Supply Committee has, however, bravely undertaken this task, and predicted a 1 and 1/2% real price yearly increase in home heating oil until 1990, a 7% increase annually from 1990-1995, and a 5% increase yearly from 1995-2000. The wood energy market should not undergo the extreme discontinuities predicted for the oil market after 1990—unless integrated resource management scenarios are not implemented.

Recognizing the speculative nature of such an enterprise, the committee predicts a 1% annual average increase in the real price of wood energy from 1978-2000. It must be emphasized that the confidence level in this projection is not high because of the expected volatile nature of future oil prices and the difficulties inherent in predicting competition with other forest products for an industry with a low market penetration to date in populous southern New England.

There will also continue to be some discontinuities in the price southern and northern New Englanders pay for wood fuel. Northern New Englanders start with a current base of $45-55 per cord (1978 dollars), while metropolitan areas of southern New England are paying $80-100 and higher. Today urban dwellers are not buying wood at competitive prices with #2 oil, because most are burning wood for aesthetic and recreational purposes in fireplaces. As wood stove sales begin to increase at levels commensurate with those in rural areas of the region, and wood heating replaces #2 oil, prices should begin to approach those of heating oil. Yet the rate of increasing demand, the distance from the supply source, and the continued reliance upon fireplaces for aesthetic purposes will keep urban area prices in southern New England $20-30 per cord higher than in Northern New England.

III. Distribution Systems

The lack of an integrated supply network to move the wood from the forests to homes, commercial establishments and industrial boilers may be the greatest impediment to full utilization

of the resource. Particularly in urban settings, the firewood market is quite disorganized. A recent Maine Audubon Society survey revealed that marketing outlets are required, producers' and consumers' cooperatives should be organized, and many more wood entrepreneurs are needed to meet the growing demand.[1]

The roundwood and wood chip markets will have very different requirements. Different harvesting machinery, categories of wood trucks, and end-users are involved. Transportation may be a particularly vexing problem. To remain economic for long hauls to metropolitan areas, large trucks carrying 15-20 cords may be required per load. Yet current state weight restrictions limit most carriers to approximately 15 cords. And the number of trucks must substantially increase—doubling or tripling in the next several years—to utilize the resource. The capital requirements for such an expansion are considerable. Railroad transportation is impractical for most locations because trucks must be proximate to logging sites to eliminate extra handling of the wood. Only in northern Maine is rail transportation regularly utilized today. The wood chip market, requiring closed vans and larger volume storage areas per unit of weight, may rely on rail more in the years to come.

The integration of forest management policies to meet the needs of these two markets, as well as the pulp and paper and lumber markets, will be a formidable task. Additionally, foresters must factor in recreation, water, wildlife and land use requirements into an overall policy for managing the forests resource. Balancing the demands of 4-5 growing industries utilizing the forests with different equipment for differing categories of wood and the interests of sportsmen, conservationists and developers poses a long-term public policy dilemma for town planners, state and local foresters, and various state and federal agencies. Coordination of these diverse interests requires elaborate, intelligent resource management strategies and implementation.

IV. Jobs

A Yale University study reports that 60,000 new jobs can be created for the region by utilizing the annual surplus growth for all its potential economic uses.[1] A recent Brookhaven National Laboratory study estimates that 10-16,000 jobs can be created in the Northeast from the wood energy business alone.[2] One 50 MW plant is projected to create 282 jobs, 147 directly in the plant or as wood harvesters.[3] For the 2-3 year construction period, 771 jobs would be created. The author also points out that a wood-fired boiler built in Vermont would most likely be located in a high unemployment area, resulting in a substantial boost to the surrounding region. Maine and New Hampshire could similarly profit by the strategic location of wood-burning plants.

V. New Technologies from Wood

A) Pelletization

This process dries wood (bark, chips, sawdust, edgings, etc.) to 25% moisture, pulverizes the mixture and presses it into pellets. Agricultural wastes, grass, peanut shells, peat, refined solid waste and bogasse (sugar cane refuse) can also be used as feedstock for pellitizing. With a BTU value of 8750/lb. wood pellets can be burned directly as a fuel or converted to gas for use as a boiler fuel. A local firm, Bick-Com, is planning to build a plant in Maine which will produce 300 tons per day. The pellets will sell for $34 per ton from the factory, or $1.95 per million BTUs. The plants are being built to supply primarily industrial boilers within 50-100 miles from the plant. If wood chip transportation costs are

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[1]Elizabeth Swain, Massachusetts Audubon Society

[2]Brookhaven National Laboratory, *Assessing Employment Implications of Alternative Energy Supplies,* National Center for Analysis of Energy Systems, February, 1978.

[3]Segerson, *Op. Cit.,* p. 6.

[4]N.E. Federal Regional Council, *Op. Cit.,*p. 28.

comparable, a one-hundred mile delivery would add $4.00-7.00 per ton to the cost, bringing the total delivered price to $2.17 to $2.35 per MMBTU, a competitive price with alternative fuels. Bick-Com's parent company, Biosolar R & D of Eugene, Oregon, is designing a firebox adaptable to any boiler. Even residential use of wood pellets is contemplated. Bick-Com expects to build many more plants during the next ten years in New England. Financing difficulties, however, are currently hampering Bick-Com's building plans, and delays are expected.

B) Wood Gasification

High combustion efficiencies ranging from 75-90%, clean burning, and relatively low capital costs are three reasons wood gasifiers coupled to boilers may be an increasing phenomenon in the industrial and residential sector. Wood chips are fed from a storage area through a dryer into a gas generator. The wood combustion maintains a temperature ranging from 1200-1600 degrees inside the gas generator. The wood decomposes by pyrolysis, yielding distillate gas and charcoal. Air supplied to the glowing charcoal reduces the charcoal to carbon monoxide and gas.[1] The distillate and carbon monoxide gases flow through a nozzle burner assembly where secondary combustion takes place. Simultaneously the heat released in primary combustion is carried with gas stream into the secondary combustion zone, producing a gas containing 200-250 BTU/cu. ft. Industrial market sales are expected to begin next year. The Massachusetts Technology Development Corporation is currently planning to install a wood gasification system to provide the space heating and hot water needs of a 489-unit apartment complex in Springfield, Mass. Initial calculations indicate annual fuel savings of $70,000 or more over the present natural gas system.

C) Methanol

Wood alcohol is a colorless, odorless, water soluble liquid produced during pyrolysis of wood. Already methanol and gasoline mixtures, containing 15% methanol, have been tested in automobiles without any engine modification. While there is some controversy about the success of the initial testing, advocates claim improved energy economy, lower emission, and improved engine performance over gasoline. Methanol currently costs about 43¢/gallon at the refinery (gasoline 38-40¢, according to New England Federal Regional Council figures). Yet methanol contains only 1/2 the BTU value of gasoline, raising its costs as methyl fuel (which includes small amounts of propanol, ethanol, and isabutanol) to about 65¢/gallon at the refinery. Only as gasoline prices increase significantly (closer to $1.00) will methanol become attractive as a fuel.

VI. Competitive Uses of Wood

The harvesting of slash, cull, and thinnings will not be affected by the forest industry utilizing roundwood or tree boles, the raw material of most forestry products. Yet pulp, reconstituted board, and possibly the chemicals industry may also have use for the low-quality wood now unutilized. The pulp industry in particular is now deriving 20% of its materials from saplings, tops and branches, and rough or dead trees. The development of the portable whole-tree chipper has accelerated their exploration of these wood resources. Chip classifiers, not in widespread use today, would increase pulp industry competition further because this machine can separate undesirable bark from wood before chipping yet the competition should not seriously deplete the forests. Even if the pulp industry maintains its present 3.7% annual growth, only 14 million tons of wood would be harvested in the year 2000 in the state of Maine, up from 4 and 1/2 million tons per year in 1970. The growing particle board industry may also compete for more of the market. With careful silviculture methods the forests should be capable of adequately supplying both the pulp and energy markets. The major effect of the limited competition between the two markets may be

[1]von Forester, *Op. Cit.*, p. 105

that of price-setting determined by the most valuable use. If fossil fuel prices increase significantly in the next decade, wood will be a popular substitute, driving prices up, resulting in an increase in the price of paper.

VII. Constraints Limiting Harvests

Five categories of constraints deserve mention: technology, physical accessibility, institutional accessibility, landowner attitudes toward harvesting, and environmental impacts. Many of these constraints vary widely by state. Others are likely to undergo major changes in a short period of time. The dimensions of still others are largely unknown. The following brief discussion cannot do justice to a very complicated set of issues, but will outline the kinds of problems and opportunities accompanying wood energy production.

A) Technology

The cutting (felling), moving (skidding) and chipping of wood have all benefited from innovations in recent years which renders previously untapped stands feasible for harvesting. The recently developed feller-buncher cuts trees with hydraulically powered cutting shears mounted on a tractor. Equipped with "accumulators", these machines are capable of carrying several felled trees at once. For small timber, production can be doubled or tripled with use of accumulators.[1] Yet small machines must be developed which can operate on hilly terrains, on wet soils, on small parcels, and for thinning. Grapple skidders, four-wheel drive machines with a claw in the rear, haul several felled trees to a landing. Skidding with horses is still done in some locations, minimizing the soil damage.

Portable whole tree chippers have revolutionized forest harvesting. Operated by one person, the chipper can convert a 22 inch diameter tree into chips in 30 seconds and transfer the chips into a truck within 50 seconds of start-up. Chipping can be performed in the forest or at a processing plant.

These new technologies improve the wood procurement system several fold. As prices for wood energy products rise, it will become increasingly economical to harvest steeply sloped, or densely forested, or remotely located stands, and we can expect yet new machines to facilitate harvesting and make more readily available what today is untouched.

B) Physical Accessibility

Steep woodland slopes and the lack of roadbeds in harvest areas restrict the availability of wood for energy uses. Slopes greater than 15° are very difficult for feller-bunchers and grapple skidders to negotiate. The unsuitability of mechanized harvesting techniques for this wood requires more labor-intensive techniques and higher prices. Only higher fuelwood prices would make such harvesting feasible. Slopes of this degree are concentrated in sizeable pockets in the Massachusetts Berkshires, New Hampshire's White Mountains, Vermont's Green Mountains, and in western Maine. Less than 15% of the region is covered by slopes of this gradient. Harvesting steep slopes is possible, however—especially with the introduction of new smaller equipment capable of negotiating this difficult terrain.

The stands farther than 1/2 mile from an accessible roadbed make current harvesting uneconomical. These areas correspond closely to the areas with steep slopes. Again we can expect that rising wood fuel prices will result in more road-building and improved access to these areas.

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[1] *Ibid.*, p. 113-115.

C) Institutional Accessibility

Local, state and federal governments collectively own 6.2% of the area's commercial forest land. Various recreational, conservation, and wilderness purposes obviously restrict the land available for harvesting. Stricter procedures and regulations than private landowners would require would similarly limit production. Yet public lands offer the potential of early and effective forest management techniques through R & D pilot programs. It is difficult to estimate what net impact public lands will have on the availability of wood.

D) Social Attitudes

What private woodlot owners are willing to do with their land is a subject of intense speculation and scrutiny. Interviews have been conducted and attitudes questioned, but this polling is a hazardous and rather unreliable process at present. What researchers have discovered generally is that larger landowners (more than 500 acres) are more willing than smaller landowners to allow whole tree harvesting—the technique necessary for low-quality wood production for energy purposes—on their property. One northern Vermont study indicates that 3/4 of the owners of all land sizes are willing to have their land harvested, but only 1/2 are willing to allow whole-tree chipping. Thinning was not queried.[1] Yet whole-tree chipping is a technique unfamiliar to most landowners, so the reliability of such question is suspect. Second, the larger landowners own a disproportionately large fraction of total commercial forest land; in northern Vermont owners of 500 acres or more own 4 times the property owned by those with 150-199 acres, and 40% more than those with 200-500 acres. Therefore those now willing to allow harvesting represent a large portion of total available land. Third, attitudes are likely to change drastically as wood energy markets cuts into the fossil fuel market and commands higher prices. Much of the present resistance among a minority of commercial landowners is rooted in an (1) unfamiliarity with harvesting techniques and impacts on their property, and (2) unfamiliarity with the price their stands can command for energy production.

Table 36
Survey of Northern Vermont Landowners Attitudes Toward Harvesting and Whole Tree Chipping on their Property
(Owners of 150 to 199 Acres)

	Willing to Harvest (Percent)	Willing to Whole-Tree Chip (Percent)	Acres Owned		Acres Available For Chipping	
			Number	Percent	Number	Percent
Yes	72	50	4,696	40	3,406	29
No	19	38	3,907	33	0	0
Unsure	9	12	3,157	27	?	?
Total Timber Acres			11,760			

No. of Owners Making Useful Responses: 109
Total Acreage in Survey: 18,087 acres

E) Environmental Constraints

At the harvest site and in combustion, wood as a fuel can have significant environmental effects. The carbonacious matter in wood removed for burning does not harm the forest, but the matter taken from the soil is a more serious problem. Decomposing leaves, needles and trees provide up to 40% of potassium and 85% of the nitrogen in the soil. Hauling away tree tops, branches, leaves and twigs may deplete two-

[1] *Ibid.*, p. 113-115.

three times the soil nutrients that conventional bole harvesting removes. The removal of slash also exposes the soil to considerably more erosion and leaching from rain. It could take 45-80 years to fully restore nutrients and biomass lost after a whole-tree harvest.[1] Planting some rapidly growing grasses or other plants, including clover, can serve to replenish the nutrients and stabilize the soil. The ash from burnt wood may be a good fertilizer. Logging operations also damage the soil surface from skidding operations. Carefully constructed, particularly permanent, logging roads reduces that damage considerably. Finally, removing trees at a rate enabling the forest to recover also diminishes erosion and improves forest quality.

Wood is a fairly clean burning fuel. It contains very little sulphur, yet ash, nitrogen, and particulate emission must be monitored and controlled. The technology developed for coal-burning plants should be adequate to control the ash and particulate emissions. Wood burning stoves and furnaces in homes present larger potential problems in aggregate, because combustion is more incomplete. Therefore, suspended particulates emitted are more voluminous, and in urban areas, unacceptable pollution levels could be reached. Benzopyrene, a carcinogencic substance, is produced in wood-burning at a rate of 50 times that of oil or gas. One study estimates that wood-burning could cause up to 10 deaths per year per million people.[2] Yet this study also points out that people smoking one cigarette per day have an excess death rate of 200 per year per million people. There is insufficient data to assess accurately the public health effects of widespread wood-burning. A preliminary analysis indicates that some adverse effects do accompany combustion, but the adequate controls, such as more efficient furnaces and stoves, can reduce the dangers considerably. More study is clearly called for at the point that wood-burning becomes widespread as a home-heating fuel in urban areas.

The Biomass Subcommittee of the Economic Development through Alternative Sources of Energy Committee has undertaken a more thorough analysis of the environmental impacts associated with wood energy harvesting and burning.

VIII. Conclusion

On balance, wood is an excellent indigenous energy resource for New England. It can be used for two purposes currently consuming large quantities of oil electricity generation and space heating. With a 2 and 1/2 year construction period and a 2 and 1/2-3 year licensing period, wood-fired electricity can be added to the grid more quickly than conventional systems. It appears to be competitive today and in the future with conventional fuels for electricity generation. It could provide 1000 MW, or 8% of today's capacity by 1990. Wood should be increasingly attractive to industries as a cogeneration source. Its potential role in space heating, which currently consumes about 30% of our petroleum usage, and 25% of all New England's energy, is even greater. In 1975, New England used approximately 1.4×10^{15} BTUs of petroleum, or 240 million barrels of oil for electricity generation and space heating in the residential, commercial, and industrial sectors. Today, we have the wood resources available to substitute for almost 1/2 of the 1975 oil consumption. By 1985 and later, given reasonable assumptions, we should be able to develop this resource to the point that 10-15% of our total energy requirement are met by wood. If an oil and gas shortage or significant price increases occur in the next decade, that contribution could be even greater.

The Supply Committee has set a goal of utilizing $.5 \times 10^{15}$ BTUs for wood energy by 2000. This is an achievable, but difficult objective to meet. It represents an increase in woodburning of 10% per year between 1978 and 2000. Landowner attitudes, plot sizes, terrain dimensions, accessibility to roads, forest management policies, new technologies, market development, oil prices and capital availability are significant factors which will impact the realizable potential. In general, the northern New England states should achieve a greater percentage of this potential than southern New England. Estimates of the contribution to the committee optimal mix follow on Table 37.

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[1] *Ibid.*, p. 113-115.

Achieving the objective established by the Supply Committee will require additional financial tax incentives to wood producers and wood stove and furnace consumers; extensive communication between foresters and landowners to encourage suitable forest management practices and appropriate wood harvesting; the development of a stable supply network, particularly in urban southern New England; the introduction of more small harvesting equipment to work on small plots, difficult terrain, and overstocked lands; the finding of environmentally acceptable consequences from increased wood-burning and harvesting; and the continuance of real price increases in oil. New England's energy future will depend to an increasing extent on its ability to convert to renewable fuels—and wood offers the greatest resource potential of the renewables for the region over the next two decades.

Table 37
Wood Contribution to Optimal Mix: 2000

State	Resource Available	Estimated % Harvested in 2000	Total BTU × 10^{15}
CT	.055 × 10^{15}	60	.033
ME	.47 × 10^{15}	70	.329
MA	.045 × 10^{15}	60	.28
NH	.115 × 10^{15}	60	.069
RI	.010 × 10^{15}	40	.004
VT	.117 × 10^{15}	60	.070
TOTAL			.537

Table 38
Some Representative Energy Prices

		$/$10^6$ BTU
Mill Residues		
Seadust, Maine, 1976	(1)	.029
Hardwood Bark, New England	(2)	.45
Hardwood Sawdust, New England	(2)	.90
Chips		
Hardwood Pulp Chips, New England	(2)	1.54
Softwood Chips, Maine	(1)	2.35
Chipped Logging Residues	(1)	1.77
Biomass Plantation Wood	(3)	1.96
Coal		1.09
Industrial Residual	(4)	2.36
Residential Distillate		3.46

Sources:

(1) Mitre/Metrek, Silvicultural Biomass Farms, Vol. VI.
(2) James T. Bones, "Residues for Energy in New England"
(3) Mitre/Metrek, Silvicultural Biomass Farms, Vol. IV.
(4) FEA, reported in "Energy User's Report". June 1977.

Table 39
Summary of Delivered Cost of Wood Chips in Northern Vermont
($/Ton: 1978 Price Basis)

Production Stage	Low Cost	High Cost
Stumpage	$0.40	$1.00
Harvesting	8.10	13.00
Transportation	2.38	3.56
Expected Delivered Chip Price Range	$10.88	$17.56

Urban Waste As An Energy Source For New England

(Clem Griscom)

I. Summary

About 15% of the organic wastes generated each year in the United States is urban refuse, or post-consumer residential and commercial waste. Urban waste is generated at the rate of four pounds per capita per day and contains 4500 BTU per pound. New Englanders generate 49 million pounds per day which is the energy equivalent of 13 million barrels of oil per year.

Resource recovery plants, which burn the refuse and separate the non-combustibles for resale, produce steam and generate electricity. The Bureau of Mines assesses the 1978 market potential for these plants as being 480 MW of electricity and cogenerate process steam. This short-term goal would replace 5-million barrels of oil per year. It is shown that 25% of this goal is extant or in advanced planning stages today. The intermediate-term goal, dependent upon modular plant sizes using no more than 1200 tons of refuse per day, would supply 730 MW of electricity and process steam, and increase oil savings by another 50% to 7.5-million barrels per year.

The paper urges two changes in attitude: (1) that this is an energy resource as well as an amelioration of solid waste problems and (2) that incentives must be forthcoming to alter utility company attitudes towards resource recovery and the cogeneration of steam and electricity.

II. Background and Goals

Each day of the year New Englanders throw away material, in the form of rubbish, trash, or garbage, whose usable energy content is equivalent to some 34,300 barrels of oil (12 million per year). This wasted energy is from residential and commercial sources only, and excludes agriculture, forestry, and industrial waste. At the same time (1976 data), New England imports from 310,000 barrels a day (113 million per year) of residual fuel oil from foreign sources. (New England Situation, Chapter II, p. 16) This is used mainly in electric and process steam generating plants. Therefore, if all discarded residential and commercial wastes were used as fuel for these plants, New England could cut her residual fuel imports by 11% (34.3 divided by 310). From the viewpoint of electric generation alone, since about 50% of the residual fuel consumed is used by the electric utilities, if all urban refuse in New England was used to fuel electric generating plants, the utilities could cut their present day residual fuel imports by 22%. The derivation of these rather significant estimates is discussed in the following sections.

III. Urban Waste Generation in New England

An investigation by the U.S. Bureau of Mines (Circular #8549, 1972) into the energy potential of organic waste in the U.S. resulted in the estimates which appear on Table 40.

As noted there, municipal solid waste, post-consumer residential and commercial waste, amounts to only 15% of the total organic waste material. In August 1977, the Office of Solid Waste, U.S. Environmental Protection Agency, delivered its fourth report to the President and the Congress on Resource Recovery and Waste Reduction. That report described the principal developments and findings in the areas of resource recovery and waste reduction, as they apply to post-consumer municipal solid wastes. The report stated (p. x) that the present high material rate of waste generation (over 1,300 pounds per person per year) and low rate of resource recovery (less than 7 percent of total waste) can be explained in large part as "the material result of an expansive, highly productive economic system endowed with an abundance of natural resources." It is further stated that "there is considerable evidence and theory to indicate that certain national government policies, institutional shortcomings, and failures in our market system of resource allocation have all contributed to a situation where waste generation is too high and resource recovery is too low." Waste generation rates were projected to grow substantially over the next 10 to 15 years (p. ix).

Table 40
U.S. Post Consumer Net Solid Waste 1975
(Millions of Tons)

Material Composition		Functional Composition	
Paper	37.2	Newpapers, Books, Magazines	9.8
Glass	13.3	Containers, Packaging	41.7
Metal	12.2	Household appliances	2.3
Ferrous	(10.8)	Furniture, furnishings	3.4
Aluminum	(0.9)	Clothing, footwear	1.3
Other	(0.4)	Other	18.9
Plastics	4.4	TOTAL non-food	77.5
Rubber, leather	3.3	Food Waste	22.8
Textiles	2.1	Total Product	100.3
Wood	4.9	Yard & Misc. Org.	27.9
TOTAL non-food	77.5		128.2
Food Waste	22.8		
TOTAL Product	100.3		
Yard waste	26.0		
Misc. org.	1.9		
	128.2		

Table 41 has been excerpted from the EPA report (p. 15 Table 2) to point out both the material and functional composition of the 129 million tons/year of urban refuse.

The Brookhaven National Laboratory reported in 1976 (*Solid Waste as an Energy Source for the Northeast*—BNL 50559, p. 15) on a model of per capita refuse generation for various Standard Metropolitan Statistical Areas (SMSA) in New England. These are listed in Table 42.

It is apparent that a planning estimate of residential and commercial waste of 4 pounds per person per day over the next decade may be conservative. Using that figure, however, the 12.23 million people of the six New England states will generate 49 million pounds, or 24,000 tons, of urban refuse each and every day.

Table 41
Organic Wastes of the U.S.

	Millions of ton per year	pounds/capita/ day
Urban refuse	129	3.29
Industrial waste	44	1.12
Municipal sewage solids	12	0.31
Logging and wood mfg. residual	55	1.40
Agricultural crops and food waste	390	9.94
Manure	200	5.10
Misc. organic waste	50	1.27
Total	880	22.43

Table 42
Per Capita Refuse Generation Rates by SMSA
(lbs/capita/day)

	1975	1990[1]
Boston	3.74	5.16
Bridgeport	4.20	5.58
Brockton	3.75	5.17
Danbury	3.97	5.36
Fall River	3.98	5.24
Hartford	4.40	5.88
Lawrence-Haverhill	3.86	5.28
Lowell	3.93	5.38
Manchester	4.08	5.32
Meriden	3.92	5.36
Nashua	3.87	5.11
New Bedford	4.30	5.56
New Britain	4.39	5.86
New Haven	3.90	5.33
New London – Groton	3.79	5.07
Norwalk	3.79	5.17
Providence	3.87	5.21
Stamford	3.77	5.15
Springfield – Chicopee	3.24	4.52
Waterbury	4.05	5.49
Newport	3.94	5.26
Concord	4.23	5.61
Bangor	3.76	4.91
Portland	3.98	5.24
Middletown	3.52	4.93

[1] A rigorous recycling program may well change the 1990 estimates downward.

IV. Energy Content of Urban Refuse

The energy yield from refuse combustion depends primarily on the composition of the refuse and its moisture content. The Brookhaven National Laboratory study, referred to previously, derives the relationship between refuse composition and BTU content of raw refuse (p. 129). Table 43 from the Brookhaven study compares their data with that of other investigators. To be noted is that the heat value of refuse is anticipated to rise as a result of expected increases in the combustible fraction.

Data on refuse composition and heat value was gathered from nine separate studies containing over 300 samples, and was published in *Solid Waste Management* (Van Nostrand Reinhold, p. 6) and is shown in Table 44.

We will use 4500 BTU/pound as the available heat content of New England's residential and commercial refuse. Since the population of New England generates 49 million pounds of refuse per day, some 220-billion BTU's are thrown away each day from this source. Table 45 will permit the translation of this waste into other units (BNL 50483, p. 193).

Table 43
Heat Content of Refuse, as Received
BTU/Pound

	1972	1985	2000
St. Louis	4500		
Philadelphia	4300	4700	
Cleveland	4200	5000	7300
National Average	5000		
Brookhaven	4500	5000	6000

Table 44
Chemical Characteristics of Municipal Refuse

Measure	Minimum	Maximum	Average	
% Moisture	20	60	38	Wet Basis
% Carbon	8	35	24	
% Nitrogen	0.2	3.0	1.0	
BTU/Pound	3000	6000	4500	
% Ash	4	9	6.5	Dry Basis
% Carbon	20	50	40	
% Nitrogen	0.3	5	1.0	
BTU/Pound	6000	10000	7700	

Table 45
Energy Content Comparisons of Various Fuels

Refuse	– urban	9.0 million BTU per ton
Coal	– anthracite	25.4 million BTU per ton
	bituminous	24.0 million BTU per ton
	peat (wet)	6.0 million BTU per ton
Oil	– crude	5.8 million BTU per barrel (42 gals.)
	residual	6.3 million BTU per barrel
	distillate	5.8 million BTU per barrel
Methyl Alcohol		2.4 million BTU per barrel
LNG		3.6 million BTU per barrel
Natural Gas		1100 BTU per cubic foot
Hydrogen		275 BTU per cubic foot

Every ton of refuse has a heat content equal to 1.4 barrels of residual fuel oil or one-third of a ton of anthracite coal. So the 24,500 tons of refuse discarded each day by New Englanders can be equated to 34,300 barrels of residual fuel oil per day (12 million barrels a year) mentioned at the beginning of this paper.

It is certain that not *all* the urban refuse can be converted to usable energy. So the question to be addressed concerns the determination of the location of resource recovery plants under today's market requirements and under the technology being developed today, so that feasible goals for resource recovery can be determined.

V. Market for Resource Recovery Plants

Mr. Robert Aldrich, First Vice President of White, Weld & Company (now part of Merrill Lynch) forecast, in an August 4, 1977 article of the *Wall Street Journal*, that within 10 years resource recovery will blossom into a "moderately profitable" industry with annual revenue of $700 million to $1 billion (in constant dollars) from about $40 million this year. About 30%—but perhaps as much as 50%—of the 147 million tons of garbage generated each year will be converted into fuel in some 100 to 130 plants, he estimated. In the same article, Mr. Michael Dingman, Chairman and President of Wheelabrator-Frye, said he saw resource recovery as a good long-term business with a rate of return comparable to telephone and utility concerns. He said Wheelabrator-Frye expects to start two new plants a year during the next ten years.

According to *Forbes Magazine* (May 1, 1977), in an article entitled "Garbage Power," people have long realized that it was only a matter of time before some system for converting garbage into energy was adopted in the U.S. At least 11 recovery systems are in place around the country, with another 8 facilities under construction. At least 50 other cities are actively developing plans for garbage-burning plants that will help solve their landfill problems and probably make profits for those who run them. The list of companies that have already jumped into this business reads like a partial *Who's Who of U.S. Manufacturing*, the *Forbes* article goes on to state. Wheelabrator-Frye is among the more active entries. The list also includes Union Carbide; UOP, a subsidiary of Signal Oil; Grumman; American Can's Americology Division; Combustion Engineering; Carborundum; and Raytheon.

The largest U.S. facility to date is the 1200 ton per day plant in Saugus, MA that was built by Wheelabrator and opened in 1975, at a cost of approximately $50 million. The resource recovery plant sells steam, over 7-million pounds a day, to the General Electric River Works Plant on the Saugus River. The payment of $13 per ton of refuse by the communities plus the $10 per ton in refuse of revenues from the sale of steam is enough to make the plant a paying proposition (*Forbes* May 1, 1977). The steam from refuse is cheaper than the steam that GE formerly purchased. Additionally, the towns save money on removal and on rising landfill costs. The refuse recovery plant uses two steam generators. Incoming refuse trucks, after weighing their load for charging purposes, deposit refuse in the large 6700 ton storage pit from which it is fed to the furnace-boilers. Superheated steam is delivered to GE at 625 psig, 825°F, at a maximum rate of about 350,000 pounds per hour. The GE plant has a steam capacity of over 1 million pounds per hour. Its power generating capacity is 80 MW, consisting of 60 MW of steam turbine capacity and 20 MW of gas turbine capacity.

The Solid Waste Management Corporation (Rhode Island) is now evaluating the final bids from Wheelabrator, Widmer-Ernst, and UOP for the 1200 ton per day plant for Cranston, R.I. A second round of proposals, received May 31, 1978, included co-disposal of waste treatment plant sludge and solid waste. The following is quoted from the Corporation's *Summary of Preliminary Evaluation Results for Proposal One*, dated June 2, 1978.

> All three bidders propose the same refuse-to-energy system technology concept (waterwall incineration-mass burning), and all have existing facilities which are in commercial operation in various locations throughout the world, based on this technology. All three firms' proposals offer the capability for processing a minimum of 1200 tons of solid waste per day, with varying capacities to handle tonnage in excess of this amount. All three bidders propose co-generation of steam and electricity, and all plan to provide for the total energy requirements of the state institutions in Cranston, as well as the sale of electricity, in excess of 25 megawatts, to the Narragansett Electric Company. All three bidders demonstrate the capability to recover ferrous metals at the post-combustion stage. Also, each bidder has demonstrated the capability of processing the remaining ferrous-free residue to a suitable quality for use as a construction material. Consideration is being given by some of the bidders, to the potential recovery of aluminum glass and other non-ferrous products . . .

According to the May 1978 publication of the Massachusetts Energy Office, *Energy in Massachusetts*, North Andover is planning a 3000 ton per day plant to serve 50 communities in the northeastern part of the state. The cost has been estimated at $117 million (*Boston Globe*, July 16, 1978). This plant will be a 60 MW installation. The long range plan outlined by the Department of Environmental Affairs calls for solid waste conversion to account for 4 to 6 percent of the state's public electric generating capacity by the mid-1980's (Ibid, p. 18). The report further states "The Commonwealth generates 3 million tons of solid waste per year, which could produce 300 megawatts of electricity. This could save the state 4 million barrels of oil a year."

Both Wheelabrator and Widmer-Ernst (personal communication) have indicated that the 1200-1500 tons per day plant is the modular size that is marketable under present day economics. However, legal restrictions on landfills, land prices, and fuel prices all argue for smaller modules. European installations tend to be smaller due to higher land prices, fuel prices and municipal ownership of the plants. The Widmer-Ernst installation at Stapelfeld, near Hamburg, Germany, is a 450 tons of refuse per day plant generating 43 tons of steam per hour and 8.4 MW effective power. The installation at Turgi, near Baden, Switzerland, is 100 tons a day producing 25 tons of steam per hour and 5.2 MW peak power. The Resource Recovery Seminar in Hartford, CN, hosted by EPA in cooperation with National Association of Counties, the National League of Cities, and the U.S. Conference of Mayors (June 22, 1978), summarized the status of the energy recovery technologies with great interest. It was pointed out that waterwall combustion was state of the art which has had a long history of success and has been proven in more than 200 plants in Europe and Japan. Additionally, it was pointed out that small modular units were a promising approach to energy recovery for small communities. (*Environment Reporter* p. 363). Thus the technology is available, the interest is present, but the economics do not yet indicate the smaller units.

The Brookhaven report referred to earlier (*Solid Waste as an Energy Source for the Northeast*, June 1976, BNL 50559) modeled the electricity that could be generated from refuse from metropolitan areas. The data for New England (Table 7, p. 45) is shown on Table 46.

For the purpose of this paper we will assume that the 1200-1500 ton per day recovery plant that cogenerates steam and 25 MW electricity is the minimum modular size that is economically feasible in 1978. Using Table 46, the present day (1978) market for resource recovery plants in New England is presented on Table 47. Table 46 indicates a goal of 485 MW of electric generating capacity from 32 trillion BTU per year. Attaining this short term goal would mean a savings of 4 million barrels per year of residual fuel oil. The region is on its way towards that goal when the plants at Saugus (30 MW), Cranston (30 MW), and North Andover (60 MW) are considered. Incentives are needed to keep the momentum going and, more importantly, to develop and introduce smaller modular units.

When the European size installations of 100 (5 MW) to 450 (9 MW) tons per day become feasible, then a total of 732 MW generating capacity from 48 trillion BTU per year will be available to New England cities and towns. Attaining this intermediate term goal would mean a savings of 7.5 million barrels per year of residual fuel, an increment of 50% over the short term goal. This 7.5 million barrel annual saving is 62 ½% of the ultimate of 12 million barrels from all residential and commercial refuse discarded by New Englanders.

Table 46

Potential Yields From Refuse Combustion: 1985

A. 1970 Data

Location	10^{12} BTU/Yr.	MWe
Massachusetts		
Boston	14.92	226.2
Brockton	1.03	15.6
Fall River	0.42	6.4
Lawrence-Haverhill	1.26	19.1
Lowell	1.15	17.5
New Bedford	0.83	12.5
Pittsfield	0.43	6.5
Springfield-Holyoke	2.87	43.5
Worcester	1.87	28.3
Total		375.6
Connecticut		
Bridgeport	1.69	25.6
Hartford	3.65	55.3
Meriden	0.30	4.6
New Britain	0.98	14.9
New Haven	1.93	29.2
New London-Groton	1.13	17.1
Norwalk	0.70	10.6
Stamford	1.12	17.0
Waterbury	1.13	17.1
Danbury	0.43	6.4
Middletown	0.93	14.2
Total		212.0
New Hampshire		
Manchester	0.63	9.5
Nashua	0.63	5.5
Concord	0.45	6.8
Total		21.8
Maine		
Lewiston-Auburn	0.39	6.0
Portland	0.77	11.6
Bangor	1.04	15.7
Total		33.3
Rhode Island		
Providence-Pawtucket	5.07	76.8
Newport	0.42	6.3
Total		83.1
Vermont		
Burlington	0.43	6.5
Total		6.5
NEW ENGLAND TOTAL	48.33	732.3

Table 46
(Continued)

B. Present Day Market Locations

Location	10^{12} BTU/Yr.	MWe
Massachusetts		
Boston	14.92	226.2
Springfield	2.87	43.5
Worcester	1.87	28.3
Total		298.0
Connecticut		
Bridgeport	1.69	25.6
Hartford	3.65	55.3
New Haven	1.93	29.2
Total		110.1
Rhode Island		
Providence	5.07	76.8
Total		76.8
NEW ENGLAND TOTAL	32.00	484.9

VI. Constraints to Resource Recovery

The growth of resource recovery plants in New England can be significantly enhanced or hindered by the mind-set of the utility industry and, behind that, the actions and philosophies of the various state public utility commissions. Much of the institutional opposition to the resource recovery industry will be based on more generic factors, namely cogeneration and small dispersed energy facilities. An additional constraint has been the reluctance of cities and towns to follow through with plans to build facilities in their locales.

There is a need for a regulatory environment that encourages innovation. There may be opportunities for non-utility industries to build resource recovery—cogeneration units that serve their own needs for steam and electricity and provide surplus power for sale to utilities, municipalities or other industries. These opportunities are unlikely to be pursued if the industry cannot sell the surplus power at competitive prices and realize full profits from doing so. Private industry needs assurance that production of electric power for resale will not make them a utility under federal and state laws. Should a non-utility industry have the potential to generate electricity for resale, it must negotiate wheeling arrangements with the utility in whose service area the industry resides. Here again guidelines are needed from the utility commissions to ensure equitable handling of the wheeling problem or innovation and competition may be stifled (1977 *Biennial Report of the California Energy Commission* p. 114-123). As is true of any cogeneration installation, an agreement will be needed with the local utility to provide power when the resource recovery unit is down or derated for whatever reason. Negotiating an agreement that allows the utility to recover the full cost of providing standby reserves yet avoids artificially pricing resource recovery-cogeneration out of the market may require the public utility commission to intervene in the contract negotiation.

The following sections have been excerpted from a Mitre study (*Forum Data Handbook for New England Energy Alternatives*, Vol. IV, Supp. 2, p. 48, 52-54):

Solid waste combustion involves a number of institutional difficulties. Among them are:

A. There may be fear on the part of facility owners of a politically insecure source of fuel, since municipal governments control contracts for collection and/or sale of solid waste

B. Amounts of solid waste may be adversely affected by the success of conservation and recycling efforts and may also be effected by downswings in general economic well-being.

C. Garbage strikes could imperil fuel supplies.

D. Constant truck traffic would create constant road maintenance and public relations problems.

E. Breakdown in the system could result in massive pileups of solid waste that might be costly to dispose of.

F. Inter-and intrastate truck licensing and taxes may make garbage hauling unnecessarily difficult or expensive. This is particularly a problem in a Balkanized area like New England.

G. Construction of too much solid waste conversion capacity could result in ruinous competition for limited solid waste supplies.

H. Utilities or industries may be unwilling to enter into long-term supply contracts for energy.

Since resource recovery plants, as discussed in this paper are in reality cogeneration plants using refuse as a fuel, the Mitre report section on constraints to cogeneration are quoted also:

A. *Barriers to cogeneration*: The primary institutional barriers to cogeneration include:

1. Current utility rate structures, such as demand ratchet charges designed to discourage occasional use of utility as a back-up power supplier and low rates for electricity purchased by the utility from industrial cogenerators;

2. Securing sources of capital financing for utility, municipality or industry-owned cogeneration plants;

3. A need for cooperation between the utility and industry concerning operation schedules, maintenance, and disposition of cogenerated electricity; and

4. The need to initiate and successfully conclude an innovative business venture.

Different barriers arise with different ownership arrangements. Under an arrangement where industry owns the cogeneration equipment, it must finance the capital investment. This can be a barrier since most industries anticipate a higher rate of return on investments in additional manufacturing capacity instead of energy-production capacity. Municipalities have a difficult time bonding most large ventures. A second barrier can be utility rates for electricity sales and purchases. Since an industrial cogenerator cannot economically match its electricity demand pattern with its cogeneration schedule, it faces the same utility interface problem as a solar, hydro, or wind system owner.

These barriers can be eliminated with utility ownership of generating equipment or a joint utility-industrial venture. However, new barriers will arise in these cases. A successful venture of this nature requires coordination between two diverse business partners, each of whom has a differing interest in the operation of the cogeneration power plant. Furthermore, recent trends in utility construction of new generating capacity construction have been towards large units in the 500-1200 MW range. Utility managers may be reluctant to plan or commit capital to a network of small cogeneration facilities—typically in the 10-50 MW range—if they are able to meet future electricity demand by building large central generating facilities.

B. *Structural changes*:

1. A shift in the nature and responsibilities of the electric utility towards distribution instead of increased generation.
2. Investment capital for electricity generating capacity construction will be delivered from utilities to industries if utilities do not invest in cogeneration facilities.
3. Utilities will have to consider industrial or municipal steam demands along with electricity demand in their scheduling decisions.

Increasing the number of cogeneration facilities may have a number of other institutional implications. Cogeneration facilities would be constructed at new or existing industrial centers, often located in urban areas. Operation of these facilities would require less fuel than building a new single-purpose power plant, but the environmental and land-use impacts of electricity generation would now occur in a high-population density area. An urban/rural conflict could develop as utilities add new capacity at many small urban cogeneration sites instead of a single, centralized rural location.

A Preliminary Assessment of Solar Heating's Potential Contribution to New England's Supply Mix (Dan Waintroob)

I. Introduction

There are widely divergent views concerning the contribution that solar energy could make to the United State's supply mix through the year 2020. Table 47 summarizes a number of studies. The results of the high and low scenarios are in no way comparable. The further away from the present these projections go, the wider the differences in projected solar supply. For example, in 1985 Mitre's high projection is only .2 Quads (34 MMB) while Lovins projects 5 Quads (860 MMB). By the year 2000 the gap is even bigger, the low prediction .1 Quad (17 MMB) versus a high prediction of 40 Quads (6.9 billion BBL), a difference in opinion by a magnitude of 400.

These differences are due to a number of reasons, including widely differing assumptions about solar's economic competitiveness, the degree of government support, technological innovations and even the definition of what is solar energy. Also, the author's views of the general nature of our society and its future development vary considerably.

A brief discussion of these varying assumptions is illustrative of the variables that must be grappled with in order to produce solar projections.

1) Probably the major area of disagreement concerns the nature of future societal development. The most radical view is that of Amory Lovins, who foresees society ultimately turning away from "hard technologies" to less energy intensive and more decentralized "soft technologies". Ultimately he sees an actual decline in total energy demand by the year 2020. No other study on the chart predicts a decline although they all vary considerably in their views of future supply and demand projections. These differences are not simply over the statistical availability of energy supplies, they also represent a judgment of what should supply the energy future and what should be the end use of this supply. Therefore, at the onset a subjective judgment is made which will dramatically affect the end result of any projection.

Table 47

Summary of Projected Solar Impacts
Quads Displaced
(Primary)

Scenario	1985			2000			2020		
	Total	Solar[1]	Percent	Total	Solar[1]	Percent	Total	Solar[1]	Percent
Mitre SPURR NEP	86	.20	.2	115	6.0	8.0	189	35.4	18.7
Mitre SPURR RTS	85	.09	.1	113	5.0	4.4	18	24.7	13.1
SRI-Reference Case	99	2.0	2.0	145	6.0	4.1	198	11.0	5.6
SRI-Solar Emphasis Case	99	5.0	5.0	148	15.0	10.1	204	44	22
SRI-Solar Demand Case	79	2.0	2.5	89	7.0	7.9	102	14	13.7
Solar Working Group:									
with Behavioral Lag	90	.4	.4	115	8.1	7.0	140	19.1	13.6
without Behavioral Lag	90	2.5	2.7	115	8.8	7.7	140	19.5	13.9
MOPPS	94.6	1.2	1.3	117.3	2.8	2.4			
IERPS				132.5	5.8	4.3	195.5	29.5	15.0
Lovins[2]	95	5.	5.3	108	40	37.0	76	70	92.0
NFS/NASA	117	.4	.4	177	11.8	6.6	300	109	36.0
Project Indep-B.A.U.	120	1.4	1.2	180	10.8	6.0			
- Accelerated Solar	120	1.4	1.2	180	38.8	21.8			
CONAES - High Solar	98	3.0	3.0	146	14.0	9.6			
- Low Solar	98	0.0	0.0	146	0.1	0.1			
ERDA-49	100	.8	.8	150	10.0	6.7	180	45.0	24.1
CEQ-April 1978[3]				100	24.5	24.5	105	45.0	43.0

[1] Solar components exclude hydropower. Some studies also exclude the current biomass consumption.
[2] Includes all soft technologies.
[3] Mid range of CEQ estimates for each technology.

2) The costs of solar energy and its cost competitiveness is also an area of some dispute. A report, *Prospects for Solar Energy*, by Los Alamos for the D.O.E. asserts: "Solar residential space heating costs remain higher than conventional natural gas and heating oil prices in both the 20 and 30 year life cycle cost time horizons"[1] Congressional Office of Technology Assessment in its report, *Application of Solar Technology to Today's Energy Needs* states, "solar space-heating and hot water systems may be competitive with oil or gas delivered to typical residential or commercial customers by the mid 1980's."[2] These differences are based on assumptions about actual costs of equipment and different views about how much oil and natural gas will cost in the next decade. The former differences are the result of the wide array of methods of application and the limited experience in monitoring solar costs. Secondly, there is a major debate in the industry as to how much the production costs of a system will drop as the industry matures.

3) The degree of governmental support to solar is problematical. One of the functions of the Supply Committee is to make recommendations concerning this aspect. Clearly, governmental subsidies would accelerate solar usage. Although, even here, there is no consensus as to how much. The question of subsidies is both an economic issue and a technological issue.The economic one is how much money must the government provide to end users and/or manufacturers to encourage the usage of solar energy. The technological problem is whether increased R and D funds would bring dramatic improvements in solar technology.

[1]Prospects for Solar Energy, DOE/Los Alamos—LA 7064, December, 1977.
[2]Application of Solar Energy to Today's Energy Needs, Office of Technology Assessment, U.S. Congress, June, 1978.

4) Finally, definitions of solar energy range from all renewable resources to strictly solar thermal and solar voltaic. Important definitions are as follows:

"The term 'energy conserving improvements' means the purchase and installation of weatherization materials as defined in section 412(9) of the Energy Conservation in Existing Buildings Act of 1976; and

"The term 'solar energy system' means any addition, alteration, or improvement to an existing or new structure which is designed to utilize wind energy or solar energy either of the active type based on mechanically forced energy transfer or of the passive type based on convective, conductive, or radiant energy transfer or some combination of these types to reduce the energy requirements of that structure from other energy sources, and which is in conformity with such criteria and standards as shall be prescribed by the Secretary in consultation with the Secretary of Energy."[2]

II. The Importance of Passive Solar Applications

The most economical option for solar heating is a passive system. Passive systems utilize natural thermal energy flows (convection, conduction, radiation and evaporation) to heat and cool buildings. In contrast, active systems use compressors, pumps, fans, and other mechanized instruments to transfer energy. Passive systems maximize the sun's energy for winter heating via south-facing glass, large structural designs and insulation techniques; and minimize summer cooling loads by structural designs and building placement. Together with weatherization techniques, passive solar designs are presently cost-competitive steps that the commercial and residential sectors can take to minimize fossil fuel use for space heating purposes.

Unfortunately developers, realtors, city planners, architects, mortgage lenders, and builders are not well informed about the economics of passive solar. A better data base, additional prototypes, and a federal procurement policy could improve the climate for passive solar development. Building codes restricting glass area must be changed in many parts of the country. Sun rights legislation, model zoning ordinances and site planning aids need to be in place across the country.

Financial incentives are required to assist the additional front-end capital costs required for passive solar construction and retrofit. The National Energy Act's solar income tax credit must specify the inclusion of passive solar for eligibility. State income tax credits and sales and property tax exemptions would help. Accelerated depreciation allowances for commercial passive systems, low-interest loans and loan guarantees on all instruments will enhance the commercialization of passive solar systems.

The remainder of this report focuses largely on active applications and incentives required to boost the commercialization of hot water and space heating solar systems incorporating passive and active elements.

III. Rationale and Format for Potential Resource Analysis

The following assumptions have been made to analyze the potential contribution of solar energy to New England.

1) A societal change from "hard" to "soft" technologies is not assumed since this type of massive shift is not viewed to represent the current realm of political acceptability.

2) Solar heating and hot water is not discussed since no dramatic improvements are assumed in the technology; for example, it is not expected that the collection efficiency of solar systems will be tripled within the next decade.

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[1]P.L. 95-619, November 9, 1978, National Energy Conservation Policy Act

3) The first section of this report describes the maximum technological limits to solar supply potential for the years 1985 and 2000. Then, in the next section, various economic and institutional constraints are weighed. Finally a cost/benefit analysis is done as to the level of government support, and recommendations are made for future governmental actions to promote the optimal development of solar energy.

IV. A Maximum Solar Usage Scenario

Based on insolation charts taken from the "Climatic Atlas of the United States," on the average there are 1200 BTU/ft.^{2}/day of solar energy striking the 66,000 square miles of New England. If it were possible to harness all this energy the total available would be 806 Quads, collected on a horizontal plan, roughly equivalent to 380 MB/D of oil. This is about 260 times our current total energy budget and 1200 times our current residential space heating budget. Obviously these figures are somewhat speculative. Nevertheless, they do indicate that there is a tremendous amount of raw energy that is available.

The technical problems of utilizing this energy when it is needed reduces this potential considerably. These technical problems are: (1) For the purposes of space heating there is less available when it is needed most. (2) System efficiency is limited to 20-25% for space heating. (3) As a general limitation solar energy is applicable for space and hot water heating and electrical production. It is unlikely that solar will be contributing much to the transportation sector in the foreseeable future.

The first two problem areas deserve further analysis since, for New England, solar's space heating potential is important.

According to a study by the Center for Energy Policy summarized in *Retrofit '78*[1], "The total New England energy budget is approximately 2.6 Quads (10^{15} BTU/yr.), of which approximately .4 Quads is used to heat office space and .6 Quads is used to heat the region's 3.9 million residences." Each residence is therefore using an average of 1.54×10^8 BTU/per year or 26.6 barrels of oil (1160 gallons). Broken down by degree days (DD), an average housing unit would need approximately 25,870 BTU/DD of fossil fuel to meet its heating load.

In order to calculate the impact of solar heating, this energy requirement must be reduced to correct for the fossil fuel seasonal efficiency of about 65%. Also it is nearly always cost effective to reduce heat demand by at least 25% by improved weatherization before installing a solar collector. Therefore, the actual BTUs required for 100% solar heating would be 12,600 BTU/DD.

Table 48 gives an indication that would be physically required to heat a home in Rhode Island using solar energy.

Table 48

Month	Degree Days	Million BTUs Required	Available Insulation @ 50° angle (BTU/ft^2)	Ft^2 of Collector Needed at 25% Efficiency
Sept.	96	1.21	47,550	102
Oct.	372	4.69	45,260	414
Nov.	660	8.32	34,350	969
Dec.	1023	12.89	32,054	1609
Jan.	1110	13.99	32,829	1705
Feb.	988	12.45	36,736	1356
Mar.	868	10.94	46,531	940
April	534	6.73	42,720	630
May	236	2.97	47,027	253

[1]Center for Energy Policy, Retrofit '78, NSF Grant OSS77-21227, p. 3.

This table does not take into account the space needed for storage of 1-2 gallons/ft.^{2} of collector. In any case in order to retrofit a house for complete solar heat an average home would need around 1700 ft.^{2}of collector at a 50-90° angle, and 2000-3000 gallons of water for storage. The economic issues involved with this size of installation will be discussed later, but the physical problems of finding this much space are obvious. A typical cape oriented directly south would only have something on the order of 700 ft.^{2} of available roof top, and perhaps another 75-100 ft.^{2} of southern window exposure. Perhaps, another 100 ft.^{2} of vertical surface could be used. Similarly for domestic hot water the experience of the HUD solar initiative seems to indicate that for 100% hot water 140 ft.^{2} would be needed. It is easy to see why builders of new solar houses spend so much time reducing heat loss. A newly constructed house properly designed would use considerably less energy. Energy consumption could range from 40-75% less than conventional homes just by using available technologies, siting and the most basic passive solar heat gain. We will assume 50% reduction in the following calculations of new housing. The obvious conclusion is that it is physically impossible to retrofit New England's housing stock with 100% solar heat and hot water. Expectations must be scaled down to meet reality. 2500 homes were inspected as part of the New England Electric's Solar Hot Water Project (from Robert O. Smith and Associates' Report) of which 1200 were deemed suitable for a solar hot water installation. For the purposes of this study we will, therefore, assume that 48% of the housing stock would be suitable for some sort of solar installation. As an estimate we will say that 10% of this 48% could have an average solar collection area of 600 ft.^{2}; the rest will be assumed to have an average collection area of 100 ft.^{2}. For the purposes of this paper 100 ft.^{2} is assumed to be primarily for hot water heating operating at 25% efficiency, 365 days a year. The larger installations are assumed to be for heating purposes. In addition, 40% of the 26% of the housing stock in duplexes and triple deckers will be assumed capable of installing water heating. Calculations are based on availability and demand. When the total available insolation exceeds demand, savings are computed on the basis of 100% demand.

Calculations for the retrofit of existing dwellings produced these results:

Table 49
Retrofit of Existing Dwellings

	Number of Units Solarized	10^{12} BTU
Single family solar water heating	945,000	11.3
Single family solar space heating	105,000	5.0
Duplex and triple, solar water heaters	490,000	5.9
TOTAL		22.2

The preceding is obviously quite a rough projection. Nevertheless, it does seem evident that solar can have a significant, if limited, impact on the energy uses of existing housing.

The technical potential for new construction is much greater. A house built from the ground up can, in most cases, be built to utilize solar heating. Therefore, for the purpose of this projection we will assume that 75% of the new housing will have an average of 600 ft.^{2} of collector area. For its solar projection the *New England Energy Situation and Alternatives for 1985* projected a growth rate of the housing stock of about 2% per year. The same growth rate is assumed, base year 1978. (Table 50)

There is a large margin for error since this performance could be increased substantially by changes in land use patterns and the implementation of solar parks, for example. There might for unforeseen reasons a reduction in these projections.

Table 50

New Housing Installations

Application	Units	Cumulative 10^{12} BTU
Retrofit	(from above)	22.2
New Housing Units by		
1985	600,000	49.2
2000	2,200,000	121.2

Commercial Sector

For the purposes of discussion let us assume a similar percentage of heat provided by solar for this sector which has 80% as large a heating demand.

Table 51

Commercial Installations

Application	Cumulative 10^{12} BTU
Retrofit	17.8
New	
1985	39.4
2000	97.0

The maximum technical solar scenario therefore produces the following total projection. (See also Figure 30.)

Table 52

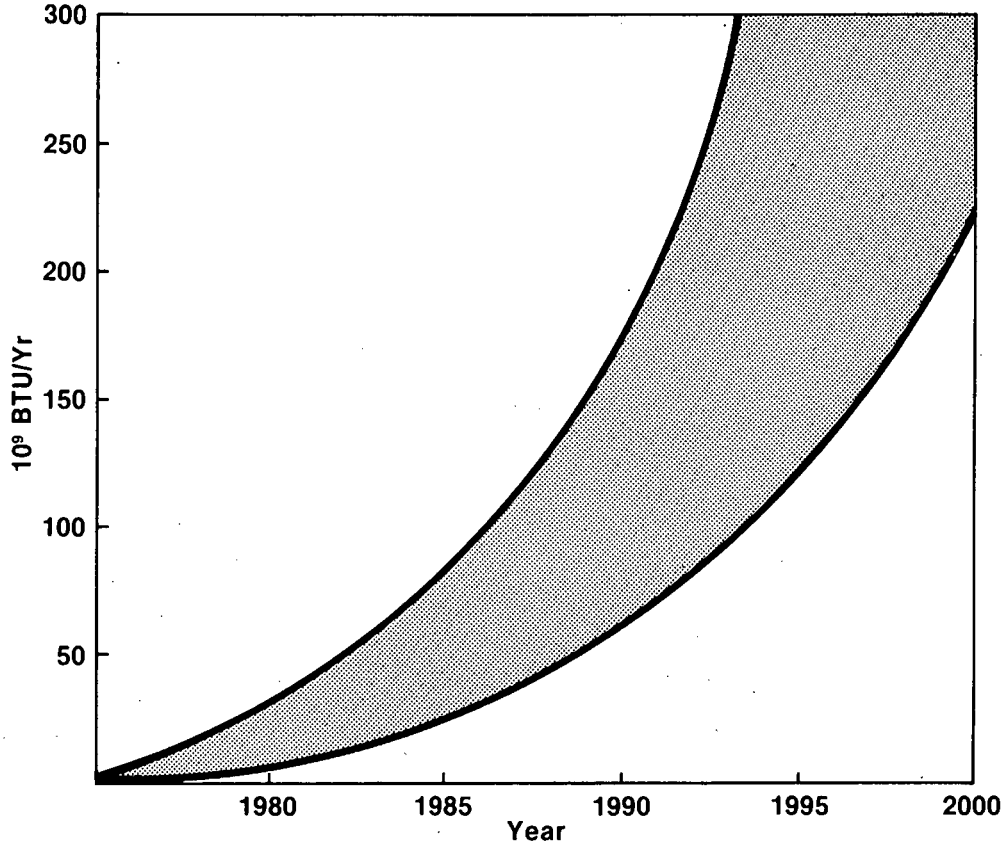
	Cumulative Total	
Application	10^{12} BTU	MM BBL Equiv.
Retrofit	40.0	6.9
New		
1985	88.6	15.2
2000	218.2	37.6

IV. Constraints to Development

A) Probably the foremost constraint to development is in the economic area. The problems are twofold: (1) the region-wide issue of the cost competitiveness of solar with conventional fuels; (2) given that it is a capital intensive investment, how can the individual be encouraged to buy a solar system.

Before describing the economics involved, a brief description of the technology would be useful in understanding the economics involved. The technology for solar space heating and hot water heating in particular is well developed. "Solar hot water

FIGURE 30
Total Maximum Feasible Solar Utilization



systems are now used in 2.7 million Japanese homes, 200,000 Israeli homes and 20,000 buildings in the U.S."[1]

Hot water heating is accomplished through an array of collectors installed facing south through which a fluid is circulated. Once it is heated it is circulated to a storage tank. Space heating is currently accomplished in one of three ways: (1) a larger version of the system described above (active system); (2) as a boost to a heat pump (also an active system) or (3) through the effective siting of buildings, use of windows and thermal mass (passive systems). There are homes currently in New England that nominally get 90% of their heat from solar. The more a system utilizes passive heating techniques as opposed to active techniques the cheaper it will cost initially. Operating and maintenance costs are considerably less also since there are no mechanical equipment requirements.

At a recent conference on passive solar systems, Harold Hayes, an inventor in the field, described the following advantages to passive solar:

> They often cost less than active solar systems and provide the same amount of energy to the building; The materials are readily available and can be installed without any special training; Little chance exists of operational failure; Few aspects require certification of equipment.[2]

[1]Center for Energy Policy, *Op Cit.*
[2]Energy User's Report, 1978.

Passive systems limit the options available to the builder and are therefore only applicable in limited circumstances. While active systems are more versatile they are also considerably more expensive than passive systems. Because of this cost differential there is a large degree of uncertainty in economic analysis of solar.

There are two levels that must be considered in analyzing solar economics: (1) at what cost is it reasonable for the individual investor buy a solar system; (2) at the governmental level, how large an investment of public funds will be required to meet its solar goals.

Pertaining to the individual invester Roger H. Bezdek, in *An Analysis of the Current Economic Feasibility of Solar Water and Space Heating*[1] offers a reasonable approach to economics of investment for the individual buyer:

> *Years to positive cash flow* is the number of years for fuel cost savings to become greater than the extra expenses of the SHAC system, after taxes. The criterion assumed is two years, because most homeowners expect rapid savings for an "energy conserving" investment.*Years to recover downpayment* is the number of years required for accumulated savings to offset initial cash payments and early cash flow losses, after taxes. The criterion assumed is five years, based on today's average housing turnover rate of five years and the expectation that homeowners will seek to recover their entire downpayment before selling.
>
> *Payback Period* is the number of years for accumulated savings to repay the full cost of the system (or equal the remaining principal on a loan if financed). The criterion assumed is ten years, assuming the homeowner wishes to be paid back entirely for his investment in no more than ten years.

If two of the preceding conditions are met the solar system is considered competitive. If only one of the conditions are met it is considered marginally competitive. The consumer obviously having a choice between a marginally competitive solar system and a more cost effective weatherization (e.g. insulation, storm windows or caulking), would logically choose the latter. Furthermore, if the payback period is not less than the life of the installation solar investment is not rational even if the other criteria are *both* satisfied.

As well as cost of the system an economic analysis must also include what is the anticipated rate of inflation for conventional fuels and how long the system is expected to last.

Initial costs vary considerably. In solar projects the DOE paid an average $37 per square foot of collector for a system installed. For the purposes of his study Bezdek assumes a current cost of $25 to $40/ft^2 installed and future cost of $15 to $20 once large scale production is reached.

The Maine Audubon building installed an active system for approximately $4/ft^2. The inflation rate for conventional fuels is problematic.For the purposes of this report, examples of 0%, 2%, 5% are used above the general inflation rate. Finally system life is assumed to be inversely related to the complexity of the system (i.e. the more complex the shorter the life span of the system). For active systems it seems likely that a major overhaul would be needed at the 25th year. $50/year in other maintenance costs is also assumed. Passive systems should last as long as the house itself with the possible replacement of glazing after 20 years and caulking every 5 years. Maintenance would, therefore, average about $25/year for the equivalent of a 600 ft^2 system.

For comparative purposes the cost for conventional fuels shown on Table 53 is being used.

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[1]Bezdek, Rodger H., *An Analysis of the Current Economic Feasibility of Solar Water and Space Heating*, DOE/CS-0023, January, 1978, p.7.

Table 53
Some Comparative Space Heating Costs

Type	Fuel Cost $/MMBTU	Delivered Heat Cost $/MMBTU	Efficiency
Resistance Electrical (.043/KWH)	$12.60	13.58	45%
Oil (.50/gal.)	$ 3.57	5.95	60%
Wood ($65/cord)	$ 3.25	5.90	55%
Gas (.29/therm)	$ 2.90	4.46	65%

It should be pointed out that these are the costs of fuel delivered to the customer and not necessarily the actual costs of the fuel.

The following represents the costs of the fuels at the different real inflation rates:

Table 54
Real Fuel Escalation Rate
($/MMBTU)

	2%	As Expected by NEEC
Electric		
1985	15.60	15.60
2000	21.00	24.30
Oil		
1985	6.83	6.13
2000	9.20	14.04
Wood		
1985	6.78	6.78
2000	9.12	9.12
Gas		
1985	5.12	5.66
2000	6.90	12.98

Assuming a 25 year life span a solar system costing $35/ft^2 would currently be equivalent to about $13/MMBTU or competitive with electrical resistance heat. In order to compete with the oil it would have to come down to about $15/ft^2. If the growth of the industry can bring the real cost down 3%/year, this $15/ft^2 figure will occur by 2007. The combination of falling solar costs and rising conventional costs should actually make solar competitive with oil and gas by the mid-1990's.

The rate of real inflation in fuel cost obviously makes a difference in what one assumes to be a reasonable investment. The questions that will be dealt with in the cost/benefit section is how much of a subsidy would be required to make solar competitive with different scenarios.

There are several institutional barriers which must also be dealt with. Bankers and insurance companies do not have enough experience with a system to, in the case of the latter, set rates and in the case of the former, charge rates. For example, if a $2500 solar system is financed at 9% for 25 years as part of a mortgage the additional cost would be $21 per month. Where at 14% for five years it would cost over $58 per month. The monthly payment would be a problem in many cases. Other institutional problems include zoning problems (e.g. set-back requirements, inconsistent building codes and jurisdictional disputes among unions. There also may be a problem with utility loan management.

Finally there is also the problem of consumer confidence in solar.

All three areas are likely to slow solar development. The economic area is the most serious, however. The question that should be dealt with is how much public money should be invested in solar energy in order to achieve optimal development that benefits society equal to its costs.

VI. Cost/Benefit/Analysis

There are several societal benefits to solar energy that should be weighed in determining subsidy levels:

1) Solar is an indigenous resource. Certainly if a major goal is to reduce our dependence on foreign oil, this is an important factor.

2) Solar energy is non-polluting.

3) It is diffuse and can be utilized in small increments.

4) Solar energy creates jobs according to the article in the September, 1977 *Solar Age* magazine (P. 11), "The Massachusetts Energy Policy Office recently concluded that if by 1985 one-half of all buildings in that state were to use solar energy for hot water production, 32,000 jobs would be created."

The public costs to implementing solar would be the money needed to make solar energy costs competitive with competing fuels. This cost is exclusive of the loan guarantees that would be needed to allow the affordable financing of systems. Additionally the committee must also consider whether to make grant installations on poor people's homes.

In New England the prominent mode for space and hot water heating is fuel oil. Therefore subsidies will have to be aimed cost competitiveness at this level.

For a fuller discussion of the relationship between subsidy levels and market penetration results, see pages 169-170 in the Alternatives Committee report.

VII. Resource List

Solar Technology to Today's Energy Needs, OTA, June 1978.

Prospects for Solar Energy, DOE/Los Alamos-LA-7064-MS, December 1977.

An Analysis of the Current Economic Feasibility of Solar Water and Space Heating, DOE/CS-0023, January 1978.

Solar Energy In America's Future, ERDA DSE 11511, March 1977.

World Energy Outlook, Exxon, March 1977.

Solar Energy: A Status Report, DOE/ET-0062, June 1978.

Solar Energy: Progress and Promise, Council on Environmental Quality, April 1978.

Minutes and papers presented by Alternative Energy Committee of Energy Congress.

Tidal Power

(Norman Laberge)

I. Introduction

The method of tidal power production presented in this paper will be limited to electrical generation similar to conventional hydroelectric production. The major difference is that the direction of flow reverses about every six hours and the water is very saline. There are other modes of generation for ocean energy production predicated on tidal current, thermal gradient, salinity gradient and osmotic pressure. The utilization potential for these sources are quite significant; however, they have been omitted from this discussion since data was not readily available and since the related technology was not immediately applicable. A tidal power plant can basically operate in three different modes for a certain percentage of the tide cycle—maximum power production (15-25%), long-time duration (40-60%), and peak hour production (typically from 4:00-6:00 P.M) These various modes adapt to three methods of development listed below:

1) *Single-pool system*, capable of suppling intermittent electricity under a progressively shifting production schedule. In this case, peak hour production can supply peak power for a predetermined time period under a varying power level dependent on tidal range and high tide occurrence.

2) *Linked-basin system*, dependable power production through a mechanical connection of two adjacent tidal basins operating under a modified long-time duration mode.

3) *Paired-basin system*, also capable of dependable power production through an electrical interface connecting two, or more, tidal basins. Increasing the number of basins in the system shifts the production schedule from long-time duration to maximum power production which can theoretically optimize production in accordance with available volume flow conditions.

Tidal production is directly dependent on the tidal function's behavior for the three cases described. This results from a tidal range which varies quite dramatically for spring tide and neap tide conditions, and also from a lunar dependence which increases high tide occurrence by approximately fifty minutes per day. In New England, tidal power development is fairly well limited to areas where the average tidal range is greater than 15 ft. Therefore, under this criteria, only the upper Maine coast would qualify until economic constraints are reduced which could then make it feasible to include tidal ranges as low as 12 ft. It should be mentioned that the other types of ocean energy systems, in general, have application along the entire New England coast.

II. Potential

1) New England

   a) Potential for tidal power development is listed in Tables 55 and 56 for three different scenarios, summarized below in terms of power production parameters:

      installed capacity, 164 MW— 1212.5 MW

      annual capacity factor, 0.353—0.522

      annual electrical output, 567—3008 million KWH, 1044—5454 thousand barrel, displaced, 6565—34300 billion BTU.

   b) Three different modes of development are presented in Table 57 for comparison.

Table 55
Tidal Power Potential
Available Sites and Scenarios

	Total Potential MW	Annual Energy Production 10^6 kwh	Realistic Uninterrupted Schedules 1980	1985	1990	1995	2000
Available Sites							
1. Cobscook Bay:							
A. Single-Pool							
i) Half Moon Cove	4-12.5	18-35	Planning	On-Line	On-Line	On-Line	On-Line
ii) Series (a)	59-180 (b)	250-485	Planning	Planning	On-Line, 20%	On-Line, 60%	On-Line
iii) U.S. Corps	40-180	-680	Planning	Planning	Constr.	On-Line	On-Line
B. Linked-Basin	100-500 (c)	-1180	Planning	Planning	Constr.	On-Line	On-Line
C. Paired-Basin	4-60 (d)	33-270	Planning	Constr.	On-Line, 40%	On-Line	On-Line
2. Upper Maine Coast	100-200	305-610 (e)	-	Planning	Constr.	On Line, 40%	On-Line

a. Quantities based on long-term duration mode for 4 MW plant at Half Moon
b. Reference, Technical Paper No. 4, Passamaquoddy Tribe Energy Office
c. Assuming U.S.-Canada International Project with the U.S. receiving one-half of the energy.
d. Note: Dependable capacity is assumed 20% of installed capacity for 13' tide
e. Calculated as being proportional to the square of average respecitve tidal ranges

Scenarios	Plant Capacity For: 1980	1985	1990	1995	2000
1. Low (1Ai, 5 MW; 1Aii, 59 MW; 2, 100 MW) 164 MW 576 10^6 KWH	-	5 MW	17 MW	81 MW	169 MW
2. Mid (1Ai, 5 MW; 1Aii, 180 MW; 2, 100 MW) 285 811 10^6 KWH	-	5 MW	41 MW	153 MW	285 MW
3. High (Ai, 12.5 MW; 1B, 500MW; 2, 200 MW) 712.5 1815×10^6 KWH	-	12.5 MW	12.5 MW	592.5 MW	712.5 MW
(1Ai, 12.5 MW; 1Aiii, 180 MW;) 2, 200 MW) 392.5 1328× 10^6 KWH	-	12.5 MW	12.5 MW	272.5 MW	392.5 MW

Table 56
Power Production Scenarios

Scenarios	Capacity MW	Annual Energy Output – 10^6 KWH	Total Cost in 1976 $ Million $	Construction Start-Up Date	Total Cost in Current $ (6% for Escalation Rate)
1. Low Projection					
Demonstration	5	21.65	11.085	1983	16.672
Series of Small	59	249.30	162.900	1983 – 20%	65.672
				1993 – 40%	175.476
				1995 – 40%	197.174
Upper Coast	100	305.00	221.700 (a)	1993 – 40%	238.815
	164 MW	575.95 10^6 KWH			1173.092
2. Middle Projection					
Demonstration	5	21.65	11.085	1983	16.672
Series of Small	180	458.70	485.000	1988 – 20%	184.581
				1993 – 40%	494.112
				1995 – 40%	555.210
Upper Coast	100	305.00	221.700	1993 – 40%	238.815
				1998 – 60%	479.404
	285 MW	811.65 10^6 KWH			1968.794
3. High Projection (c) Case A					
Demonstration	12.5	37.81	22.460	1983	33.780
Linked Basin	500.	1180.00	915.000	1989	1951.520
Upper Coast	200.	610.00	443.400	1988 – 20%	178.424
				1993 – 40%	477.630
				1995 – 40%	536.691
	712.5 MW	1825.80 10^6 KWH			3178.000
Case B					
Demonstration	12.5	37.81	22.460	1983	33.780
U.S. Corps	180.	680.00	492.000	1989	1049.436
Upper Coast	200.	610.00	443.400	1988 – 20%	178.424
				1993 – 40%	477.630
				1995 – 40%	536.691
	392.5 MW	1327.81 10^6 KWH			2275.961

a. Assume $2217/KW

b. Total Cost $(1 + Y)^X$
Y – Escalation Rate
X – Year – 1976

c. Assumes one-half of the International Project energy goes to the U.S.

2) Attributes

   a) Politically desirable since it involves the development of renewable resources

   b) High efficiency when compared to thermal plant for supplying base-load level

   c) Reliable and predictable supply capable of being easily integrated with power network

   d) Can be used to temporarily off-load oil-burning plant

   e) Can complement nuclear and large fossil sources

   f) Capacity to respond quickly and efficiently to load fluctuations

   g) Technology moderately well developed, a properly designed demonstration project could identify and solve most of the problems

   h) When compared with conventional hydroelectric on an engineering basis, the barrage has less static forces and no significant leakage problems.

3) Economic

   a) Total capital cost, including transmission, per installed capacity in 1976 dollars varies from $1979/MW to $3600/MW (see Table 56).

   b) Average power cost, defined as total annual cost divided by annual production, in 1976 dollars ranges from 49.6 Mills/KWH to 62.5 Mills/KWH (or, 4.351—5.482 $/MMBTU—Table 58).

   c) Economic viability based on a static benefit-to-cost ratio does not exist for power production benefits (i.e., 0.344—0.533); however, by including ancillary benefits this ratio increases quite appreciably (i.e., 0.581—1.333).

   d) Table 58(B) shows projected average power cost and construction cost for the three examples previously cited for an assumed 6%/yr escalation rate; whereas, tidal power value is assumed to increase at a 8%/yr rate. This comparison indicates that the "Corps" project would be nearly cost-competitive after only five years of operation.

   e) Actual life-cycle cost analysis listed in Table 59 shows that the 5MW Half-Moon Cove plant could be competitive after less than ten years of operation for a 8%/yr., escalation in tidal power value for the assumptions listed. This is a better economic profile than the analysis performed in Table 58(B) due to the fact that *annual cost* would not increase at 6%/yr., since fixed charges which comprise a significant percent of annual cost are constant and not inflation-controlled as the other compenent (i.e., operation & maintenance).

   f) Positive economic elements of a tidal power plant include the following:

      i) Nominal running cost; i.e., no fuel cost

      ii) Low discount rates applicable for national or municipal projects

      iii) Long plant life with relatively little maintenance and few components that need to be replaced

      iv) Minimum land requirement.

   g) The LaRance Tidal Power Project (France) commissioned in 1966 has shown a favorable life cycle behavior. It has been reported that tidal power is now cheaper than electricity produced by nuclear plants.

4) Environmental

   a) In general, the physical changes brought about by construction of a tidal power plant would appear to be the physical obstruction created by the dams, altered mean levels and ranges in the impoundments, change in current patterns, reduced velocities, reduced tidal exchange (flushing) less vertical mixing, lower rates of oxygen uptake, greater stratification, higher summer temperatures, winter icing, reduced salinity in surface layers, reduced dissolved oxygen in deeper layers, and erosion and siltation effects.

   b) Minimum water pollution and air pollution as compared with alternative forms of power production

   c) Minimum public safety hazard related to power plant operation

5) Socio-Economic

   a) Assorted number of project-related benefits attributed to increased recreational/tourist facilities, construction and indirect employment opportunities, potential for aquaculture development, and the benefits associated with research and development programs

   b) Potential effect on nearby water tables

   c) Potential effect on tidal resonance effect

   d) Construction activities and tourist influx affecting existing environmental quality and over-burdening present municipal services

6) Societal

   a) Related to an increased population and its potential effect on the socio-economic characteristic of the region; i.e., "boom-bust" effect

   b) Effect on local wage rate imposed by higher salaries available from a federal project and its imminent consequences on local industries forced to compete for a limited work-force

III. Recommendations

1) *Build a demonstration project as the most logical first step of development.*

2) *Ensure utilization of renewable resource by federal assistance and subsidies (i.e., research and development program).*

3) *Properly consider life cycle cost analysis as an economic measure of renewable resources.*

4) *Decrease institutional barriers by streamlining institutional/regulatory processes.*

Table 57

Project Information and Economic Analyses
For June 1976 Prevailing Costs

	U.S. Corps of Engr. International Project Two-Pool (Linked)	DOE All-American Single-Pool	Half-Moon Cove Demonstration Project Single-Pool	Half-Moon Cove Demonstration Project Two Way
Capacity — MW				
Total	500	180	5.0	12.5
Dep. Peaking	500	none	none	none
Annual Production				
10^6 Kilowatt-Hour	1932	680	21.65	37.81
Annual Capacity Factor[1]	.44	.43	.522	.353
Interest Rate (%)	6.375	7.00	7.00	7.00
Economic Lifetime (Yr.)	100	50	50	50
Total At-Site Costs[2]				
10^6 $	1775.2	464.0	11.085	22.460
Cost of Equipment for Transmission - 10^6 $	54.7	28.0	—	—
TOTAL	1829.9	492.0	11.085	22.460
Annual Cost[3] - 10^6 $	120.7	38.42	1.073	2.289
Annual Benefits - 10^6 $				
Power[4] - Peaking	20.7	none	none	none
- Energy[5]	43.59	14.38	0.438	0.765
Recreational	.375		0.281	0.281
Area Redevelopment	19.513	7.95	0.162	0.307
Aquaculture	5.500		0.300	0.300
Research & Development	0.0	0.0	0.250	0.250
TOTAL	89.678	22.332	1.431	1.903
Benefit-To-Cost Ratio				
Power Only	0.533	0.374	0.408	0.334
Total Benefits	0.743	0.581	1.333	0.831
Average Power Cost				
Mills/KWH[6]	62.5	56.5	49.6	60.5
Total Cost - $/KW[7]	3600.0	2720.0	2217.0	1797.0

[1] Average annual power output divided by installed capacity.
[2] Including plant costs, contingency, engineering design, supervision, administration, and interest during construction.
[3] Includes interest, amortization, replacement, operation and maintenance, transmission, and others.
[4] Power benefits calculated according to the following schedule:

	U.S. Corps	DOE	Half-Moon
Peaking - $/KW	45.0	56.0	56.0
Energy - $/KWH	0.024	0.0215	0.0215

Prevailing 1976 Estimates
[5] In transmission, a 8% loss is assumed for peaking and a 6% loss for energy.
[6] Total annual cost divided by annual output.
[7] Including transmission capital cost.

Reference Material:
1. U.S. Corps of Engineers, *Preliminary Economic Feasibility for International Passamaquoddy Tidal Power Project,* November 1976, revised April 1977.
2. *Final Report on Tidal Power Study for the United States Research and Development Administration,* prepared by Stone & Webster Engineering Company, March 1977.
3. Technical Papers No. 1-7, Passamaquoddy Tribe Energy Office on Studies of the Half-Moon Cove Tidal Power Project, March 1977.

Table 58
Estimated Economic Operating Parameters Up to 2000

A. Production Parameters

	Capacity	Annual Energy Production		
	MW	10^6 KWH	10^7 BTU (a)	10^3 BBL Oil (b)
U.S. Corps	500	1932	22009	3440
DOE	180	680	7012	1211
Half-Moon	5	21.65	225	38.6

a. Assume 10400 BTU/KWH for oil-fueled electricty
b. Assume 5,800,000 BTU/BBL Residual Oil

B. Projected Operating Parameters

		Ave. Power Cost		Constr.	Tidal Power Value
Year	*Project*	*Mills/KWH*	*$/10⁶ BTU*	*$/KW*[1]	*Mills/KWH*[2]
1976	U.S. Corps	62.5	5.01	3600	33.28[3]
	DOE	56.5	5.43	2720	21.50
	Half-Moon (5 MW)	49.6	4.77	2217	21.50
1980	U.S. Corps	–	–	4345	45.28
	DOE	–	–	3434	29.25
	Half-Moon	–	–	2799	29.25
1985	U.S. Corps	–	–	6082	66.53
	DOE	–	–	4595	42.98
	Half-Moon	83.79[4]	8.06	3334	**1983** 42.98
2000	U.S. Corps	253.06	24.33	7679	**1989** 211.0 [5]
	Doe	228.76	22.00	5802	**1989** 136.3 [5]
	Half-Moon	200.83	19.31	–	136.34

Note: Bold figures denotes the year when contructions starts

[1]6%/Yr. rise for inflation
[2]8%/Yr. rise for fuel costs
[3]Greater value due to peaking credit, Table 56
[4]Half-Moon Cove On-Line 1985
[5]On-Line 1995

C. Parameters: Different Scenarios

	1980	1985		2000			
Scenario	–	1&2	3	1	2	3-A	3-B
Installed Capacity, MW	-0-	5	12.5	164	285	1212.5	392.5
Annual Energy Output							
-10^6 KWH/Yr	-0-	21.65	37.81	575.9	811.6	1825	1327.8
-10^9 BTU	-0-	225	393	5989	8441	18980	13809
-10^3 BBL Oil	-0-	38.6	67.7	1033	1455	3250	2381
Total Capital Investment In Current $/KW	-0-	334.	2702.	7153.0	6908.0	4231.0	5799.0

Table 59
Life Cycle Cost Analysis of Half-Moon Bay

Year	Annual Cost - 10^6 $			Ann. Inc.[1] - 10^6 $		Cost Break-Even
	Fixed	Oprtn. & Maint.	Total	6%	8%	Mills/KWH[4]
1985	1.080[2]	0.342	1.422	0.727	0.860	69.87
1990	1.080	0.416	1.496	0.973[3]	1.264[3]	73.51
1995	1.080	0.506	1.586	1.302	1.857	77.94
2000	1.080	0.616	1.696	1.743	2.729	83.34

Assumptions:
- Installed capacity - 5 MW
- Total cost - $11,085,000 (1976 dollars)
- Annual electrical output - 21,650,000 kilowatt-hours
- Construction start-up date - 1983
- On-line date - 1985

Notes:
[1] Annual income based on 1976 value of tidal power and escalated according to the following expression:
$(.94)(0.0216\ \$/KWH)\ (21{,}650{,}000\ KWH/Yr.)\ (1 + y)^x$
Where: y = annual escalation rate; i.e., 6%/yr, or 8%/yr.
x = year in question - 1976

[2] Fixed charge comprised of the following elements:

Cost of money	= 7.0 %
Amortization	= .25%
Federal taxes	= .00%
State and local taxes	= .00%
Insurance	= .20%
Interim replacement	= .15%
	7.60%

[3] Annual income increased each year in accordance with the different escalation rates listed.
[4] Break-even cost is calculated by the following equation:
B-E cost = (Annual Cost)/(21,650,000 KWH/Yr. × 0.94)
Where 0.94 is the transmission loss coefficient.

Hydroelectric Power

I. Introduction

This form of renewable source has been available for many decades and has made a significant contribution to New England's electrical supply mix. The usefulness and future development potential of hydroelectric depends on the following factors:

1) Availability of water resources at suitable sites.

2) Relative escalation rate of fuel supplies.

3) Federal/state incentives encouraging development.

4) Reducing institutional/environmental restrictions.

Hydroelectric development has an upper saturation limit imposed by physical constraints and environmental considerations. This paper will classify hydroelectric plants into the three categories listed and described below:

1) *Small hydro,* typically from 50 KW up to 20,000 KW for sites with a hydraulic head less than 20 meters. Includes existing sites and undeveloped sites for intermediate power production designed for public utility integration.

2) *Conventional,* for installed capacity greater than 20 MW and developable in two ways:

   a) *Storage,* used for peak production by building up a reservoir and generating for short periods during the day corresponding to peak load demand

   b) *Run-of-river,* usually available water flow producing base-load power during most of the year and peaking power during spring runoff.

3) *Pumped storage,* produces peak and/or intermediate power from off-peak electricity generated at a nearby plant and used to pump water into the reservoir. Typically, three kilowatt-hours are needed to produce two kilowatt-hours of more valuable peak-load energy. Two types of pumped storage installations can be constructed:

   i) Energy produced only from water that has previously been pumped

   ii) Pumped water plus natural runoff

It should be emphasized that pumped storage has a negative electrical output; however, its value is measured in terms of demand for peak power.

Various hydroelectric stations can collectively produce a fairly well diversified energy mix, capable of satisfying a regional load demand curve if proper conditions exist. The sites, identified and applicable to this type of development, are fairly well distributed in New England's land mass. However, certain states have a greater number of sites for retrofit and/or new construction.

II. Potential

1) New England

   a) New England's current hydro supply is listed in Table 60. Distribution of capacity by state is also listed as a footnote.

Table 60
Existing New England Hydro Supply

Year	INSTALLED CAPACITY - MW Conventional	Pumped	ANNUAL ENERGY OUTPUT 10^6 KWH	REFERENCE
1974*	1,174	1,477	4,753	Electric Util. Ind
1975	1,287	1,632	–	NEPLAN
1975	–	–	4,359	FRC
1977	1,217	1,477	–	U.S. Corps

* HYDRO

	Conventional	Pumped
Maine	310	–
N.H.	380	–
VT.	186	–
Mass.	193	1,446
R.I.	2	–
Conn.	103	31

Table 61
Potential Hydro Sites in New England

A) Small Dams

1) *Estimate of National Hydroelectric Power Potential at Existing Dams,* U.S. Corps & Engineers Institute for Water Resources, July 20, 1977

Cap:	2,970 MW
Annual Output:	13.219 (10^9) Kilowatt Hours
Replacement Cost:	$300,000,000 in displacing fossil fuels

2) *A Report on New England Hydroelectric Development Potential,* New England Federal Regional Council, June 1976

Number:	3000 dams
Range:	50 KW - 500 KW
Capacity:	180 MW (15% of dams, can be easily developed)

3) *Proceedings New England—Eastern Canadian Provinces Conference on Alternative Energy,* Hydro Workshop, April 27-28, 1978

Note: One estimate placed the actual utilization value at 5-10% of potential list in line A1 above.

4) *Interim Report on Inventory of Existing Dams in New England,* New England River Basins Commission, December, 1978
Total number at existing dams that do not presently have turbines (22% are presently breached).

Number:	9605
Total Capacity	1,783 MW
Annual Capacity	6.27×10^9 KWH

B) Conventional (Reference 2 & 3)

1) Nine major sites with benefit-to-cost ratio greater than unity

	(8) Sites	Dickey-Lincoln
Range:	25 MW-80 MW	-
Total Capacity:	390 MW	760 MW
Capacity Factor:	.19 - .30	.11 - .37
Annual Output:	850 (10^6) KWH	1540 (10^6) KWH
Benefit-to-Cost Range:	1.00 - 1.62	-
Benefit-to-Cost Average:	1.245	2.61**
Average Cost*:	$357. ($10^6$)	$463 ($10^6$)

* Excluding Transmission
** Recently Revised to 1.22 by the Corps of Engineers

2) Nine major sites with benefit-to-cost ratios between 0.8 and 1.0

Range:	20 MW - 220 MW
Total Capacity:	585 MW
Annual Output:	1170 (10^6) KWH
Cost:	$614,000,000

C) Pumped Storage

Total Capacity:	19,300 MW - 34,080 MW

Table 62
Hydro Power Production Parameters

	Small-Scale	Conventional (8) Best	Conventional (9) Marginal	Conventional Dickey-Lincoln	Pumped Storage
Installed Capacity (MW)	85-2,970	390	585	760	34,000
Capacity Factor	.4-.5	.19-.30	?	.24	?
Annual Output					
(10^6KWH)	378 - 14,400	850	1,170	1,540	-
(10^3BBL oil)	675-25,640	1,510	2,085	2,740	
(10^9BTU)	3,930-149,760	8,840	12,170	16,615	-

b) In order to measure total potential capacity it was decided to classify projects according to the aforementioned groups and to use the estimates derived from the studies referenced in Table 61. Power production parameters are listed below in Table 62.

2) Attributes

a) The attributes of hydro power include the following:

i) Inexhaustible resource

ii) Low machine outage rates

iii) Immediate power availability

iv) Potential to decrease fossil fuel dependence

v) Technology sound and well-established with simple technical principles

vi) Substitute to "spinning reserve" for steam plants.

b) With reference to pumped storage installations, the following attributes can also be included:

i) By pumping in off-peak hours, enables the plant factor of base-load thermal units to improve their efficiency.

ii) Use of base-load nuclear can decrease the cost of nuclear generation by operating at high load factors.

c) Small-scale hydro is ideally suited to the needs of small communities, i.e. for street lighting.

3) Economics

a) Total capital investment cost (excluding transmission) per installed capacity ranges from $609/KW to $1049/KW in 1976 dollars.

b) Proposed average power cost for a large project (i.e., Dickey-Lincoln) and a relatively small project (i.e., Black-River) are 38.16 Mills/KWH and 57.99 Mills/KWH, respectively. The cost data for Dickey-Lincoln was re-analyzed in terms of a 7% interest rate taken over 50 years, instead of 3 1/4% for 100 years, in order to reflect current cost of money.

Table 63
Hydro Capacity, Production, and Economic Summaries

A) Production Parameters

	Ultimate Capacity MW	Annual Energy Production 10^6 KWH	10^9 BTU (a)	10^3 BBL Oil (b)
Small Scale	2,970	13,219.	150,697.	23,970.
	85	378. (c)	4,309.	685.
	180	800. (c)	9,120.	1,450.
Conventional				
(8) Best Sites	390	850	9,690.	1,541.
(9) Marginal	585	1,170	13,338.	2,122.
Dickey-Lincoln	760	1,540	17,556.	2,792.
Pumped Storage	34,000	-	-	-

a. Assume 11,400 BTU/KWH for oil-fueled electricity

b. Assume 6,287,000 BTU/BBL residual oil

c. Proportioned according to 2970 MW estimate

B) Federal Regional Council Scenario

For 1985
Annual Reclaim Hydro: 8.9(10^6) BBL Oil Equivalence
: 51.6 (10^{12}) BTU
: 4963. (10^6) KWH (1115 MW)

No large hydroelectric projects until after 1985

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c) Table 64 compares the two aforementioned projects on the basis of three relevant economic indicators. The major difference is the cost per installed capacity which significantly affects the average power cost. Also it is apparent that the Black River project overestimates power value when compared to Dickey-Lincoln which has a favorable effect on its benefit-to-cost ratio.

d) Economic aspects of hydroelectric power plants that add to project feasibility include the following:

i) Low operating cost

ii) long plant life

iii) Reliable production.

e) Under life cycle cost analysis, hydroelectric power is competitive with other energy sources because it is relatively free from the inflationary pressures on fuel.

4) Environmental

a) Non-pollutant (air and water)

b) No hazardous materials

Table 64
Comparison Between Dickey-Lincoln and Black River Projects

	Dickey	Black River
Total Investment [a]		
Per Capacity ($/KW)	883	1793
Annual Cost [a] Per		
Annual Output (Mills/KWH)	35.40	66.7
Power Benefits [c] Per		
Annual Output (Mills/KWH)	36.72	54.29

a. including Transmission
b. without 5% transmission loss
c. peaking and energy credit

5) Socio-Economic

a) Major benefit is associated with the commitment to a renewable resource, a transition from the utilization of depletable supplies.

b) Additional values of recreational facilities, flood prevention, area redevelopment, and the establishment of conservation pools.

III. Problems

1) Institutional & Operational

a) Complicated regulatory requirements add time and effort to the planning phase.

b) Legal questions concerning private versus public control of streamflow and reservoir levels.

c) Environmental studies are deemed excessive for small projects since same guidelines apply to small and large plants.

d) Licensing procedures (i.e., FPC, PUC) are too lengthy, especially, for small projects.

e) Operational aspect of hydro plants are dependent on several uncontrollable factors; i.e., climatic conditions, storage/ power drawdown, streamflow variation (typically, 50% during spring runoff).

f) Pumped storage plants need the availability of a dependable supply (i.e., during off-peak periods) of low cost pumping energy.

g) Dependent on public utility cooperation and system integration.

h) Thermal and hydro plants are not directly interchangeable, since thermal plants can operate for extended periods.

2) Financial

a) Sites rarely close to demand, and this increases cost of transmission; i.e., initial capital and annual operation & maintenance.

b) The cost of prime movers and generators (per unit output) increases rapidly as the head decreases a handicap for low head hydro projects.

c) For small scale hydro, economic viability must come from reductions in equipment and operating cost; e.g., fully automated facilities, central pooled maintenance facilities.

d) There is no established means of financing for small and intermediately-sized projects.

e) The cash flows during early years of operation is prohibitively slow.

f) Highly dependent on interest rates and discount rates.

3) Environmental

a) Potential fisheries impact:

i) Upstream: turbine injuries to down-migrating fish, water level alterations, siltation, decrease in spawning success and in food production

ii) Downstream: bank erosion, bottom scouring, loss of cover & food, periodic flow shortage

iii) Other factors: embolism, migration blockage, bank slumping, changes in water quality and species composition, loss of stream habitats and spawning sites

b) Land reclamation

c) Transmission corridors

d) Potential affect on salmon restoration program

e) Groundwater effects

f) Impediment of watershed developments

4) Societal

a) Associated problems related to influx of construction workers

IV. Recommendations

1) *Construct demonstration projects for small-scale hydro to quantify unit prices, establish mass production capability, identify and rectify problem areas, and encourage private incentive.*

2) *Increase federal/ state assistance and subsidies.*

3) *Streamline regulatory/licensing procedures.*

4) *Develop a comprehensive energy policy which would determine priorities considered within the framework of environmental, institutional, operational, and economic guidelines.*

5) *Promote and encourage the development of renewable resources.* Hydro is an excellent candidate since technology is readily available and previous experience is quite extensive for different plant types.

Table 65

Economic Analysis - Annual Costs and Benefits
Springfield, Vermont (Jan, 1975 P.L.)

1)	Total Investment - Dams (Including distribution system & diesel unit)	
	Construction Cost of Dams	$40,710,000
	Interest During Construction	3,160,000
	Reserve Fund	3,650,000
	Total Investment	$47,520,000
2)	Annual Costs - Dams	
	Interest and Amortization (7% for 40-year bond)	$ 3,564,000
	Operation and Maintenance	
	Major Replacements	
	Loss of Land Taxes	$ 650,000
	Sub-Total Dams	$ 4,214,000
3)	Annual Costs - Power	
	Purchased Power	$ 287,000
3)	Total Annual Cost	
	Total	$ 4,501
5)	Annual Benefits	
	Customer Charge	$ 235,500
	Power: Peaking	2,081,010
	Energy	1,350,010
	Total	$ 3,666,520
6)	Benefit-to-Cost Ratio	
	Power only	0.870
7)	Average Power Cost*	
	Mills/KWH	70.2
8)	Production Parameters	
	Installed Capacity (KW)	22,500 - Hydro 4,000 - Diesel
	Annual Electrical Output (10^6 KWH)	60,250 - Hydro 7.280 - Diesel
	Average Plant Factor	0.306

$$* \quad \frac{\text{Annual Cost}}{\text{Output (.95)}} = \frac{\$4{,}501{,}000}{(67{,}530{,}000 \text{ KWH})\ (.95)}$$

Table 66
Wind/Tidal/Hydro Potential Electricity Production and Costs

	New Cap.		Annual Output			Construction Cost (c)	Operating Cost		% of New England Projected Electric Demand (d)
	Year	MW	10^9 KWH	10^{12} BTU (a)	10^6 BBL (b)	$/KW (c)	Mills/KWH	$/MM BU	
Wind	1972 (e)	24000 (f)	168.2 (g)	1917.4	305.0	754	17.1	1.500	-
	1985	-	0.023	0.26	0.04	1985-7940	-	-	0.026
	2000	5400	14.0	159.60	25.39	4758-19030	-	-	11.516
		10800	28.0	319.20	50.78	4758-19030	-	-	23.031
									11.534 - 23.050
Tidal	1976	180	0.68	7.75	1.23	2720	56.5	4.956	-
	1985 (h)	12.5	0.038	0.43	0.07	3343 (1985) (i)	-	-	0.044
	2000	380	1.290	14.71	2.35	Project Mix	-	-	1.061
									1.092
Hydro	1976	760.0 (j)	1.540	17.56	2.79	609	38.16	3.386	-
	1985	1135 (k)	2.765	31.52	5.01	Project Mix	-	-	3.175
	2000	1238 (l)	4.595	52.38	8.33	Project Mix	-	-	3.780
									6.054

a. Assume 11400 BTU/KW for Oil-Fueled Electricity
b. Assume 6,287,000 BTU/BBL Residual Oil
c. Construction Cost Escalated at 6 %/Yr.
d. Escalated at 2.25 %/Yr. from 1975 Estimates
e. Estimates for that year
f. Off-Shore Wind Power System
g. According To: (Cap) (Load Factor = 0.8) (8760 Hrs./Yr.)
h. High Scenario - Case (b)
i. Figures in parenthesis denote the year on-line
j. Dickey-Lincoln evaluated at 7% interest rate for 50 years
k. Assume: Dickey-Lincoln, 760 MW
(4) "Best-Sites", 195 MW
"Small-Scale", 180 MW
l. Assume: (4) Best-Sites, 195 MW
(3) Marginal, 193 MW
Small-Scale, 180 MW

Year	Projected Electrical Demand - 10^9 KWH
1975	69.705
1985	87.075 (2.25 %/Yr.)
2000	121.575 (2.25 %/Yr.)

Electric Generation New England (1975 Preliminary)

Type	10^6 KWH	10^{12} BTU	10^6 BBL	%
Oil	40493	461.6	73.4	58.1
Coal	4395	50.1	8.0	6.3
Nat Gas	192	2.2	0.4	0.3
Nuclear	20266	231.0	36.7	29.1
Hydro	4359	49.7	7.9	6.2

An Assessment of Wind's Potential Contribution to New England's Supply Mix

I. Potential

The wind has been used for centuries as an important source of power. Though traditional wind machines only pumped water, the basic principles are just as applicable to the modern wind turbine. In fact, the technology and most of the components of current wind systems have not changed significantly over time. Only the equipment for the generating and storage of electricity represent new additions to the process of harnessing the wind.

The comparative simplicity of a wind machine is one of its most attractive attributes. There are only three major components to a wind machine — a rotor which is turned by the wind, a tower which holds the rotor in a clear airstream, and the electrical equipment which convert the mechanical energy into electricity. These components are the same for both large and small wind systems.

The power produced is a function of both the size of the rotor and the velocity of the wind. Every doubling of blade length results in quadrupling power output. For example, a rotor with a diameter of 40 feet will produce four times as many kilowatt hours as a 20 foot rotor and sixteen times more than a 10 foot rotor. In addition as wind speeds increase, power goes up by the cube of the increase in velocity. This means that every doubling in velocity increases the power generation by a factor of eight. Thus a twenty-mile-an-hour wind produces eight times the power available from a ten-mile-an-hour wind.

The wind provides power on a basis that varies from minute to minute. These variations are independent of an individual building's needs which also vary over time. Any power produced in excess of the building's instantaneous needs will be lost unless 1) storage capacity exists or 2) the excess can be fed directly into the utility grid.

Different types of storage mechanisms are appropriate for different size units. The options most appropriate for small systems are batteries and thermal storage, e.g. domestic hot water. The options for large systems are pumped hydro storage, compressed air storage and electrolysis. Storage enables a wind machine owner to more fully utilize the power generated. However, storage equipment is extensive, increases capital costs, and it is relatively inefficient. Batteries, for example, are only 70 percent efficient, thus, 30 percent of the electricity is lost. In addition, the air storage and electrolysis techniques proposed for large systems are still in the developmental stage.

Another option for a small wind system is to connect the wind machine into the utility grid. This can be accomplished by installing a synchronous inverter to convert the DC electricity produced by the wind machine to AC which can be fed into the utility system. This opens up the possibility of loaning or selling power to the utility during periods of excess production. However, although tests have demonstrated that the synchronous inverter is safe, utilities have been reluctant to allow such systems to be hooked up.

Potential capacity of wind-electric systems is theoretically unlimited; however, on a practical basis there are institutional, economic, and operational constraints that severely limit implementation of this energy resource. Council of Environmental Quality estimates for wind-electric potential for the United States in the year 2000 were scaled down for New England as indicated in Table 67. Power production parameters are listed below in a modified basis for the year 2000:

installed capacity, 5400 MW - 10800 MW

annual capacity factor, 0.3

annual electrical output, 14 - 28 million KWH 25.5 - 51 million barrel, displaced 160-320 trillion BTU

Table 67
Production and Economic Parameters

A. Wind Potential

Ulitmate U.S. Potential (Excluding Off-Shore Sites)
:1-2 (10^{12}) KWH/yr

New England Potential (Excluding Off-Shore Sites)*
:35-70 10^9) KWH/Yr
:13320-26640 MW**

B. Development Scenarios

1985: Federal Regional Council Estimates Production At:
:23 (10^6) KWH/yr

2000: Council on Environmental Quality Estimates Production At:
U.S.: 0.4-0.8 (10^{12} KWH?yr
N.E.: 14-28 (10^9) KW/Yr*
5400-10800 MW**

C. Cost Estimates

Source	Cost ($)/KW	Remarks
1	1000-1800	For 2 & 3 KW Units Sold as Reconditioned (1978)
2	610 (1.7 MW) 520 (4.0 MW)	ERDA (1975) Production Cost Only
3	10000 (100 KW)	NASA (1976) Sandusky, Ohio
4	4700 (1.5 MW)	General Electric (1978)
5	1175 (200 KW)	Quebec, Turnkey Construction

*From The Production of U.S. Electrical Demand (= 10^{12} KWH)
To N.E. Electrical Demand (= 10^{12} KWH)
**Assume 0.3 Capacity Factor, Then Projected Installed Capacity Is:

$$\frac{\text{(Annual Output) (MW/10}^3\text{ KW)}}{\text{(0.3) (8760 Hr/Yr)}}$$

Summary

A. Production Parameters

	Ultimate	Annual Energy		
	Capacity – MW	10^9 KWH	10^{12} BTU*	10^6 BBL**
FRC	–	.023	.26	.04
CEQ	5400	14.0	159.6	25.39
	10800	28.0	319.2	50.78

*Assume 11400 BTU/KWH For Oil Fueled Electricity
**Assume 6,287,000 BTU/BBL Residual Oil

B. Project Cost

		Cost ($) / KW *** For	
	1976	1985	2000
6% Escalation			
	1175	1985	4758.
	4700	7940	19030.
8% Escalation			
	1175	2349	7450.
	4700	9395	29800

However, Federal Regional Council estimate for 1985 is only between 8-10MW which would necessitate a tremendous effort to realize CEQ estimates by the year 2000. To achieve the full potential, the following must be considered.

a) Advanced aeronautical engineering offers the potential for improvement, especially since wind turbine development will probably be constrained by engineering limits of propeller size.

b) Wind technology is fairly well developed and capable of being applied immediately; however, mass production and an effective R&D program could significantly reduce the initial investment and serve as a catalytic factor for future efforts.

II. Economics

The economics of wind systems are dependent on a number of factors: the capital costs, the wind conditions, the financing, the types of federal incentives and the cost of conventionally produced electricity.

There are only a limited number of small wind systems in operation today and, thus, it is difficult to assess average costs. Figures from the Massachusetts Energy Office's Wind Report provide estimates of the annual capital costs for a 2 KW, 6 KW and 15 KW wind machine (Table 68(a)). Dividing these annual costs by the annual output of each system, which in this case assumes an average annual wind speed of 13 mph, gives a cost per kilowatt hour for the electricity produced (Table 68(b)). Even allowing for income tax deduction of the interest payments, the cost/KWH — 8-13¢/KWH, is substantially above the average 1978 residential price of electricity (5-6¢/KWH). Thus, none of the wind systems presently available is able to provide electricity at rates less than current electric rates.

Table 68

Cost Data for 3 Small Wind Machines

A. Annualized Costs for 3 Small Wind Machines

	Total Cost	Annual Loan Payment-9% 20 Years	Operation & Maintenance[1]	Total Annual Cost
2 KW	$ 7,300	$ 800	$ 75	1 875
6 KW	11,100	1,215	100	1,315
15 KW	26,000	2,850	260	3,110

B. Cost/KWH for 3 Small Wind Machines

	Total Annual Cost	Total Annual Output[1] (v=13 mph)	Cost/KWH (Before Taxes)	Cost/KWH (After Taxes) (Year 1)
2 KW	$ 875	5,600 KWH	15.6¢	12.7¢
6 KW	1,315	13,500 KWH	9.7¢	7.8¢
15 KW	3,110	27,100 KWH	11.5¢	9.3¢

[1] Estimates derived from manufacturers' data and data compiled for *An Economic Analysis of Small Wind Systems*, JBF Scientific. See Appendix A.

However, when viewed over a 20 year lifetime rather than simply one year, a wind machine is significantly more attractive. Barring major repairs, the energy costs for wind generation are expected to remain relatively constant. The cost of conventionally produced electricity, though, is expected to continue to rise. The Wind Report indicates that assuming electric prices increase at 8 percent per year, as they have over the last seven years, the 6 and 15 KW machines will begin to produce competitively priced electricity in 5 and 8 years respectively.

The assumption made about future energy price increases, interest rates and wind velocities are important determinants of the financial viability of wind systems. For example, the Wind Report indicates that lowering the interest rate to 6 percent and raising average wind speeds to 14 mph brings after tax costs/KWH down to the point where wind energy is only .2 to 3.9¢/KWH more expensive than present utility rates.

The costs of large wind systems are even more difficult to estimate. NASA has recently begun operating several 100-200 KW machines and is in final stages of development for a 2 MW unit. The operating costs for these machines are likely to be high estimates since the results are tied to the experimental nature of the units. Several studies were conducted prior to construction, in order to estimate capital and operating costs for these experimental machines. Capital costs ranged from $430/KW to $1130/KW. The "busbar" energy costs range from 4-6¢/KWH.

The technology for small wind machines is sufficiently well developed today to justify the installation of these units. Both small and large units, however, have the potential for significant cost reductions through additional research and development. In the future mass production and continuing research and development can significantly reduce the initial investment costs and increase the economic viability of wind power.

III. Environmental

There is a need for further study into the environmental impacts of wind machines, particularly on noise issues, television interference and aesthetic appearance. Initially it appears that small wind machines have minimal environmental impacts. These machines cause some noise problems, but with proper design the noise is unlikely to extend beyond the owner's property. Because television interference is primarily a function of machine size, small systems should not encounter this problem. Finally, careful site selection and design considerations can minimize the aesthetic impacts.

Large wind systems are, however, unusual and highly visible. This is significant because many of the prime sites are also prime locations for recreational uses. Public reaction to these installations could limit the number in some locations. Also, wind machines with metal blades, in certain instances, can affect TV reception at distances of 1 to 2 miles. Fiberglass and other materials will help reduce, but not completely eliminate, this problem. The noise issue can be managed with proper design and modest land buffers around the wind turbine. Finally, the initial studies indicate that wind machines pose no significant problems for either ground or airborne wildlife.

Wind power is a valuable energy source for New England. The region has numerous sites with sufficient wind velocities for wind generation. At the same time, the region is presently paying the highest utility rates in the country, and this makes the development of alternative energy sources such as wind all the more attractive. Additional research and development together with mass production and federal tax incentives should lower the capital investment costs for wind machines and increase the likelihood that wind power will provide a significant contribution to the region's energy needs by 2000.

An Assessment of Photovoltaics Potential Contribution to New England's Supply Mix

Large scale utilization of photovoltaic solar cells for conversion of sunlight directly into electricity requires reducing the current cost of solar cell arrays from their present level of about $10 per peak watt[1] to a level between $0.20 and $1.00 per peak watt. (Their price was about $500 per peak watt about six years ago.) Presently available commercial silicon solar cells convert about 12% of the sun's energy incident on them into electricity.

Solar cells can be made from many semiconductors in addition to silicon. A number of these alternative solar cell types could in principle be manufactured at a substantially lower cost than silicon cells but their sunlight conversion efficiency is currently around 5%. Economic analyses have shown that, because of the need for support structures, interconnections, etc., there exists a minimum conversion efficiency — close to 10% — which solar cells must have if electricity produced by them is to be competitive with electricity produced by conventional fossil fuel or nuclear power plants.

The Department of Energy is now conducting a two-pronged research and development effort to address the problem. On the one hand, DOE is trying to find ways to reduce the cost of silicon single crystal cells; on the other, they are seeking ways to increase the efficiency and improve the performance of solar cells made from other semiconductors. Solar cells could be used in central power stations or they could be dispersed on roof tops of buildings, like solar thermal collectors, where they would produce the power at the point of consumption. Economic analyses of these two modes of deployment show that under some circumstances dispersed on-site systems have an economic advantage over the central power station mode and vice-versa.

Several studies of the future of photovoltaics have resulted in various predictions about the size of the contributions which they will make to the national and regional energy budget. For example, the Congressional Office of Technology Assessment released a report in 1978 in which they contend that on-site photovoltaic systems will become economically competitive within 10-15 years, and that they will begin to be introduced at that time. However, a recent (1979) study by a committee established by the American Physical Society concluded that only central power stations are feasible and that about 1% of the total electrical generation in the U.S. will be produced by such stations. On the other hand, the Council on Environmental Quality, in a 1978 report, claims that as much as 25% of the total energy used in the U.S. could be provided by solar energy in the year 2000 if a vigorous program aimed at its development and commercialization is pursued. This includes a maximum potential of 2-10% of total energy supply, perhaps 5-30% of electricity from photovoltaics. In view of these disagreements among groups who have confronted the problem, it is difficult to estimate how much energy will be contributed by photovoltaics in New England over the next 10 to 20 years. The committee has concluded that a reasonable estimate for photovoltaic electricity production in New England by the year 2000 lies between the most conservative and most optimistic estimates; it assumes that, in the year 2000, 10% of New England's electrical energy will be produced by photovoltaic solar cells. It is reasonable to expect that photovoltaic electricity will become competitive in New England before it becomes competitive elsewhere because of the high cost of conventional energy in the region. This reinforces the view that, even if the nation only produces a very small percentage of its electricity by photovoltaic cells, New England will probably produce a larger fraction of its electricity from these devices. This optimism must be tempered somewhat by the understanding that New England has a lower availability of sunshine than do some other regions of the country.

[1]One "peak watt" of solar cells is an array amount of cells which produce one electrical watt when exposed to full sunlight falling on them perpendicular to their surface.

PEAT*

I. Why Peat?

In New England it is fashionable to talk of "biomass" as a future energy resource: waste wood, manure, potatoes, sewage sludge, be what may—all have received some play. All, that is, except for that accumulation of dead biomass called peat.

There are 105 peat producing sites in the United States but virtually all of their product is consumed for agricultural and horticultural purposes. Not so in the rest of the world where 32 percent of all peat is used for fuel—mostly to generate electrical power. In the U.S.S.R. about 66 million tons of peat are burned annually to produce 14.5 billion kilowatt-hours of electricity. In Ireland, about one-third of the country's electrical power requirements are generated by burning peat. Lesser amounts of energy are generated from peat in Finland and West Germany.

The Institute of Gas Technology (IGT) estimates that the energy equivalent of the United States peat resource is 1443 quads ("quad"— quadrillion BTU's) or 240 billion barrels of oil equivalent. About 21 quads of that total is estimated to be in Maine and perhaps 4 or 5 additional quads are in the other 5 New England states. If all the potential of U.S. peat resources could be utilized in the form of synthetic natural gas (SNG) it has been estimated that the yield would amount to 1 1/2 times the present national consumption of natural gas and that such a production level could be sustained for 20 years.

II. What is Peat?

Peat is partly decomposed plant matter that has accumulated under water or in a water-saturated environment. It is the initial stage in the process that ultimately converts vegetable matter into coal. Peat comes in varying degrees of decomposition and with a range of properties resulting from the variety of plants that formed it, climatic differences, and the environment of accumulation. One simplistic classification divides peat into moss peat, reed-sedge peat, and peat humus. Peat derived from moss is called moss peat, from anything else and from mixed vegetation it is reed-sedge peat, and if it is so decomposed that botanical identity is not apparent, it is peat humus.

III. How About New England Peat?

If the world contains an estimated resources of 233 billion tons of air-dried peat and about 6 percent, or 13.8 billion tons, are in the United States, where does New England fit in?

The U. S Geological Survey has estimated the peat resources of the New England states as follows:

Table 69

Maine	10^8 tons (hundreds of millions)
New Hampshire	10^7 tons (tens of millions)
Vermont	10^7 tons (tens of millions)
Massachusetts	10^7 tons (tens of millions)
Connecticut	10^7 tons (tens of millions)
Rhode Island	10^5 tons (tens of millions)

*Prepared by William R. Barton and Joseph M. Pecoraro for The New England Energy Task Force of the Federal Regional Council as a Briefing Paper for the New England Energy Congress.

Other authorities consider U. S. Geological Survey figures to be conservative and have estimated Maine peat resources to be 1.8 million tons (1.8×10^9).

New England peat bogs or swamps are typically several feet to a few tens of feet thick and consist of moss, sedge and humus peat with some intermixed tree trunks, limbs, or other debris. Raised bogs, more common in Maine, may have several inches or feet of high quality and high value sphaghum moss peat as a surface layer. The bog or swamp may, or may not, be overgrown with trees or an undergrowth of shrubs and other small plants.

Raw peat typically contains 90 percent or more of water by weight. By air drying the moisture content can be reduced to 25-30 percent and for resource estimate purposes an acre-foot of bog may be considered to yield about 200 tons of air-dried peat equivalent. On a dry basis, peat has a theoretical heating value of 9,000 BTU/lb. However, air-dried peat with a 5 percent ash content would contain a net heating value more on the order of 6,000 BTU/lb and in actual practice, with less than optimal drying and with allowance for impurities 3,000—5,000 BTU/lb. might be closer to reality. Variations in peat composition from bog to bog and layer to layer within a bog also cause variation in BTU content.

The precise measurement and evaluation of United States peat resources is only now beginning. Few bogs have been explored for peat systematically. In New England, the Maine bogs are considered to have by far the greatest potential and consequently have received by far the bulk of investigation. In 1909, the U. S. Geological Survey published the 127 page Bulletin 376 titled: *Peat Deposits in Maine*, and sporadic study of the peat in Maine and other New England states has continued under various auspices to this day.

Without knowing the true energy potential of New England peat, only a theoretical yield figure can be constructed. But a 10,000 acre complex of Maine peat bogs averaging 15 feet thick, if developed, would appear to offer a harvest of about 30 million tons of air-dried peat equal in potential energy yield to about 15 million tons of coal, or 60 million barrels of oil.

IV. How Can It Be Mined And Used?

Peat can be harvested in a variety of ways. Specialized peat extracting machinery has been developed and is available, and conventional types of excavating and earth-moving machinery, or modified conventional types can be used. Equipment ranges from power shovels, bulldozers, front-end loaders and millers used in ditched and drained bogs to draglines, clamshells, and dredges for submerged deposits.

The extracted peat is air-dried to various degrees using one of several systems depending upon mining method, end use, peat type, and climate. If necessary for marketing, artificial drying may be practiced, but it is not ordinarily done for peat intended for use as a bulk fuel. In Ireland, for example, the upper bog level is drained to partly dewater the peat, the top layer of dried peat is milled off by a bogging machine which shreds the product to desired size, ridged to await transport, and finally consumed by electric utilities while still containing 40 to 65 percent moisture and averaging a net heating value of 3,350 BTU/lb. (about 30 percent of the heat content of a typical U. S. bituminous steam coal).

In Maine if a peat deposit has a surface layer of sphagnum moss peat, it could be selectively removed by milling machine or other method for shipment to horticultural or agricultural markets where higher values may attain than the estimated $10/ton value for air-dried fuel peat f.o.b. bogside in Maine.

It should be noted that there are also unconventional methods available by which New England peat could be harvested. One with possibilities is hydraulic movement by a monitor jet followed by pumping as a slurry to drying fields. This method would offer advantages if the deposit contains a large proportion of stumps, tree roots, and hog-holes.

Peat offers the potential for conversion to energy in more than one way. Conventionally, in Europe shredded peat is blown directly into the combustion chambers in steam-electric generating plants. The plants are typically multi-unit and what may be termed "bog-mouth". Usually they are within sight of the peat site to avoid undue transportation costs. It is also possible that peat could be fired mixed with coal or oil the same way shredded waste paper can be used in certain installations. That possibility would seem less economically attractive than "bog-mouth" power generation, and offer no particular advantages that I can conceive of for New England.

Peat has been converted experimentally into synthetic natural gas. Based on work by the Institute of Gas Technology, the incomplete combustion of peat in the presence of hot air and steam will yield an intermediate calorific value gas with byproduct ammonia and hydrogen sulfate. The cleaned gas can be upgraded to SNG by a methanation process. The method is technically feasible and is said to be economically attractive. While the full-scale commercial feasibility of the process has not been fully demonstrated,the Minnesota Gas Company in 1975 applied for a lease on 200,000 acres of state-owned peat bog containing enough peat to produce an estimated 250 million cubic feet per day of SNG for a twenty year life. That annual production would be equivalent to about 1/4 of all the natural gas consumed in Minnesota in 1974.

Minor fuel uses would include pressed briquets for domestic heating and cooking. In addition chemicals, coke, and waxes are potential byproducts.

V. What Are The Restraints To Mining Peat For Fuel In New England?

While there is a lot of peat in New England, it has not been investigated specifically and systematically as a potential energy source. Where is the best peat for fuel use? The peat with the most consistent BTU content? The peat easiest to mine? The best peat in conjunction with desirable power generation sites? The peat most environmentally and socially acceptable for extraction? Those and many other questions have to be answered.

Finding that enough peat is there, and that it is good peat is just the beginning. Can it be legally profitably removed and used?

Environmental restrictions are a serious constraint to peat operations in many states, probably more so in New England than in most areas. New England is environmentally very aware and also capitalizes on its inherent physical beauty to attract tourists.

Most New England peat occurs in wetland areas which provide critical wildlife habitat and to be important for water retention and ground water recharge. In all of the New England states except Maine it is difficult to conceive of large scale peat removal for energy purposes being permitted. The other New England states have less land area coupled with fewer and smaller peat bogs than Maine and have rigorous regulation of any wetland alterations.

A sizable peat for fuel operation in Maine, one the size proposed for Minnesota, would have considerable impact even in New England's far northern reaches. Two hundred thousand acres is about one percent of the land surface area of Maine. While it would be land of limited present economic value, it is land considered to be of significant ecological consequence and probably would involve something on the scale of one-fourth of Maine's peat bogs.

A peat operation would have to conform with all federal, state and local mining and environmental laws as well as any applicable local zoning and planning regulations (as any mining operation must).

Alteration of coastal wetlands in Maine is prohibited without a permit from the Maine Board of Environmental Protection or from the affected municipalities acting under the provisions of RSA 38-3, sec. 473 and sec. 474. The provisions of those sections effectively *preclude* peat operations from any area classified as coastal wetland in Maine.

Elsewhere in Maine, peat extraction is regulated but not prohibited by Maine planning and land use laws, as is any development which may substantially affect the environment. Such development specifically requires the approval of the Maine Board of Environmental Protection under RSA-38-3, sec. 482. Of direct and specific applicability, RSA 10-451 requires rehabilitation of worked land and specifically includes peat. Its declared policy includes: "enhancement of wildlife and aquatic resources, conservation, development, management and appropriate use of all the natural resources (of an area) for compatible multiple purposes, and to protect the health, safety, and welfare of the people, as well as natural beauty and environmental values." How such a policy is interpreted and implemented would be critical to any planned large-scale peat development.

Other questions that involve Maine peat development would include increased fire hazard resulting from mining methods using bog-drainage techniques, and potential for conflicts arising from the fact that much of Maine's peat with the most attractive development potential lies in areas contested by Maine's Indian tribes.

VI. How May We Resolve Those Problems And Move Ahead?

Critical to development of peat for energy in New England will be the task of convincing people that we need the potential energy benefits to be realized from using a few percent of Maine's peat bogs and that enough of Maine's peat bogs will remain to offer an acceptable amount of ecological sustenance. And by careful development and logical planning new and desirable environments and excellent far land can be created.

Peat harvesting can be conducted to create new "Great Ponds" in Maine. By definition they include artificially created bodies of water 30 acres or more in size and under RSA 38-3, sec. 386 are recognized as "having unsurpassed recreational, cultural, historical, and environmental value to citizens". By total bog peat removal, new great ponds would be created to offset the process of entrophication adversely affecting some existing great ponds and to provide new recreational opportunities. As an alternative, using the techniques of the Irish Bord Na Mona (Peat Board), bogs are partly drained and then gradually moved down only to a pre-determined level and left suitable for subsequent use as truly prime agricultural land.

By education and proper planning the peat could be utilized and the land and water left in an attractive and useful state, although a changed one.

New England and Maine will have to decide which they want more, energy from peat or pristine bogs. Peat helps Ireland and the U.S.S.R., it could help us.

Something the size of the Minnesota peat proposal (200,000 acres) would appear to grand to be applied on a New England scale, but Yankee ingenuity should be able to devise an alternative magnitude. One that will yield a maximum of energy benefits with an acceptable minimum of adverse environmental impacts.

MAJOR DEFINITIONS AND ASSUMPTIONS USED IN SUPPLY COMMITTEE CALCULATIONS

1) Costs and Inflation

   A) All dollar values are given in 1978 $s unless otherwise stated.

   B) Historical values are divided by the GNP deflator.

   C) Future inflation is assumed to be 6% per year, the same as it averaged from 1967-1977.

2) Fuel Equivalents

A) A barrel of oil is given the nominal value of 5,800,000 BTU.

B) One million barrels per day (MB/D) is 2.12×10^{14} BTU/yr.

C) Electricity is counted at its typical fossil input of 10,400 BTU/KWH so 1 MB/D = 204×10^9 KWH/Yr = 23,200 MW

D) One nominal barrel = 0.92 BBL residual oil = 1.00 BBL distillate oil = 1.11 BBL or 46 gal. gasoline = 5600 ft^3 of natural gas = about 0.23 ton coal = 560 KWH of nuclear, hydroelectric, or alternatively produced electricity.

3) World Energy Prices (normative forecast)

A) Oil product prices will rise 2% per year faster than inflation from 1982 to the mid-1990's. They will more than double in real terms between 1990 and 2000. In *current* dollars, crude oil will rise from $12.70/BBL in 1978 to more than $100/BBL in 2000.

Dissent From Figures 3a and 3b

Delegate Alan Davis dissents from the inclusion of Figures 3a and 3b in the Executive Summary of the Supply Committee for the following reasons:

Importance of Economics. The importance of comparative cost analysis to the energy future of the region cannot be underestimated. Therefore, the portrayal of relative cost estimates in the Executive Summary must be credible, clear and consistent. Figures 3a and 3b meet none of these tests.

No Independent Analysis or Reasonable Debate. Despite the importance of comparative economic assessments, significant aspects of Figures 3a and 3b were never independently analyzed by the Supply Committee or the Energy Congress as a whole. For example, New England Electric Systems estimates of "historic" nuclear and oil costs for the 1974-78 period were uncritically included on the chart. The 1990 coal and oil estimates were similarly provided by NEES, but without the supporting documents sufficient for a thorough analysis. The lack of scrutiny is particularly regrettable in light of the powerful regulatory and tax incentives to utilities to overstate coal and oil (versus nuclear costs) and the obvious controversy surrounding the entire subject.

Distorted Nuclear Cost Estimates. Past, present, and reasonably foreseeable future costs of electricity from nuclear plants cannot be calculated with precision. This is true because a wide range of so-called "hidden costs" are not recovered from ratepayers but are instead recovered from taxpayers in the form of subsidies. Significant nuclear costs are simply deferred for technological/institutional reasons (e.g., the costs of permanent waste disposal). There are also legitimate disagreements over the proper way to calculate nuclear power costs. For example, should the unanticipated costs of expensive replacement power necessitated by frequent and lengthy outages at nuclear facilities be included in the costs of nuclear power? Or should these very real costs to the ratepayers be ignored and present costs be calculated based on some hypothetical performance? NEES estimates of 1.6 cents per/KWH do not represent the cost of nuclear power in New England. Accordingly, I do not believe these are "actual" costs. As for future (1990) nuclear costs, I have requested that the cost estimates I prepared for the nuclear subcommittee be removed from the chart, since, as I explained in that analysis (p. 55), they were never intended for comparison with nonnuclear alternatives.

Distorted View of Cost Trends. Figure 3a is an attempt to compare the proverbial "apples and oranges"—the 1974-78 costs purport to be embedded, systemwide costs in New England. Thus, the cost of old and new, turnkey and non-turnkey, large and small units which burn the same fuel are all lumped together to produce low present estimates (or, in the case of 1974-1978, past estimates) of the bus-bar of electricity. These are connected, from 1978 onward, by straight lines to various estimates of the cost of electricity from *new capacity*. Thus, excessively sharp cost rises are incorrectly suggested by the chart. If systemwide costs in 1978 were compared with systemwide costs in 1990, the increases would not be nearly so dramatic. The same would be true if the cost of electricity from new capacity in 1978 were compared with the cost of electricity from new capacity in 1990. Finally, I note that drawing of straight lines from the 1978 to the 1990 figures suggests a steady, linear cost escalation which has no basis in Supply Committee analysis or discussion.

Limitations on Using Bus-Bar Costs. Figures 3a and 3b distort the relative economics of alternative sources because only bus-bar, not delivered, costs are mentioned. Thus, the cost of the substantial amounts of electricity produced at the plant but lost in transmission and distribution are not included or even mentioned. Nor are the heavy costs of construction and maintenance transmission and distribution facilities discussed. While these costs do not readily lend themselves to generalization by power source, there is no mention of the shortcomings of evaluating competing alternatives exclusively in terms of bus-bar costs. A small wind generator, for example, may have a relatively high bus-bar cost, yet its economic disadvantages compared to centralized alternatives might disappear if it were located near the likely user.

Inconsistent Cost Expressions. Some of the costs on Figures 3a and 3b are expressed in significantly different ways. For example, while the Arthur D. Little/New England Electric Systems nuclear estimate for 1990 was levelized over a 15-year period, the de La Chapelle nuclear estimate for the same year was not levelized at all. A full, consistent, life-cycle cost approach to competing alternatives would have provided a better basis for comparison as well as consistency with the Energy Congress's stated recommendations.

JOINT COMMITTEE ON ALTERNATIVES

Supply Committee and Alternative Energy Committee

SUMMARY[1]

The Joint Committee on Alternatives has developed a comprehensive set of recommendations for encouraging renewable energy resource utilization in New England. The programs, policies and studies recommended constitute an intensive stimulus to spur alternative energy use as a substitute for nonrenewable energy use in the region, and are focused on the achievement of specific, significant levels of utilization by 1985. The overall program described below, and the tentative costs identified, represent a minimum level of funding for alternative energy in the region. A portion of this funding may be provided as the result of regulations promulgated under the National Energy Act, but generally, the recommendations specify measures *not* taken as part of the NEA. The outline of the program follows.

A. Stimulate and subsidize the commercialization of the alternatives and the development of active markets in New England. More specifically, approximate goals and their costs through 1985 are:

1. Wood

200 MW of new electrical capacity (1.7 MMBBL/yr) including cogeneration, encouraged by tax credits, loan guarantees ($100 million in New England, $200 million nationally) and regulatory reform.

60 x 10^{12} BTUs/year of direct thermal applications (10 MMBBL/yr) for industry, encouraged by loan guarantees ($100 million in New England, $400 million nationally).

54 x 10^{12} BTUs/year in residential applications (9 MMBBL/yr) encouraged by tax credits for wood stoves and furnaces.

Assist the development of a wood supply infrastructure thru tax credits.

[1]These recommendations received the full agreement of all members of the Supply and Alternative Energy Committees prior to the full endorsement of the Energy Congress.

Undertake or complete studies of environmental impacts of wood energy use ($10 million, nationally).

Expand forestry management services ($5 million in New England, $25 million nationally).

2. Hydro

375 MW of small-scale and utility applications (2 MMBBL/yr) encouraged by feasibility study loans ($10 million nationally per year for 3 years) and construction/engineering loans ($100 million nationally per year for 3 years), in addition to presently allocated funding, and thru tax incentives and federal and state regulatory reform.

Create a limited liability insurance program.

3. Solar

Active: 25 x 10^{12} BTUs/year solar heating applications (4 MMBBL/yr) encouraged by grants ($35 million in New England, $692 million nationally per year for 10 years) and refundable tax credits.

Passive: Modify the National Energy Act and induce state and local bodies to reduce barriers to passive design.

4. Solid Waste

25 x 10^{12} BTUs/year utilized in various applications (4 MMBBL/yr) with particular emphasis on cogeneration, funded with PL 95-238 Construction Grants ($40 million in New England, $200 million nationally) and loan guarantees ($160 million in New England, $800 million nationally) thru 1985.

Develop DOE program to promote technological transfer ($.1 million per year nationally), New England Site Specific Planning Study ($500,000), and regulatory reform.

5. Wind

100 MW of capacity (.5 MMBBL/yr): 50 MW capacity at private installations from loan guarantees ($75 million in New England, $750 million nationally) thru 1985; and 50 MW encouraged by (a) federal purchases in New England (Supply Committee preference: $10 million in New England, $100 million nationally per year thru 1985) or (b) private financing (Alternatives Committee preference).

6. Tidal

12.5 MW (0.7 MMBBL/yr) at a demonstration facility (approximately $2 million).

Feasibility study of Half-Moon Cove Project ($250,000).

7. Peat

40 MW (.3 MMBBL/yr) demonstration and prototype plant encouraged by loan guarantees ($10 million).

Study of peat resources, feasibility study of small electrical peat generating plant ($500,000).

8. Methane from Animal Wastes

Feasibility Study ($50,000).

9. Photovoltaics

   Grants to encourage the demonstration of residential and commercial photovoltaic applications, combined with a publicity effort to inform the public.

10. Miscellaneous

    Small Farm Energy Project ($250,000).

    Study potential of alcohol production from biomass and fund a demonstration project ($200,000).

    Encourage production of methane from sewage sludge.

    New England should make a regional commitment of funds to solve its own energy problems.

    A New England Energy Demonstration Authority should be created.

    Support a study of New England Renewable Energy Potential.

    Maintain and expand the National Science Foundation Appropriate Technology Program.

B. Provide support for this development, identify and remove potential barriers and address long term problems and potentials. Measures include:

   1) Establishing just and reasonable rates for small power producers, for the sale of surplus power and the purchase of supplementary energy.

   2) Implementing appropriate regulatory reform relating to alternative energy as required for the achievement of commercialization goals.

   3) Revising the public utility commission guidelines for reviewing alternative energy systems.

   4) Conducting studies of the business and employment benefits resulting from the use of alternative and conventional energy systems ($500,000).

   5) Requiring publicly assisted projects to utilize life-cycle cost analysis.

SPECIFIC RECOMMENDATIONS[1]

I. Wood Energy

A) Electricity Generation

Provide subsidies and assistance to public and private parties to enable the development of at least 200 MW (1.7 MMBBL/yr) of wood-fired electrical capacity in New England by 1985. This capacity should be dispersed throughout the region and should be comprised of appropriately sized units proximate to the available supply. Specifically, this program will require:

1) *Extending the time-frame for the investment tax credit for alternative energy from 1982 through 1985 by amending the Energy Tax Act of 1978, Title 3.*

2) *Requiring FERC to rule, under the Public Utility Regulatory Policies Act of 1978, that biomass generating plants under 80 MW in size shall be exempt*

[1]The corresponding Supply Committee recommendation number is listed below after its respective Joint Committee on Alternatives title: I. Wood - 11; II. Hydro - 12; III. Solar A, B - 13; IV. Solid Waste - 14; V. Wind - 15; VI. Tidal - 16; VII. Peat - 17; VIII. Methane - 18; IX. Photovoltaic - 19; X. Miscellaneous A) - 20, B) - 21, C) - 22, D) - 23, F) - 24, G) - 25.

from federal utility regulatory authority as long as the state in which such a plant is so sited has adequate state environmental laws and regulatory powers.

3) *Developing a loan guarantee program ($100 million for New England, $200 million nationally through 1985) that provides collateral backing for commercial loans given for the purpose of building wood-fired cogeneration systems.*

B) Thermal

Provide subsidies and assistance to develop a market of approximately 60 x 10^{12} BTUs/year of thermal applications (10 MMBBL/yr) in industry and 54 x 10^{12} BTUs/year of residential applications (9 MMBBL/yr) by 1985. Specific elements are:

1) *Develop a loan guarantee program (in conjunction with program under A) for thermal wood energy applications in industry ($100 million for New England, $400 million nationally through 1985).*

2) *Require the Secretary of the Treasury to include wood stoves and furnaces as applicable energy conservation investments for the purposes of the residential tax credits of the Energy Tax Act of 1978.*

C) Supply Infrastructure

Provide an additional 10% investment tax credit (from 10% to 20% through 1988), in addition to NEA provisions, for purchase of equipment for harvesting, processing and transporting wood supplies for the wood energy market.

D) Forest Management

Expand forestry management services, particularly those provided by the U.S. Forestry Service, County Extension Services, and state forestry departments. For New England, the expansion should be a minimum $1 million per year ($5 million per year nationally through 1985), and should be directed towards:

1) *Informing landowners of the merits of environmentally sound wood energy harvesting techniques, and demonstrating such techniques publicly.*

2) *Working with appropriate agencies in order to help wood energy entrepreneurs and marketers in developing marketing plans and instituting sound business practices.*

3) *Working with landowners and wood harvesters teaching good forestry management practices.*

4) *Completing accurate and up-to-date subregion total biomass surveys.*

5) *Disseminating educational materials to the public on multiple uses of forestland, utilizing a variety of communications media.*

E) Environmental Impact

Instruct the Department of Energy, the Environmental Protection Agency and other appropriate federal agencies to undertake and/or complete studies of the environmental impacts of wood energy use, focusing primarily on air quality impacts and the question of forest nutrient cycles. These studies will cost an estimated $10 million (nationally) and should include, but not be limited to, these topics:

1) *The characteristics of pollutants and the relationship between pollutant emissions and the characteristics of the wood resource.*

2) *The relationship between system design and operation and pollution.*

3) *The impact of creosote on household safety.*

4) *The chemical content and health effects of pollutants.*

5) *The impacts of whole-tree and other intensive harvesting techniques on forest nutrient cycles.*

II. Hydro

A) *Federal*

Provide for the development of 375 MW of small-scale and utility applications (2 MMBBL/yr) of hydro by 1985. Specifically:

1) *The committees recommend the reduction and streamlining of FERC review of small scale hydroelectric energy projects at the present time. In addition, Congress should study the option of allowing licensing of hydroelectric dams up to 15 MW by state regulatory agencies only, provided that the state's procedures satisfy the FERC.*

2) *Provide loans for feasibility studies and construction for small hydro projects, beyond the amounts specified in the National Energy Act. ($10 million per year for feasibility study loans and $100 million per year for construction and engineering loans, nationally; program to last three years).*

3) *Establish a limited liability insurance program for small hydro systems, linking such a program to a mandated and rigorous dam inspection program. Provide on-going funding to states for comprehensive dam inspection programs.*

4) *Allow accelerated depreciation or investment tax credits (temporarily increased through 1985 from 10% to 20%) for small hydro developments.*

B) *State agencies should act to:*

1) *Clarify their own jurisdiction; conflicts should be resolved by state legislation; and one-stop, lead agency licensing should be considered, coordinating the entire process on one standardized form.*

2) *Clarify all existing mechanisms for formally arbitrating energy and water resource disputes as well as create an informal arbitration process so that legal challenges can be avoided.*

III. Solar

A) Active Solar[1]

Develop 25 x 10^{12} BTUs of solar heating applications (4 MMBBL/yr) in New England by 1985.

The following recommendations comprise a funding total approximately equivalent to the current yearly appropriations to nuclear power research and development. While it is recognized that this sum is a sizeable departure from our past commitment to direct solar subsidization, this substantial federal commitment is justified. First, the commitment is justified because, unlike most other alternative and all other conventional fuels, the potential energy generation is unlimited. Second, the limitations to solar development are primarily economic. The best available information indicates that about five doublings of current production levels of solar will enable it to become competitive with oil for space heating. Our recommended subsidy levels should make solar competitive with oil by 1980—after which oil prices are expected to rise sharply. Third, the substitution of solar for oil has important strategic advantages in the event of another oil embargo

[1]Supply Committee recommendations only.

or supply disruption. Fourth, the installation of solar in low-income homes is a much better long-term investment than fuel grants, which totalled $200 million for FY 1976. Fifth, the solar industry will generate jobs and dollars which will remain in the region, reversing a damaging and long-term trend of exporting our energy dollars.

Important steps were taken by the 95th Congress in providing support for the development of solar energy. Tax credits and loan monies should now be available for those who seek to utilize the sun's energy. These programs go a long way toward achieving many of the goals as set by the Supply Committee in its *Preliminary Report*.

The proposals that follow are intended to supplement and strengthen rather than supersede the important legislation passed by the 95th Congress. The following recommendations address two concerns: (1) All segments of our society, the low-income in particular, should be able to benefit from the coming age of solar energy. (2) The tax credits as currently written limit their accessibility to upper income households.

The issuance of federal installation standards should accompany the monies for these programs.

A three-tiered approach providing high subsidies to poor households and low subsidies to upper income should be substituted for the present tax credit system. Following are the details of this program.

1) *A low income solarization program should be established, utilizing the current low-income weatherization programs. 2,895,000 poverty homes, should have solar systems (e.g. hot water, passive greenhouses, window boxes, etc.) which average $2,000 per installation.[1] Additionally, 250,000 homes should be retrofitted for solar space heating. Total cost for this segment is $6.9 billion, $692 million per year. New England's share would be $35 million per year. This is approximately 3 and 1/2 times the present DOE weatherization budget, which should be expanded.*

2) *Higher income assistance shall be based on a sliding tax credit scale ranging from 30-50%, on the first $2,000 spent on an active system, and 20-40% on additional outlays not to exceed $6,000.*

   a) *The current income tax law should be amended to allow credit for dual purpose solar installations (e.g. solar greenhouses).*

   b) *The solar tax credits should be amended to be fully refundable within the first year.[2]*

B) Passive Solar[3]

1) National Energy Act Modifications

The tax credit provisions of the National Energy Act should be amended to include the following provisions:

   a) *Allowance for passive solar systems*

   b) *Allowance for combination of active, passive and other systems.*

2) *The federal government should encourage through available fiscal instruments, (e.g. revenue sharing), all states:*

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[1]$2,000 represents building material costs only; labor is not included because CETA provides labor.

[2]Results: 18 million homes solarized; expect 11% of national installations to be in New England, resulting in 2,000,000 by 1989.

[3]Alternatives Committee recommendations only.

a) *To induce municipalities and counties to revise zoning and subdivision regulations to incorporate passive design concepts (e.g. street layout, lot orientation, lot size, shading, landscaping, etc.) and to permit variances to such revised regulations based upon energy conservation considerations.*

b) *To enact, where absent, solar access and solar easement statutes.*

c) *To enact, where absent, solar property tax incentives which include an allowance for the cost of easements.*

d) *To induce municipalities to consider the energy efficiency of a structure prior to the issuance of a building permit.*

e) *To induce municipalities to create readily accessible consulting and review services available to property owners engaged in remodeling projects.*

IV. Solid Waste

Develop 25 x 10^{12} BTUs of utilization (4 MMBBL/yr) in New England by 1985. Specifically:

1) *Under PL 95-238 and PL 94-580, fund a major ($.5 million) site specific planning study in New England under the direction of a region-wide organization such as NERCOM, to locate attractive sites for resource recovery facilities, to identify optimal plant sizes and types of those sites and to facilitate regional planning for such facilities. Factors to be considered include technologies available, cogeneration potential, existing and planned steam uses, connection to utility grid, population concentration, jurisdictional boundaries, bonding authority, etc.*

2) *Appropriate funds for loan guarantees ($60 million in New England, $300 million nationally) and construction grants ($40 million in New England, $200 million nationally) under Title II and Title IV of PL 95-238 to bring about construction of resource recovery plants with an aggregate utilization of 7500 tons per day in New England by the 1985 frame, in order to implement study (1) above, and including a representative mix of plant sizes.*

3) *Provide a loan guarantee program for independent resource recovery projects, to be utilized when the risks associated with a project are not unreasonable and when one or more participants in the project is not capable of assuming risk. Therefore loan guarantees are appropriate when: 1) energy buyer is unable or unwilling to make long-term "take or pay" commitments; or 2) municipal supplier of waste is unable to make long term "put or pay" commitment due to debt equivalency; or 3) long term performance guarantees for recovery system can not be made acceptable ($100 million in New England, $500 million nationally).*

4) *Direct the EPA to reduce environmental regulatory uncertainties by accelerating promulgation of new source performance standards (NSPS) governing combined firing and other MSW-energy processes, and to provide for consideration of solid waste disposal improvements in air quality "offset" deliberations in non-attainment areas.*

5) *Direct DOE to develop a program that promotes technology transfer to regional decision-makers from countries and locations with more municipal solid waste recovery experience. This program should include utility executives, investment community, state governments, regional planners, environmentalists and news media ($.1 million/year nationally).*

V. Wind

Develop 100 MW of capacity (.5 MMBBL/yr in New England by 1985). Specifically:

1) *Initiate a federally-funded program to develop a site inventory of New England, including annual wind data collection program.*

2) *Study the optimal value of megawatt scale wind energy conversion for different applications.*

3) *Appropriate $100 million per year for five years for federal purchase and installation of windmills at federal facilities, allocating at least $10 million per year for New England. By 1985 the following New England installations, with a total of 50 MW of capacity (.25 MMBBL/yr), should be in place:*

   1) *100 small machines (1-100 KW).*

   2) *2-3 large machines (1-2 MW) for large industrial applications.*

   3) *1-2 utility applications, each an array of 10-15 2.5 MW.*

4) *Make available loan guarantees and/or low-interest loans for purchases of small (1-100 KW) wind systems with a total of 50 MW of capacity (.25 MMBBL/yr) ($75 million in New England, $750 million nationally through 1985).*

5) *Allow accelerated depreciation for purchase of small wind systems for commercial users.*

6) *Quantify operating parameters at a commercial or industrial demonstration project to evaluate public utility integration, cost of operation and maintenance, and user response to wind systems.*

VI. Tidal

Develop 12.5 MW of capacity (.3 MMBBL/yr by 1985). Specifically:

Support the construction of a demonstration project as the first step in the development of tidal power. A comprehensive plan should be implemented in the following sequence:

1) *Conduct a feasibility study of the proposed Half-Moon Cove tidal power project. A request submitted to the U.S. Department of Energy has been awaiting a decision for nearly 2 years (approximate cost: $250,000).*

2) *Coordinate this study with the U.S. Army Corps of Engineers, who have recently embarked on a four year study of the Cobscook Bay tidal project.*

3) *Expedite the licensing procedure for the pilot plant in order to reduce time delays, thereby minimizing inflationary cost increases.*

4) *Partially subsidize the cost of the project (capacity range 5-12.5 MWe) in the form of research and development grants, loan guarantees (e.g. inflation indexed interest rates), and operating credits. This subsidization aimed at making tidal power cost-competitive with conventional sources will cost from $370,000/year during the initial year of operation down to $80,000/year on a graduated ten year time scale. This assumes a 5 MW plant operating during a period when the cost of electricity from an oil-fueled installation increases at the rate of 8%/year as compared to an inflation rate of 6%/year ($2 million total over 10 years).*

5) *Conduct scientific and technical studies during the actual construction stages of the project; i.e., pre-, actual and post. The areas of investigation should include the following topics: environmental impact, material protection, structural analysis, tidal dynamics, and turbo-generator efficiencies.*

6) *Continue the planning phases of the larger projects within Cobscook Bay in conjunction with the goals and objectives of the demonstration project.*

7) *Increase federal grants and improve information transfer network for research and development topics associated with tidal power; e.g. energy storage.*

VII. Peat

Develop a peat resource program for New England with the following objectives:

1) *Undertake an accurate study of peat resources in the region (particularly Maine) ($250,000).*

2) *Conduct a feasibility study of a small (to 50 MW) electric or cogenerating plant ($250,000).*

3) *Fund a 40 MW (.3 MMBBL/yr) demonstration prototype plant if it is found to be feasible and environmentally acceptable ($10 million loan guarantee).*

VIII. Methane from Animal Wastes

Conduct a feasibility study of a methane demonstration project using chicken or other livestock wastes at a large New England farm ($50,000).

IX. Photovoltaics

Within the existing DOE photovoltaic program, sufficient resources should be redirected to implement photovoltaic residential field demonstrations through incentives for architects and developers. Specifically, DOE should offer grants adequate to cover the costs of innovative design in new construction for the following:

1) *Residential: For each 1 million population, one demonstration in (a) a single family unit and (b) a multi-family dwelling;*

2) *Commercial: For each 2 million population, a commercial demonstration involving a combination photovoltaic and heat recovery system.*

Appropriations should be sufficient to fund a publicity effort in conjunction with these demonstrations during their construction and public review. Builders should be required to maintain each project open for public inspection for a specified period of time and be guaranteed adequate support for a back-up system in each project. New England should be guaranteed participation in the program.

X. Miscellaneous

A) *Develop a Small Farm Energy Project for New England modelled on the existing project in Nebraska, to assist small New England farms in the development, demonstration and use of methane generation and other alternative technologies such as conservation, solar energy, alcohol fuel production, composting, and recycling ($50,000/year, $250,000 total for 5 years).*

B) *Conduct a study ($200,000) of the potential for and impacts of alcohol production*

from biomass in New England. The production of methanol or ethanol from woody or herbaceous material should be studied, and a demonstration unit should be funded in New England if such a plant is feasible.

C) Encourage the production and utilization of methane from sewage sludge. Specify under the Construction Grants Program of PL 92-500 that the methane produced from sewage sludge digestion should be used to fulfill the energy requirements of the plant. Also, Construction Grants funds and other inducements should be allowed for innovative projects to make use of extra sewage-derived methane in beneficial ways, such as for industrial process heat or cogeneration, or as a supplement to natural gas distributed through the pipeline.

D) New England should make a commitment of regional funds to its own energy problems and to the implementation of this entire report. This will provide an added incentive for private investment and federal funding of projects in the region, and assure that federal monies expended are responsive to state and/or regional needs.

E) A New England Energy Demonstration Authority should be created to:

1) Stimulate the demonstration of new energy technologies and alternative energy sources in the region.

2) Negotiate with the Federal Government for the design/construction of demonstration projects in the region.

3) Raise money from the states, the utilities and the private sector to finance demonstration projects. This would include an allotment of state seed monies, private contributions, and tax-free bonding authority.

The Authority may be linked to the New England Regional Commission to assure that projects are balanced and consistent with the economic and resource development objectives in the region.

F) Support a comprehensive study of New England's renewable energy potential for the next several decades, such as the proposed New England Renewable Energy Project.

G) Support the maintenance and expansion of the National Science Foundation's Appropriate Technology Program, which offers grants to individuals and organizations developing, demonstrating, or educating the public about energy, agricultural and related technologies adaptable to decentralized, small and medium scale applications. DOE should increase its public education efforts and budgetary allocations for all renewable resources and conservation programs.

ECONOMIC DEVELOPMENT THROUGH ALTERNATIVE SOURCES OF ENERGY COMMITTEE

DELEGATES

David L. Deen (Chair, Jobs Subcommittee)
Executive Director, Southeastern Vermont Community Action, Inc., Bellows Falls, VT—low income

Paul A. Doscher
Associate, Solar Survival, Inc., Harrisville, NH—environmentalists

George R. Gantz (Chair, Systems Integration Subcommittee)
Director of Policy and Research, Governor's Council on Energy, Concord, NH—government

Drew A. Gillett
Chairman, New England Solar Energy Association, Bedford, NH—environmentalists

Thomas B. Hyde
Associate Director, Administration, The Jackson Laboratory, Bar Harbor, ME— R&D

Joseph J. Loferski (Committee Chair)
Professor of Engineering, Brown University, Providence, RI —educators

John M. McNamara (Chair, Biomass Subcommittee and Capital/Financing Subcommittee)
Senior Financial Specialist, Northeast Solar Energy Center, Cambridge, MA—finance

John J. Mahoney
Vice President and General Manager, Avco Systems Division, Wilmington, MA—industry and manufacturing

Conn Nugent (Chair, Direct Solar Subcommittee)
Co-Director, New Alchemy Institute, Woods Hole, MA—R&D

William C. Osborn
Former Director, Massachusetts Solar Action Office, Boston, MA— government

John B. Randazza (Chair, Hydro/Wind Subcommittee)
Assistant Vice President, Central Maine Power Co., Augusta, ME—utilities

Bruce M. Reeves
Project Organizer, Maine Citizens Committee for Utility Rate Reform, Gardiner, ME—consumers

George Riley
Business Manager, Sheetmetal Workers, Local #17, Boston, MA—labor

Judy P. Rosenstreich (Committee Vice Chair)
Assistant to the President, Green Mountain Power Corp., Burlington, VT—utilities

Daniel Schiff
Proprietor, Research Consultants, Inc., Framingham, MA—small business

Natalie Schneiderman
Chairperson, Energy and Utilities, Massachusetts Fair Share, Boston, MA—consumers

Larry W. Shobe
Executive Director, Training, Education and Manpower, Inc., Derby, CT—low income
Thomas N. Tillotson
General Manager, Tillotson Rubber Company, Dixville Notch, NH—industry and manufacturing

RESOURCE CONSULTANTS

Tim Malarkey
General Manager, Cambridge Alternative Power Company, Cambridge, MA
John McCloskey
Executive Vice President, Acme Glass Company, Natick, MA
William G. Poist
Vice President and General Manager, Commonwealth Gas Company, Southborough, MA
Charles S. Rotenberg, AIP
Sr. Housing Program Coordinator, Dept. of Community Affairs, Hartford, CT
Robert Swann
Institute for Community Economics, Cambridge, MA
Fred March
JBF Scientific Corp., Wilmington, MA

STAFF RESEARCHER

Allen White

EXECUTIVE SUMMARY

The Committee on Economic Development Through Alternative Sources of Energy (The Alternatives Committee) has focused its efforts on three central themes: (1) defining the state of the art and future directions of the technologies applicable to renewable energy resources, specifically, biomass, direct solar, and wind/hydroelectric/tidal/wave energy; (2) identifying, and formulating policies to reduce the institutional impediments and adverse environmental impacts of developing these resources, and; (3) evaluating the relationship between renewable energy systems and regional economic development.

During the first three months of study, three subcommittees of 6-7 members each were organized according to the major resources under investigation: Biomass, Direct Solar and Wind/Hydro. Each subcommittee prepared a technical discussion of its respective resource, including an evaluation of its availability, applicable technologies for each end use, institutional impediments and environmental constraints. These documents were reviewed by the full committee membership and revised accordingly. They appear in full as part of the report.

In August, the full committee restructured itself into three new policy oriented subcommittees: Capital/Financing, Jobs and Systems Integration. Members agreed that the new subcommittees would utilize the initial technical reports as a basis for formulating specific recommendations in each of the three topical areas, as well as continue their investigations, where necessary, in each of the original three resource areas.

In the final month of work, the committee continued its revision of technical reports and recommendations presented in the *Preliminary Report* of the Energy Congress. The most notable changes resulting from this effort include: (1) a set of joint recommendations covering all

alternative energy resources formulated in conjunction with the Alternatives Subcommittee of the Supply Committee; (2) the addition of a passive solar section to the Direct Solar Subcommittee; (3) an expanded Jobs Subcommittee report entitled "The Employment Impacts of Energy Use and Production"; (4) an elaboration of the key electric grid-alternatives interface issue and (5) the contributions of two committee members to the development of a Residential Conservation Package. (See page 365-380.)

In the following section, abstracts of each subcommittee report are presented. It should be noted that each technical report represents the consensus findings of the individual subcommittees.

Biomass Subcommittee

Wood is by far the most promising *biomass* resource available in New England. On a sustained yield basis, wood can probably provide in excess of .86 x 10^{15} BTUs annually. As a home heating fuel, the use of wood is increasing extremely rapidly throughout the region. As a boiler fuel for generating electricity, wood is receiving increasing attention from utilities seeking alternatives to oil and nuclear. Exploration of wood resources must proceed in a manner consistent with the environmental risks involved. At present, the dangers of an overburdened infrastructural network and the mismanagement of the resource by unplanned utilization must be addressed as the region looks toward its forests as an alternate energy source. Effective forest management and careful selection of the type and distribution of conversion systems will insure long term benefits in the form of resource sustainability, environmental compatibility and employment opportunities.

Direct Solar Subcommittee

New England receives sufficient solar energy input to supply a major portion of the region's space and water heating requirements. The major barriers to realizing this potential are primarily economic in nature. Current costs of flat plate collector systems are \$20-\$30/ft.^{2} (installed), which translates into heating costs competitive only with the most expensive conventional system, electric baseboard heating. Since most materials utilized in the manufacture of collectors are already produced in voluminous quantities, major cost reductions will be difficult to achieve. Cost competitiveness of heating by solar energy, therefore, will most likely be achieved through: (1) the rising cost of conventional fuels; (2) perfection and utilization of passive solar technologies; (3) greater public acceptance of the life-cycle cost concept and; (4) reduction of installation costs through improved installation methods. Many passive design concepts, which utilize buildings' structural components and microenvironment without the assistance of mechanical devices, offer short-term market potential.

Photovoltaic power is an evolving power source. Single crystal cells made from silicon, gallium, arsenide or other semi-conductors are reasonably efficient but excessively costly; thin film cells, on the other hand, are less efficient but more attractive from a cost standpoint. Concentrator systems offer more promising opportunities for cost reduction, but their suitability for New England is inferior to that of flat panel cells. Encapsulation costs often equal those of the cells themselves, and further research is needed to develop a method appropriate to the climatic variations characteristic of New England. Given the electrical consumption of the typical 1500 ft ^{2} single story residence in the region the roof area is such that retrofitting with 10 percent efficient solar cells would produce enough electricity to meet a household's needs. A major unanswered question, however, is the number of existing housing units which could be retrofitted.

Rapid commercialization of direct solar applications for space and water heating will require a joint federal, state and local government effort. Within the federal government's purview are a

range of fiscal incentives to producers and consumers and demonstration programs. The states are in a position to provide rate protection for solar users, tax incentives, demonstrations, information and building code modifications. Local governments may act to insure solar access and conduct demonstrations. The single most preferred incentive is the direct grant whose effectiveness probably increases exponentially with the amount of the grant.

As the utilization of solar systems becomes increasingly widespread, integration of the many dispersed power generation systems into the existing electric grid must be achieved. If the solar systems include storage batteries or some other electrical energy storage means, the utilities could use these storage systems for load-leveling: they could fill them during off-peak hours and use excess power produced during high insolation periods.

Wind/Hydroelectric/Tidal/Wave Subcommittee

At the present time, approximately twenty small wind turbines with rated capacities of 2-15 KW are commercially available. A typical 10 KW unit will provide approximately 11,000 KWH/year at a site with a mean annual wind speed of 12 MPH, the upper end of the range characteristic of most New England sites. This quantity of electricity is equivalent to the average residential requirements exclusive of space heating and air conditioning. Larger turbines in the 2 MW range are under construction, but unlike the smaller units, have not been technologically proven. If wind systems are to provide a significant contribution to New England's energy mix, several major issues must be addressed: (1) reduction in capital cost through mass production of standardized units; (2) satisfactory interconnection arrangements with utilities for producers of surplus power; (3) minimization of safety hazards and adverse aesthetic impacts through adequate siting controls.

Conventional hydroelectric capacity in New England totals approximately 1500 MW, and estimates of developable capacity range from 1200-3300 MW. A major portion of the latter is the proposed 830 MW Dickey-Lincoln project in northern Maine. The remainder is accounted for by hundreds of potential small-scale sites in the 1-25 MW range most of which would operate as run-of-the-river systems with no storage capacity. In general, reactivation of existing hydro facilities is currently more economically feasible than developing new sites. Reactivation also will raise fewer environmental objections than either small or large-scale new projects. Reducing the regulatory burden on potential developers and providing up-front subsidies for feasibility studies and capital costs will facilitate the implementation of small-scale hydro projects. With such assistance, an *additional* 1500 MW of capacity is a reasonable goal for the region.

Tidal power studies of Cobscook Bay and Passamaquoddy Bay conducted by Canada and the U.S. Army Corps of Engineers have concluded that neither is economic at the present time. The Corps has turned its attention exclusively to the Cobscook project, although it is unlikely that further study will reach conclusions different from the previous ones. A smaller 4 MW project at Half Moon Cove within Cobscook Bay has been proposed by the Passamaquoddy tribe. From an overall cost/benefit standpoint, especially when local secondary impacts are considered, the Half Moon Cove may prove worthy of implementation.

Ocean thermal and wave power projects are neither economic nor environmentally acceptable to the region at present.

Capital/Financing Subcommittee

The most effective government financing schemes for promoting renewable energy systems are those which simultaneously stimulate supply and demand. A mix of increased investment tax credits, accelerated depreciation allowances, loan guarantees, low interest loans, dividend/capital gains exemptions, together with credits, rebates and grants for consumers, is most desirable.

Although such programs are costly, substantial secondary "effects" in the regional and national economy ultimately reduce the net cost to the governmental sponsor. Such benefits should be formally incorporated into the policy formulation process.

Jobs Subcommittee

The common assumption that energy consumption correlates closely with economic growth is valid only during the post-World War II period. Prior to that time, the ratio of energy consumption/gross domestic product shifted substantially from growth (1880-1920) to decline (1920-1945) before achieving relative stability during the last 35 years. Although future changes in ratio are dependent upon a host of technological, economic and institutional factors, it appears that the U.S. can—as do numerous other industrialized nations—maintain its high standard of living with significantly lower per unit energy consumption. The opportunity for translating reduced consumption into additional employment can be realized if labor is accorded a level of government subsidies historically confined to its two major competing factors in manufacturing costs, i.e. capital and energy.

In the production of energy, many existing studies demonstrate the substantial employment advantages of a conservation/solar path versus a conventional, centralized systems approach to meeting a region's energy needs. When all direct and indirect effects are accounted for, the conservation/solar option probably creates between 5-10 times more labor/years of employment than a nuclear option.

Government decision-makers at all levels—federal, state and local—must be sensitized to this wealth of employment opportunities and incorporate job-creation as a criterion in the allocation of resources and in the regulatory process.

Systems Integration Subcommittee

Policy impacting alternate energies must be framed to achieve four basic objectives: (1) equalizing incentives with conventional energy forms; (2) elimination of discriminatory regulations; (3) demonstration of economically attractive alternatives to potential consumers; (4) stimulation of supply markets for those systems already demonstrated. For example, home heating with renewable energy systems, including conservation, requires a variety of unit, neighborhood and community-scale demonstration projects. In contrast, interfacing hydro/wind electric power generation with the existing grid is primarily a regulatory problem. Greater flexibility must be allowed for the non-utility, small-scale producer of electricity, including provisions for backup power and market guarantees. Finally, wood combustion, at both centralized and dispersed sites will be facilitated by improving the supply network to consumers. Such improvements, however, must be undertaken with an awareness of the risks of "over-incentivizing" suppliers of the resource.

RECOMMENDATIONS[1]

The following lists Alternative Energy Committee recommendations exclusive of those developed jointly with the Supply Committee which appear on page 135-143.

1) General

The committee views the federal government's longstanding favored treatment of conventional energy sources versus renewable energy sources as one of the greatest

[1]One member of the committee dissented from these recommendations.

impediments to the rapid development and commercialization of alternative energy systems and realization of the economic development and employment opportunities they present. The committee, therefore, recommends that the federal government thoroughly investigate the extent of such inequality and immediately take the necessary steps to insure that renewable energy systems are, at a minimum, as favored as conventional systems.

2) Retrofit of Public Buildings

The committee recommends the enactment of state legislation enabling state and municipal government to issue general obligation bonds to finance the retrofit of public buildings and buildings owned by non-profit institutions, for purposes of energy conservation and conversion to renewable energy systems, when such projects are economically justifiable on a life-cycle cost basis.

3) Streamline Application Requirements for Small Producers

The committee recommends that the Economic Development Administration, Small Business Administration and Federal Housing Administration application requirements be streamlined to eliminate overlap and excessive cost to the small producer who uses renewable energy resources.

4) Jobs Impact Analysis

The committee recommends that Congress enact legislation requiring all federal agencies involved in energy-related programs to evaluate, and incorporate into their program selection, development and funding decisions, the jobs and other economic development impacts of the various policy options. This evaluation should be based on forecasts of the number, occupational mix and geographic distribution of all employment associated with such options. These forecasts shall be used as one criterion in the allocation of federal funds to all energy-related expenditures such as research and development of new technologies; grants, credits, rebates and other subsidies to end-users, equipment manufacturers and utilities. Furthermore, the Department of Energy shall be responsible for utilizing the best available forecasting techniques to fulfill this responsibility.

5) Training Programs

The committee recommends that the Community Services Administration, the Department of Energy, the New England Regional Commission and the Department of Labor employment and training programs emphasize alternative energy and conservation as their first priorities. A larger percentage of the funding for such programs should be aimed at preparing trainees to enter labor markets associated with these activities in their local communities.

6) Income Retention for Energy Enterprises

To foster long-term community development and job creation in energy-related enterprises, the program income provisions contained in Federal Management Circular (FMC) 74-7, Attachment E—Section 6(b), which govern the administrative requirements for grants-in-aid to state and local governments, should be amended by modifying Section 6(b), to permit local grantees to retain income earned in federally sponsored programs involving energy-related enterprises.

7) Weatherization Programs

The committee recommends increased funding of existing weatherization programs and that a study be undertaken to determine the most effective and efficient working relationship between the Department of Labor, Community Services

Administration and Department of Energy in managing and funding weatherization programs. This study should focus on the Department of Labor as a source of labor; the Community Services Administration as an advocate for low-income people; and the Department of Energy as a funding source.

8) Public Education

The committee recommends that the various state departments of education mandate and finance the development of energy related curricula in all elementary, secondary and vocational schools. The curriculum should include treatment of both conventional and alternate energy sources as well as conservation technologies.

9) Comprehensive Cogeneration Program

The committee recommends the development of a comprehensive program on state and federal levels for the purpose of encouraging cogeneration. Such a program should provide incentives and assistance to cogenerators and should eliminate or reduce the regulatory and institutional barriers to cogeneration. It could also examine utility regulations and rate structures as they impact cogeneration.

SUBCOMMITTEE REPORTS

Biomass Subcommittee

I. Introduction and Summary

New England is blessed with extensive and underutilized biomass resources which hold much potential for the region. The total energy eventually available on an annual basis from biomass in New England is probably greater than 0.86 quadrillion BTUs, virtually all of which is from wood and wood residues. Solid and agricultural wastes, the remaining biomass sources, are limited resources usable in certain applications. Wood energy is potentially convertible to all of the needed energy forms, including heat, steam, electricity and transportation fuels, although the near term potential for different applications varies tremendously. Home heating with wood is an established practice and is increasing rapidly within the region. Use of wood as a boiler fuel in industrial and commercial applications has achieved limited acceptance, and several facilities use wood for producing electricity (all but one are cogenerators). Alcohol produced from wood is not currently available as a fuel, and will not likely play a significant role by 1985.

There are a variety of problems which prevent the biomass resource from being fully utilized. The single greatest problem at this time is the lack of an established supply network for wood fuels. Ideally, such a network would fulfill the multiple goals of protecting the resource from overutilization, coordinating the supplies of wood for energy with other forest product industry needs, providing adequate supplies at reasonable prices, and insuring product quality control. Meeting these goals would eliminate the major constraints to using wood for energy, and would allow other problems, such as lack of public acceptance, high initial capital costs and possible air quality impacts to be addressed more easily. Perhaps the greatest danger at this point is that the lack of a supply network will mean that any demand pressures, such as those from major government incentives for wood energy use, could result in precipitous, uncontrolled harvesting of the region's forestland, with consequent loss of value and long-term sustainability.

Developing the region's biomass resources in an environmentally sound manner will have tremendous positive economic consequences. Aside from the obvious benefits of reducing energy importation, the productivity and value of the forest resources will improve substantially, a major job-creating industry will be developed, and knowledge and expertise in biomass utilization will be developed which can be marketed outside the region.

II. Resource Assessment

Biomass is available in a variety of forms in the region, although the wood resource, quantified below, is the dominant source. Solid waste is a significant source of biomass and has also been quantified, but agricultural wastes and sewage, which can provide energy only in very limited applications, have not.

Estimates of wood resources available for energy use have been compiled by a number of sources. The most significant sources of wood for energy are mill wastes, forest non-commercial wood, and harvest of non-commercial (for other forest products) trees and species. The best quantitative estimates available have been compiled and documented in the Supply Committee report of the Energy Congress. As a reasonable "guess" for the total potential resource available the figures in the report are more than adequate, and they are presented in Table 1 below.

Table 1
New England Wood Energy Potential
10^{15} BTUs

	ME	NH	VT	MA	CT	RI	N.E. (Total)
Renewable Yield							
Cull Increment	.13841	.03844	.045367	.02292	.014796	.003236	.26317
Annual Mortality	.00054	.00015	.00014	.000089	.000058	.000001	.00978
Annual Thinning Poletimber Stands[1]	.009568	.004245	.00341	.00299	.00209	.000417	.02272
Mill Residues	.00255	.00069	.000476	.000405	.000069	.000012	.004202
Logging Residues	.04345	.00520	.005525	.003502	.000816	.00017	.058803
Non-Renewable Yield							
Land Clearing	.00787	.00520	.00158	.01409	.00967	.00145	.03986
Existing Cull	.096776	.026878	.031757	.016029	.01346	.002207	.187162
One-Time Thinning	.04271	.01895	.012193	.013353	.009345	.00186	.09841
1985 TOTAL	.431874	.099753	.100448	.073195	.050348	.0094087	.684047
Post-1985 Renewable Yield							
Logging Residue Increment	.0869	.0101	.0110	.0070	.00163	.00034	.1176
Mill Residue Increment	.0051	.0014	.00095	.00081	.00014	.000024	.00840
Biomass Plantations	.00150	.00082	.00219	.00088	.00236	.00076	.01759
20% Productivity Increase	.02119	.00315	.0031	.00216	.000772	.000156	.0305
2000 TOTAL	.4700	.115223	.117688	.084045	.05525	.010688	.858
Barrels of Oil Equivalent	80,967,000	19,866,000	20,291,000	14,490,000	9,525,000	1,842,000	147,951,000

[1] Pole-sized stands acreage: Maine: 5339; New Hampshire: 2369; Vermont: 1524; Massachusetts: 1669; Connecticut: 1168; Rhode Island: 233.

Quantitative data on solid waste is also available and has been compiled in a number of sources. In the report to the Supply Committee, the New England market potential for solid waste energy recovery was estimated to be 29.4×10^{12} BTUs/yr in the near term and 44.1×10^{12} BTUs/yr in the intermediate term. This source is variable, as consumer tastes, packaging practices, and the volumes of material recycled may change.

Wood biomass is available in several forms, and the quality of the resource as a fuel can vary considerably. The most common sources in New England will be:

A) Mill wood wastes

This is the most readily available and predictable type, usable at both decentralized and centralized conversion plants. The proximity of mills to household and industrial consumers permits steam generation at 60-70% thermal efficiency. Electrical cogeneration potential is substantial, and the "waste-based" price pattern makes conversion viable today.

B) Non-commercial and Harvest Wastes

This resource may be disaggregated into: a) dead and deformed trees and non-commercial species, and b) waste left from commercial harvesting. Dead and deformed tree wood is generally located in more remote regions, and is subject to high transport costs. Conservatively estimated to cost $24-$34 per bone dry ton (BDT) for on-site harvest, it is most easily produced in the form of chips. However, because this source is associated with periodic woodlot thinning and requires a substantial capital investment, regional or cooperative small scale processing of the fuel will be required. Tops and limbs form the bulk of the waste from commercial harvest. Collecting this resource for energy use is feasible under whole-tree harvesting or dual chipping schemes, and would be difficult (expensive) for small woodlot owners and jobbers. A substantial market currently exists only for hardwood chips. The volume of this waste represents on the order of 40% of the mass of the tree.

C) Harvested Wood

This category would include the clearing of land, clearcutting or harvesting of biomass plantations, thinning of forests and woodlots, and harvesting of non-commercial species for energy. Large operations would generally produce wood chips and use whole-tree harvesting techniques. This fuel would be marketed to industrial and commercial (and possibly utility) users within a specified radius of the operation. However, there is also a significant role in the production of cordwood for home heating. Small and intermediate woodlots can benefit considerably from selective cutting of non-commercial hardwood species, of overstocked stands, and of dead and deformed trees. Cordwood operations are a small but growing industry and can provide a valuable function for the smaller woodlots.

The cost of wood fuels is a function of quality and of many individual characteristics such as local supply, transport mode and cost, and existence of competing demand for the supply. In many areas of the region where even a rudimentary supply network for wood fuels or wastes has developed, wood is considerably cheaper than competing fuels. Although it is dangerous to generalize this result across the region due to the high variability in the demand for wood fuels, most sources agree that wood is now price competitive with conventional fuels for much of the region and that wood prices will escalate slower than conventionals.

III. Technical Considerations

Table 2 summarizes the development stages, most appropriate biomass resource, and end-use for the five primary conversion processes available for converting wood to usable energy. Fireplace, wood stove, furnace and boiler combustion are known and time-tested processes for generating heat, process steam and even electricity. Gasification, pyrolysis, methanation and fermentation are in varying stages of development and offer medium and long-term potential for generating heat, steam and electricity for gas and oil production, and for producing alcohol fuels. Although the last category in Table 2 is the least developed, it should be pointed out that methanation is commonly utilized in the treatment of sewage sludge and that portions of the fermentation process have been used for some time in the pulp industry.

One common problem with biomass is the quality of the fuel. Successful and profitable utilization of wood energy does require some consistency in the fuel source. Quality is not now assured because of the lack of a supply infrastructure. Cordwood can be satisfactorily aged by either user or producer or even burned green without too great a loss in efficiency, but this is not the case for larger and more sophisticated combustion systems or other conversion systems. The best technologies for providing a consistent fuel include chipping and drying, pelletization, and charcoal manufacture. Chipping is the easiest and will contribute significantly in the near term, but it does not provide a truly consistent product and is still quite expensive to transport any great

distance. Pelletization provides a much more consistent and easily transportable fuel, but has not been commercialized in New England. Charcoal is a high grade solid fuel which can be used in a variety of applications, but its use has become rare since petroleum fuels became so common.

The uses displayed in Table 2 represent applications in virtually all sectors of the New England economy. Residential, industrial, commercial and utility applications are immediately feasible on a technical basis. Although the dispersed nature of the resource limits the size and density of the use within any particular area, it is clear that the potential market for the biomass resource is as great as the resource itself. The uses with the greatest immediate potential are those in the forest products and related industries where wood wastes are produced in very close proximity to the energy demand. Cordwood also represents an immediate potential, and in fact has grown rapidly in recent years. As the supply networks for wood energy products develops, the biomass energy resource can be expected to reach a good portion of the potential markets in the region.

Table 2
Conversion Process, Development Stage, Resource and End-Uses for Biomass in New England

PROCESS	DEVELOPMENT STAGE	RESOURCE	END-USES
1. Fireplace and wood stove combustion.	feasible, active commercially available	cordwood	heating
2. Furnace and boiler combustion	feasible, demonstrated	wood chips, crop residues, and solid waste	process steam, electrcity, misc. heating
3. Gasification combustion	feasible, need for market development and further demonstration	wood chips, crop residues and solid waste	process steam, electricity, misc. heating
4. Pyrolysis	feasible, need for further demonstration	wood chips, crop residues and solid waste	gas, oil, charcoal and/or heat and steam
5. Methanation and fermentation	probable feasibility, need for further demonstration	wood chips, crop residues, solid waste, sewage and livestock waste	methane gas or alchohol for fuel

IV. Commercial Potential

The resource availability and technical feasibility of using the biomass resource indicates substantial commercial potential. The fact that this commercial potential has not been realized points to the many difficulties which remain. Economics has played a role in discouraging biomass utilization and will continue to do so, particularly if the subsidies enjoyed by conventional fuels continue. The somewhat higher initial capital costs required for processing and handling a solid fuel is also a barrier, as is the uncertainty of acquiring a consistent supply at a reasonable price. Nevertheless, lower fuel costs should make biomass economically attractive for many applications now or in the very near term. Technical difiiculties, for instance those relating to fuel consistency, have also acted as an impediment, although these problems will disappear as the biomass energy industry becomes more robust.

The major institutional problem is that no large-scale supply network for wood fuels has yet emerged. Utilization remains an isolated phenomenon, most common in the pulp and paper industry, where wood wastes are utilized, and among small woodlot owners who cut their own cordwood. A wood energy supply industry must develop if the resource is going to be a significant contributor to the region's energy demand. Such an industry may be developing, but the necessary connections between the wood resource, the wood energy supplier and the wood energy user have not developed. The existing forest products industry can be used as a model, and can be expected to expand into the wood energy supply network, as can the existing cordwood operations. As the wood energy supply network will involve the small and intermediate sized woodlot owners, it is clear that the County Forestry Extension Service will become a major focus of the wood energy industry. This framework for the supply network is as yet incomplete, but it does provide a glimpse of what a fully mature wood energy supply network would look like. It is important that this network develop quickly and in such a way that the multiple goals for the forest resources in the region are met.

A number of other factors affecting the commercialization of biomass energy in New England are outlined below:

1) Problems exist with central station electrical generation with wood. The dispersed nature of the resource will not permit substantial economies of scale to be achieved, and 50 MW may be a maximum size for such a facility. Even with smaller plants, disruptions in the existing forest products industries can be expected in the area, and the economic impacts could far outweigh the economic benefits of the plant. However, wood, particularly in pelletized form, could probably be used successfully in any coal-capable units as part of a mixed fuel.

2) Dispersed generation of electricity from wood-fired cogenerating facilities offers a number of advantages. These smaller plants would have substantially reduced economic impacts in their area and could more economically use the local wood resources. The higher efficiencies of cogeneration would also assure that maximum benefits are derived from use of the fuel.

3) Any large-scale use of wood for energy will affect the existing forest products industry in New England. Whether these effects are positive or detrimental will depend on how the wood energy resource is developed and how the resource is used. The forest products industry in New England is a primary industry for much of the New England region, and the potential impacts should be carefully reviewed before action is taken. Positive impacts will more likely occur if energy and other uses of wood are viewed as complementary rather than competitive.

4) Existing patterns of land ownership in New England are a constraint to large-scale wood utilization. Much of the wooded land is in very small, privately owned parcels, where commercial practices, such as clear-cutting or whole-tree harvesting, will not be acceptable. A great majority of these woodlots would benefit from active forest management, although such practice will require an institutional and market apparatus which is currently non-existent. Attitudes of private woodlot owners have been changing, however, and the economics of limited harvesting for commercial wood or energy uses is being seen as a potential benefit in addition to its aesthetic advantages.

5) Wood must be harvested according to best management practices. For wood to be a truly renewable resource, we will have to avoid mining this resource indiscriminately for short-term economic gain. Best management practices (BMP) should be required for all wood harvesting, and it should be based on the principle of sustained and multiple use of the wood resource.

6) The environmental effects of large-scale harvesting of wood for energy will have to be

determined, and major problems avoided. BMP will provide some measure of protection, but further research will be needed in some areas, specifically, what are the near term effects on species distribution and on the general health of the forest of such harvesting; and what are the long-term implications for nutrient formation and recycling of the various harvesting schemes and practices.

7) Industrial process and plant heating, and commercial heating, are extremely important potential uses of wood in New England. Although home heating with wood, in woodstoves or central heating systems, is somewhat larger in potential, industrial and commercial applications may be more attractive to the users because of their closer attention to economics. The technologies of pelletization and gasification/combustion also offer substantial benefits to this category of users, and with proper economic incentives, the market would react quickly.

8) The problems of wood transportation are serious and may constrain the use of the resource. Truck transport of wood on a large scale is somewhat unsatisfactory due to the high costs, the need for petroleum fuels, and the negative environmental impacts. As yet, no other alternative, such as an extensive and operating rail system, is readily available.

9) In order for wood to have an immediate impact on the energy picture in New England, many existing facilities will have to convert to wood. Such conversions are eminently feasible for industrial/commercial facilities, and the technology of hooking up a wood gasifier to an existing boiler should be very attractive in the near future. However, there will be problems limiting such conversions. In particular, difficulty in obtaining firm supplies of wood, the high initial capital cost of conversion, and technical difficulties will have to be overcome if retrofits are to constitute an important use of the wood resource.

10) New England is basically powered by portable fuels. Electricity constitutes only 10% of end-use energy. Therefore, the most pressing energy problem we face is the substitution of these portable fuels with cheaper or renewable alternatives, and conservation. This implies that the best use of wood is as a replacement for these portable fuels. Any contribution wood can make to space heating loads, industrial needs or transportation will be a valuable benefit to the region.

11) Although biomass developments will be more labor intensive than most other energy sources, and will therefore create jobs, it is not clear that these jobs will be attractive, or that they will substantially ease the unemployment problem in the region. There are two major reasons for this. First, work derived from wood harvesting and collection will, for the most part, be menial physical labor and will not satisfy the expectations of most of the unemployed labor force in New England. Second, most of these jobs will be isolated and rural, and may not coincide with areas with the largest labor surpluses. It is unlikely that unemployed central city inhabitants will move to northern New England to secure jobs in the wood energy industry.

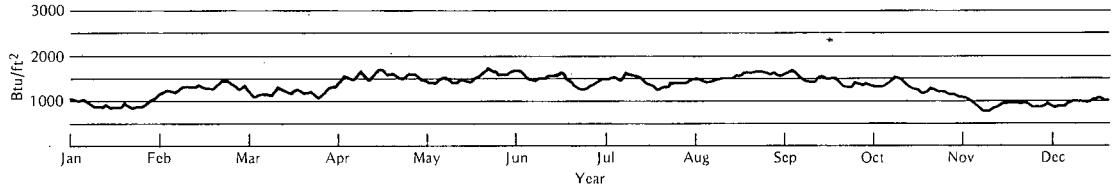
12) There will be secondary labor and economic impacts as a result of biomass development, most notably for the engineering and construction trades. In particular, retrofits and small installations of wood-fired equipment will stimulate the industry in New England, creating jobs and economic benefits. However, large projects requiring heavy manufacturing and specialized engineering will tend to involve industries based outside of the region, thereby resulting in capital exportation. This consideration is very important in comparing biomass development to other alternatives such as nuclear. Indigenous industries in New England may also be stimulated by extensive, small-scale biomass conversion to the point where knowledge and equipment can be exported, thus generating income for the region.

Direct Solar Subcommittee

I. Resource Assessment

Figure 1 illustrates the average daily insolation measured in the Boston area for a solar panel inclined at 45°. In the winter months, the average is seen to be 10^3 BTU/ft²/day with large daily variations. The variation of the average value over the New England area, as indicated in Table 3, is seen to be about 20% over the region.

FIGURE 1
Insolation Pattern in BTU/FT²
Blue Hill Mass—1958
45 Degree Surface



Taken from *Solar Heating of New England Homes*, Mass. Design, Inc. (1976).

Table 3
Various Measures of Mean Insolation at Specific Locations in New England

Location	Mean % of Possible Sunshine	Mean Total No. of Hours of Sunshine	Mean Daily Solar Radiation (Langleys)
Conn., Hartford	56	2541	–
New Haven	–	2704	–
Maine, Eastport	50	2309	–
Portland	–	2653	350
Mass., Blue Hills	–	2257	328
Boston	57	2615	301
New Hampshire, Concord	52	2354	–
Rhode Island, Block Island	56	–	–
Newport	–	–	338
Providence	–	2589	–
Vermont, Burlington	46	2178	–

Taken from the Appendices in *Harnessing the Sun*, John Keyes, Morgan & Morgan Publishers, New York (1975).

Table 4
Energy Consumption in New England
1976 (Preliminary)

Residential		
	Electricity	95×10^{12} BTU/Year
	Total, excluding electricity	764
Commercial		
	Electricity	77
	Total, excluding electricity	153
Industrial		
	Electricty	68
	Total excluding electricty	393
Power Plant		
	Total	793
Totals		
	Electricity	240
	Total, excluding electricty	2103

Source: New England Congressional Caucus, *New England Statistical Energy Profile*, May 20, 1978, p. 28.

This supply may be compared with the energy consumption in New England in Table 4 for 1976. The total energy consumption, 2.1×10^{15} BTU/year, was equivalent to the solar energy incident on an area of 200 square miles, which is 0.3% of the total area of the New England states. In 1972 there were 3.7×10^{6} residential housing units in New England[1], and this number together with the 1976 data in Table 4 leads to a figure of 2.1×10^{8} BTU/year/housing unit excluding electricity, and 0.26×10^{8} BTU/year/housing unit for electricity. These figures are considerably below those given for 1972 in a Brookhaven National Laboratory Energy Perspectives Study,[2] which are 4.2×10^{8} BTU/year/housing unit excluding electricity and 1.0×10^{8} BTU/year/housing unit for electricity. These numbers indicate that the residential non-electrical energy needed per unit corresponds to the insolation of between 575 and 1150 square feet of collector, and the residential electrical energy needed per unit to the insolation of between 70 and 275 square feet of collector. Since the efficiencies of solar energy systems are substantially below 100%, the areas necessary to supply the energy needs would actually be larger by factors of 2 to 10.

The BNL study quotes a 1972 figure of 9.1×10^{8} BTU/year/building for heating and cooling retail stores and office buildings which corresponds to the insolation of 2500 square feet of collector.

Thus, the supply of solar energy is certainly more than adequate for the energy demands of New England. However, factors such as the space available for collectors, density and storage capability for sunless periods will act as constraints to the full realization of solar potential in the region.

II. Technical Characteristics

A) Space Heating

All solar technologies designed for space heating work most efficiently when structural heat loss due to induction and conduction is minimized. There must be a

[1]John Lee, *Future Residential and Commercial Energy Demand in the Northeast*, Brookhaven National Laboratory, Northeast Energy Perspectives.
[2]Ibid

strong linkage with an overall program of maximum thermal efficiency for new and existing buildings. It is difficult to overstress this point.

Passive solar technologies are currently capable of providing up to 80% of a new one-family residence's heat needs in southern New England. Structures erected by various individual builders throughout the region demonstrate this point.[1] Passive retrofits—new southern windows, greenhouses, etc.—have been demonstrated effective by Total Environmental Action, Inc. of New Hampshire.

An efficient passive system requires: a well-insulated, tightly built structure; maximized transparent surfaces on the south, minimal transparencies on the north; and some form of thermal storage/heat moderation system. Traditional passive designs employ natural mass—masonry, rocks, water—as their storage media. The success of the new MIT House, with its use of synthetic freeze-thaw storage materials, indicates a new and useful direction.

Active flat-plate solar collectors (water or air) are also technologically mature. There are no current examples of a New England structure deriving more than 60% of its space heating needs. Active collectors are especially useful for retrofit on south-facing windows or rooftops.

A passive-active hybrid called a "thermic diode" is under development by the MIT Department of Mechanical Engineering. The device is a 8' x 4' x 2' prefabricated panel with a self-contained storage system. Initial tests are encouraging.

B) Water Heating

Both trickle-top solar collectors and stationery "breadbox" systems have proven efficient devices for providing hot water. Quality varies with the manufacturer and (most especially) the installer, but the technological maturity of the systems is indisputable.

C) Decentralized Solar-Electric Systems

Photovoltaic solar cells have a demonstrated ability to generate electricity. Energy conversion efficiencies are highest with single crystal silicon cells, though costs are high. Lower cost thin-film cells are less efficient converters. The possibility of concentrator systems improving efficiencies in New England seems likely, but not yet proven. Available rooftop space in New England is probably adequate to provide room for photovoltaic arrays sufficient to meet current and projected electricity demands.

System design studies indicate the technical feasibility of a "power tower" on which an array of mirrors concentrates high-temperature heat to create steam for electrical generation. Field studies are just beginning in the Southwest, and local testing for New England would be necessary to determine a regionalized state of the art.

III. Potential of Solar Space Heating in New England

That solar energy can provide a significant part of the energy needed to heat buildings in the Northeast has been amply demonstrated by the numerous installations which have been designed, constructed and operated in the region over the past three and a half decades. One of the first solar heated houses in the country was constructed by MIT scientists, Hottel and Telkes in Lexington, Massachusetts in 1944. The system was technically acceptable but was not economically competitive, a comment as valid now as it was then.

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[1] Based on data in: *Solar Heated Buildings*, W.A. Shurcliff, 13th Edition, Jan. 1977.

Interest in solar heating revived in the early 1970's and solar heated buildings, financed by both private and public funds, began to appear throughout the region. During the period 1972-1976, about fifty eight solar heated buildings were constructed in New England alone.[1] As an indication of the current level of activity, HUD recently (July 1977) announced the results of the third cycle competition for grants in its solar demonstration program. About 222 solar flat plate collector space heating and hot water systems have been funded for buildings in the Northeast out of a total of 535 such systems funded for buildings throughout the nation.

Analyses of flat plate collector space heating systems for the Northeast region have shown that between 50 and 80% of the space heating needs of a "properly insulated" one story building can be supplied by a system in which the area of the flat plate collectors lies between 20-40% of the floor area of the building.

Experience in the marketplace has shown, however, that the cost of such systems in mid-1977 for a "good" system was in the range of \$200 to \$300/m^2 (\$20 to \$30/ft^2) installed. This price includes the storage system, controls, etc., in addition to the collector panels themselves. The system is competitive with the most expensive alternate home heating method, namely—electric resistance baseboard heating—but not with the most common methods of home heating in the Northeast, i.e., fuel oil and natural gas combustion. As an example of the economics of solar collector heating systems, an analysis[2] of such a system, in which water or anti-freeze is used as the heat transfer fluid, concludes that the system would deliver thermal energy at a cost in the vicinity of \$16/MMBTU under the following assumptions: 1) the interest rate is 8.5%; 2) the system has a 25 year life; 3) no federal tax subsidies are involved; 4) no local property tax is assessed on solar heating system; 5) the inflation rate over the life of the system is 5.25% and 6) the installed cost of the system is \$250/m^2 (\$25/ft.^{2}) of panels. The price of delivered thermal energy is very sensitive to changes in these assumptions. For example, if the assumed life of the system dropped to 10 years, and all other assumptions were retained, the cost would rise to \$33/MMBTU. Systems in which air is the working fluid have a lower installed cost (\$150 to \$200/m^2 or \$15 to \$20/ft^2) and the cost of heat delivered is correspondingly less: about \$12/MMBTU assuming a 25 year life of the system, and \$25/MMBTU assuming a ten year life, all other assumptions remaining the same for the air and fluid systems.

In the Northeast, the cost of heat delivered by an electric resistance heating system lies in the range \$12 to \$15/MMBTU; the cost of heat from oil and gas fired heating systems lies in the range \$4 to \$8/MMBTU.

This brief summary illustrates the problems of solar flat plate collector systems. The technology of the systems is acceptable; however,their cost remains somewhat too high. To be competitive with the most commonly used alternatives, the cost of solar thermal energy must be reduced by a factor of about three. This can be done in a number of ways.

The price of solar thermal energy could be decreased by reducing the initial cost of the hardware and its installation. If the installed cost were reduced into the range of \$70 to \$100/m^2 (\$7 to \$10/ ft^2), thermal energy from solar thermal collector systems would become competitive with thermal energy from oil.

The cost of the solar collector panels themselves has remained relatively stable over the past five years in spite of a substantial increase in U.S. production from a level of about 700m^2 in 1972 to 3.7 x 10^5m^2 in 1975 and 5.8 x 10^5m^2 in 1976.

To be sure, these areas are small compared to the areas which would be required to make a significant impact on the energy budget of the Northeast Region. The Northeast Region contains about 9 million housing units with a total floor area of about 1.5 x 10^9m^2. If 20% of these housing units were fitted with solar collectors having an area equal to 30% of their floor area, the required collector area would be 9 x 10^8m^2. If the accumulated production were to increase by the required factor of several thousand, the price would surely drop, but it is difficult to predict by how much. If

[1]Ibid
[2]Based on a report by the Center for Energy Policy, Inc., July 21, 1977.

the assumption is made that for each doubling of accumulated production the price drops by 10% (the price decrease per doubling ranges from 10-30% for new products based on experience in the artificial fibre market, the semiconductor industry, etc.), then a 2000 fold increase of accumulated production should reduce the price to about 0.32 of its initial value. Such a price reduction from the current \$200 to \$300/ m^2 (\$20 to \$30/ft^2) would make solar collector systems competitive with alternative energy sources.

It is not obvious, however, that simply increasing production would bring about such a large price cut. Solar thermal panels of the current design are constructed from materials which are already produced in such extremely large volume—glass, steel, aluminim, copper, plastic—that the increased production needed to satisfy the solar collector market would constitute a small increment in the demand for these materials and, therefore, little impact on their price. Solar collectors are relatively simple devices, essentially a box with a transparent cover, and, therefore, it is unlikely that significant differences in design resulting in substantial price reduction can occur.

As of August 1977 there were about 200 manufacturers of solar thermal panels in the U.S. Many of these firms came into existence because their founders believed that they had improved, new designs for collectors, and all of them are striving to reduce the cost of collector panels. No significant reductions have, however, occurred. It is often suggested that substitution of plastics for metal and glass could lead to large price reductions, but this concept has yet to be demonstrated. Reductions in installation costs would result from improvements in the way panels are interconnected.

In summary, it appears that the price of thermal collector panels has been remarkably resistant to change, even after the market has been stimulated by government supported purchases of collector systems. In the recently completed third cycle of the HUD solar demonstration program, the federal government purchased about 13,000 m^2 of solar panels; in the July, 1977 solar hot water initiative it would purchase about $10^5 m^2$ of solar collector panels, i.e., at least 20% of the current annual production for that year.

IV. Passive Solar Systems

Passive solar design utilizes a building's structural components and microenvironment as a primary space conditioning system in conjunction with a conventional backup system. In contrast to active solar systems which depend on mechanical devices such as compressors, pumps, fans to transfer energy, passive design concepts rely on a building's materials, orientation and landscaping to regulate inside temperature.

Five generic types of passive systems are commonly utilized in the U.S.,[1] although the most passively designed structures incorporate at least two of these basic concepts (see plates 1-6). The first is the *direct gain approach* in which a southfacing, primarily glass, wall captures solar heat during the winter months. Buildings of this type are usually constructed with extra thermal mass: concrete floors, simple massive masonry or brick walls or water to retain solar heat for night time use.

The second type of passive system is the *thermal storage wall* commonly known as *Trombe wall*. The Trombe wall stores heat using either a water or masonry wall located behind glazing on the southern exposure. Trombe walls may combine with direct gain concept to create an aesthetically pleasing design. Windows may be constructed within the wall to increase the sunlight entering the living space, the effectiveness of the system and its liveability. An alternative variation

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[1]"Solar Energy and Today's Consumer," a Report by the Subcommittee on Oversight and Investigation, Committee on Interstate and Foreign Commerce, U.S. House of Representatives, December, 1978, pp. 44-51; Battelle Columbus Laboratories, *Integrated Energy Plan for Riverside, California*, October, 1978, Vol. 2, pp. C4-32. For recent statement of DOE's position on passive solar technology and commercialization, see Frederick H. Morse and Michael W. Maybaum, "Commercialization Strategy Report for Passive Solar Heating," draft copy, 1978.

Plates 1-6
Examples of Passive Solar Designs in New England



1. An early 50's *direct gain* system



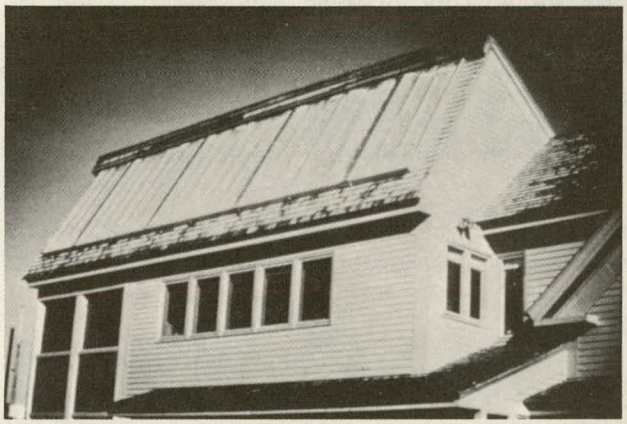
2. A modern *direct gain* system



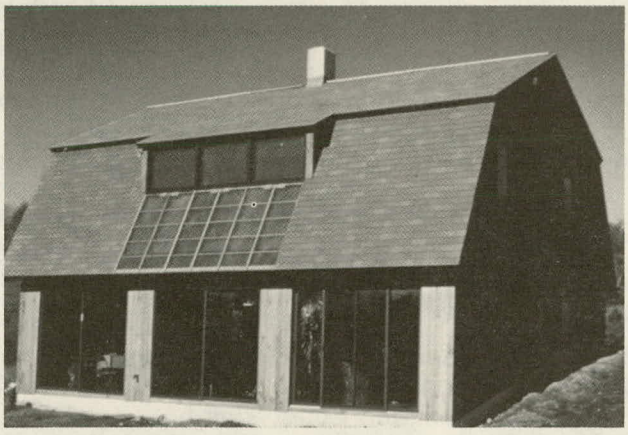
3. A contemporary *trombe wall* system



4. A federalist colonial *greenhouse* system



5. A farmhouse addition *roof pond* system



6. A builder's *thermosyphon* solar gambrel

Homes designed by Community Builders, Canterbury, N.H. Photographs courtesy of the New England Solar Energy Association, Brattleboro, VT.

Table 5
Passive System Costs

System Type	Cost of Collector $/ft²
Thermal storage wall	2–11
Direct gain	8–18
Attached sunspace (greenhouse)	5–15
Convective loop	5–8

Source: Statement of J. Douglas Balcomb, Hearings of the Committee on Interstate and Foreign Commerce, U.S. House of Representatives, "Passive Solar Energy", August 11, 1978, p. 27. For supplementary data, see *Passive Solar Buildings: A Compilation of Data and Results*, Sandia Laboratories, 1977.

involves the use of large (9"-18") dark or translucent cylinders containing water as storage medium and located behind, or as part of, the exterior glazed wall of the structure.

The *solar greenhouse* is a third basic passive design concept which blends the characteristics of the direct gain and thermal storage approaches. A greenhouse is attached to the south facing wall to collect solar heat in a thermal storage wall which is part of the structure. In addition to space heating, the greenhouse can serve as a year round food-growing area. In structres designed and constructed by the New Alchemy Institute on Cape Cod, translucent, water filled cylinders in greenhouses have operated effectively without conventional back-up systems. Greenhouses are particularly useful as a building retrofit technique.

A fourth passive design approach is the *roofpond* which functions with the assistance of a movable insulation cover. In winter, the cover is removed during the day and replaced at night to retain captured heat. Although these systems can operate in New England, they are most promising in areas with substantial cooling loads.

A fifth type of passive system is the *conventional loop* or *indirect thermosyphon*. This sytem utilizes conventional solar collector panels placed below the thermal storage area, thereby transferring rising heat by the natural circulation of a working fluid without using mechanical devices. This type of system utilizes manufactured or site built conventional flat plate collectors.

Table 5 provides estimates of the costs of each type of passive solar heating system. Costs range from a potential low of $2/ft² for a thermal storage to $25/ft² for the roof pond. In fact, the direct gain costs may be reduced to zero if windows which are normally located on the north face are shifted to the south face. However, to achieve a substantial contribution to a building's heating load, some form of storage medium is essential; this is reflected in the $2-$15/ft² estimate. As indicated in Table 6, passive solar heating costs range from 4.3¢/KWHR in Madison, Wisconsin to 6.1¢/KWHR in Washington, D.C. and Seattle. These estimates suggest that passive systems are cost-effective in all cities except Seattle (which still enjoys low cost hydroelectric power at less than 2¢/KWHR) and substantially more attractive than active systems for which costs range between $20-$40/ft² of installed collector. The output of passive systems per dollar expended is comparable to active solar systems.

Passive systems costs also may be viewed within a payback and present value framework when compared with heating oil, (Table 7) the most common fuel used for residential space heating in New England. Considering the case of Boston in 1978, a Trombe wall design delivers heat at a cost of $8.73/MMBTU as compared to $9.61/MMBTU for heating oil, and allowing a 14 year payback period, and a two-year positive savings time frame (the time elapsed before annual savings exceed annual costs). Thus, passive once again appears to be a cost effective investment on a life-cycle cost basis. Of course, we know that individuals rarely utilize life-cycle costing in making investment decisions and these estimates must be evaluated with that fundamental caveat in mind. This question will be explored in the subsequent section on solar commercialization.

Table 6

Passive System Costs, Potential Contribution Savings in Four U.S. Cities*

City	% of total heat requirement*	Annual Savings BTU/Ft³	Heating Cost** ¢/KWHR
Albuquerque, NM	80	94,000	4.7
Washington, DC	65	74,000	6.1
Seattle, WA	62	74,000	6.1
Madison, WI	50	106,000	4.3

* Attainable with a Trombe wall with night insulation in area to one third of the floor area of the house.

** Assumes $12/ft³ installed, capital recovery factor=10%, operation and maintenance cost=1%/yr.

Source: Statement of J. Douglas Balcomb, Hearings of the Committee on Interstate and Foreign Commerce, U.S. House of Representatives, "Passive Solar Energy," August 11, 1978, pp. 27-28.

Table 7

Economic Performance of Passive Solar Residential Heating For Trombe Wall and Heating Oil Fuel Alternative

	Year	Solar Fraction	Area	Total Cost	Yield MMBTU/Yr.	$ MMBTU/Yr.	Delivered Heat Cost $/MMBTU	Conventional Cost $/MMBTU	Simple Payback Time	Years To Positive Savings	$ Net Present Value
Los Angeles, CA	1978	.60	116	1521	16.7	91	7.32	9.49	12	0	1313
Atlanta, GA	1978	.45	182	1898	18.0	105	8.17	9.30	14	0	1079
Boston, MA	1978	.40	287	3502	30.4	115	8.73	9.61	14	2	1694
Albuquerque, NM	1978	.55	237	2615	32.3	81	7.03	9.26	12	0	2745
Cleveland, OH	1978	.20	152	1963	34.3	77	8.68	9.01	15	4	776
Medford, OR	1978	.40	214	2680	25.5	103	8.40	9.49	14	0	1634
Madison, WI	1978	.45	422	4617	47.8	97	7.75	9.01	13	0	3055

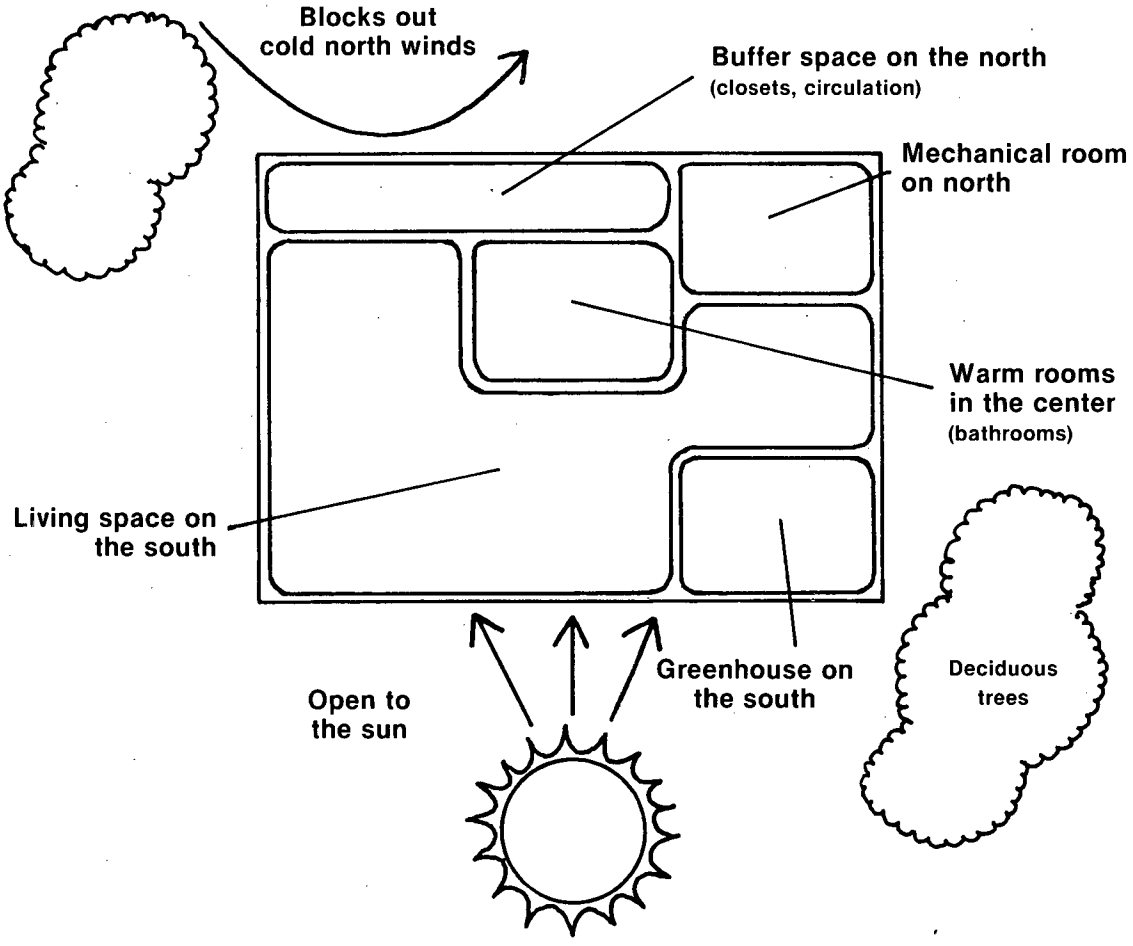
Source: Statement of Scott A. Noll, Hearings of the Committee on Interstate and Foreign Commerce, U.S. House of Representatives, "Passive Solar Energy," August 11, 1978, p.53.

While external structural characteristics of the types described above are central to the passive solar concept, a building's overall energy performance can be substantially improved by its internal configuration and external microenvironment. The former is schematically represented in Figure 2 on the following page. In this unit, living space,—living room, kitchen, bedrooms—is concentrated on the south side with buffer space in the form of closets and work space located on the north face. The bathroom, which both requires and generates substantial space heat, is located in the center of the structure. Shading is confined to areas which will not impede solar access on the south side.

In summary, passive design amounts to the more efficient utilization of building materials and designs to take advantage of the heating and cooling capabilities of a structure's natural environment. No new or exotic technologies are necessary. A comprehensive program to achieve a greater awareness of passive design concepts must involve incentives and education for all relevant actors: consumers, lending institutions, local and state government (especially zoning and land use decision-makers), builders and architects. In addition, the federal tax policy must be sensitized and modified to utilize the enormous potential of passive solar in New England and throughout the U.S.[1]

[1]For a lucid presentation of a comprehensive passive solar commercialization strategy, see Frederick H. Morse and Michael W. Maybaum, "Commercialization Strategy Report for Passive Solar Heating," U.S. Department of Energy, 1978.

FIGURE 2
Elements of Passive Design



Source: "Sun/Earth - How to Use Solar and Climatic Energies Today," Richard L. Crowther, A.I.A; February 1977, p. 130.

V. Potential of Photovoltaic Power

The only kind of solar cell which can be purchased in significant quantities anywhere in the world at this time is the single crystal silicon cell. It commonly exhibits a solar energy conversion efficiency of about 10%; laboratory models having efficiencies up to 18% (AMI illumination) have been reported. These cells can be purchased in kilowatt quantities at a price as low as about $9,000/KW. Studies indicate that if photovoltaic power is to be competitive with nuclear and fossil fuel produced electricity, the price of 10% efficient cells must drop below $500/peak kilowatt by 1986. A research and development program aimed at achieving this goal has been underway since about 1973. It is not clear at this time that the DOE goal of $500/peak kilowatt can ever be met by single crystal silicon cells. Even if that price goal were met, it is generally conceded that the prices below $500/peak kilowatt—which must be achieved if photovoltaic power is ever to achieve a significant impact on the national energy budget—cannot be achieved in single crystal silicon cells or, for that matter, in any cell made from single crystals.

It is for this reason that interest in alternatives to the single crystal silicon cell continues to be high. One such alternative is the concentrator-photovoltaic system. Here the onus for price reduction is shifted from the solar cell to the concentrator, commonly a Fresnel lens or a concave mirror. Even with today's prices for solar cells, advocates of concentrator systems claim that they can achieve overall system prices of about $2000/peak kilowatt in 1978 and $500/peak kilowatt in 1982. Concentrator systems are more compatible with regions like the Southwest where the ratio of direct to total sunlight is significantly higher than in the Northeast. However, a recent study has shown that even in a location like Cleveland where cloudy days are frequent, the total amount of radiation collected by a tracking concentrator is somewhat larger than the total amount collected by a flat panel collector of fixed orientation. Consequently, the possible role of concentrator-photovoltaic systems in the Northeast is yet to be determined. Because the cost of the cells incorporated into a concentrator system can be an insignificant part of the overall cost of the system (this would be the case for high concentration ratios), the cells can be relatively inexpensive, high efficiency types. It is for this reason that a substantial research and development effort is devoted to solar cells made from relatively expensive semiconductors such as gallium arsenide. Such cells have exhibited efficiencies in excess of 20% when illuminated by solar intensities up to several hundred suns. The properties of gallium arsenide make cells fabricated from it better able to tolerate elevated temperatures than cells made from silicon, and this is yet another advantage to using it in concentrator systems. Even higher efficiency solar cells like those consisting of cells made from more than one semiconductor are currently under consideration.

The other approach to lowering cost is to fabricate cells from thin films of semiconductors rather than from single crystals. To date the highest efficiency reported in thin film cells is the 9% efficiency as reported in 1977 by a University of Delaware group for the thin film copper sulfide/cadmium sulfide cell. Efficiencies between 3-6% have been reported in a number of thin film solar cells including cells made from silicon, gallium arsenide, indium phosphide, copper indium selenide, etc. Thin film copper sulfide/cadmium sulfide cells are presently being marketed in the U.S. by Solar Energy Systems, Inc. of Deleware and Photon, Inc. at a price comparable to that of silicon cells. The manufacturer claims that the cells cost considerably less to manufacture than silicon cells and promises substantial reductions in price/watt as production volume increases. The efficiency of these commercially available copper sulfide/cadmium sulfide cells is, however, only about 3%. In other words, the higher laboratory efficiencies have yet to be transferred to the pilot plant.

DOE's studies of the economics of solar cell systems indicate that the cells must have some minimum efficiency before they can be of any use for large systems. The magnitude of this minimum efficiency is a subject for discussion; however, estimates have been converging on a value in the vicinity of 10%. The cost of support structure and interconnections between cells is the reason for the existence of a lower limit on efficiency. Thus it is evident that thin film solar cells of the types currently available do not satisfy the criteria which they must meet before large scale solar power becomes economically viable. Attainment of higher efficiency requires further research, often of a rather fundamental kind, into the mechanism of the photovoltaic effect in such thin film cells.

To summarize, there exist single crystal cells made from silicon, gallium arsenide and other semiconductors whose efficiency is high enough so that they qualify as candidates for building blocks of solar photovoltaic systems but whose cost is much too high (factors of 30 to 70) for them to be economically acceptable. On the other hand, there exist thin film cells whose cost may be acceptable but whose efficiency is too low (10%) for cost effective photovoltaic power systems. Concentrator photovoltaic systems promise a more rapid reduction of cost than flat panel systems but such systems have a more limited range of applications than flat panel cells, and in particular they may not be as suitable for the Northeast as flat panel cells.

The solar cell is only the beginning of a photovoltaic power system. The cell must be mounted as part of an array and encapsulated to protect it from the weather. At present the cost of

encapsulation is comparable to the cost of the cells themselves and therefore development of less expensive, more reliable encapsulation is a topic of high priority. Encapsulation may have regional aspects: the wide range of temperatures and frequent temperature cycling which solar cells will experience when they are used in the Northeast may require a different encapsulation solution than that which is appropriate for the Southwest. The array mounting system must also be particularized to the region. This suggests that cell manufacturers may produce a different product for use in the Northeast than that intended for the Southwest.

Analyses of photovoltaic power systems conducted by various organizations (University of Pennsylvania, Westinghouse, General Electric. Aerospace Corp., Arthur D. Little, Inc., MITRE Corp., et. al) have identified and concentrated on a limited number of potential kinds of photovoltaic systems. These can be classified in terms of the degree of localization of the system into: A) "roof top" systems which produce the power where it is consumed, and B) central power stations.

A. "Roof top" Systems

Such systems range in size from those intended to service single family dwellings to those intended to service low-rise, large area structures like shopping malls, factories, etc. If one assumes an average daily insolation in the region of 5 KWH/m^2, then 10% efficient solar cells would deliver about 0.5 KWH/m^2 day. If the roof area of a "standard" one story 1500 $ft.^2$ (150m^2) dwelling were covered by such solar cells, they would generate 750 KWH/day and 27,000 KWH/annum. The average annual consumption of electric power in the Northeast region ranges between 5000 and 8000 KWH/annum for units which do not use electricity for electric hot water or space heating. Thus the 150 m^2 of 10% efficient solar cells would produce at least three times as much power as is consumed by the occupants of the average unit.

Two kinds of residential power supply systems have been analyzed. In the first of these, the photovoltaic solar cells produce electric power only. In the other, the cells are incorporated into a thermal panel where they serve as part of the absorbing surface of the panel, thus forming a hybrid system which produces both electricity and thermal energy for use in the building. The economics of these two kinds of systems differ substantially: for a given price of delivered KWH, one can afford to pay a higher price for solar cells to be incorporated into a hybrid system than for the photovoltaic only system.

The Northeast region contains about 9 million housing units with a total roof area of about $1.5 \times 10^9 m^2$ and about $2.0 \times 10^8 m^2$ of roof area on its commercial structures. If these roofs were covered with 10% efficient solar cells, they would produce about 3.1×10^{11} KWH/annum which is to be compared to a total electric power generation in the region of about 3.5×10^{11} KWH/annum.

These calculations do not include all the buildings in the region because sufficiently accurate data is not available: the results are meant to show that the area of the roof of the buildings in the region is so large that if the buildings were retrofitted with solar cells of the type currently available the resulting photovoltaic power system would produce enough power to satisfy nearly all the needs of the region.

B. Central Power Stations

The Northeast region consumes about 3.5×10^{11} KWH/annum. The area which needs to be covered by 10% efficient solar cells to produce this amount of power—assuming on average insolation of 5 KWH/day—is about 2000 km^2 or about 770 sq. miles which constitutes about 0.44% of the total land area of the Northeast (175,000 sq. mi.). If the power were to be produced by Central Power Stations, access roads and paths would increase the area devoted to the cells by a factor of about 1.3 to about 1000 sq. mi. or about 0.57% of the total land area of the region. A central power station capable of

producing as much electrical energy per day as a conventional 100 MWe plant operating at an average 60% of its capacity would require an area of about 3.8 Km^2 or about 1.5 sq. mi. About 670 plants of this type would need to be distributed over the region to satisfy its electrical energy generation needs.

Another type of photovoltaic power system which was originally proposed by Dr. Peter Glaser of Arthur D. Little, Inc. is the Satellite Space Power System. Studies of such systems indicate that one such satellite could deliver 10,000 MWe continuously onto a microwave receiving antenna having an area of about 40 km^2. About seven satellites of this type would be needed to deliver all the electrical energy needed by the Northeast and the receiving antennas would cover an area of about 280 km^2 (108 sq. mi.). The construction of satellite power systems of this kind would require a major national commitment comparable to the decision to land a man on the moon, and implementation would require about 20 years. No such commitment has been made as yet and, therefore, it is unreasonable to expect that satellite power systems are likely to play a role in the Northeast region power generation system until after the year 2000 if they are ever implemented.

It is likely that if photovoltaic power systems are to play a role in the Northeast, a combination of central power stations and roof top systems will constitute the system. Installation of roof top systems on existing buildings is a form of retrofitting; it is not possible at this time to estimate the fraction of buildings on which retrofitting will be viable. Consequently, residential photovoltaic systems are more likely to appear on new buildings and since new construction in the Northeast is lagging behind the rest of the nation, central power stations will probably play an important role in any photovoltaic power system designed for the region.

Photovoltaic systems which are under study include both flat plate and concentrator systems. It is usually assumed that concentrator systems are more compatible with the Sunbelt than with the Northeast where the ratio of direct to total sunlight is smaller. However, recent studies have shown that tracking concentrator systems can deliver as much or even more power than fixed flat plate systems in the Northeast. Consequently, it is not possible at this time to definitively identify a preferred system.

The average annual insolation of the Northeast is less than a factor of two smaller than the insolation in the Arizona desert which is one of the most intensely sun-illuminated regions in the world. Furthermore, sunlight is much more intermittent in the Northeast than in the Southwest and therefore the electrical energy storage problems are quite different in the two regions. Obviously, longer term storage is needed in the Northeast, and the solar cell systems intended for this region must take this into account.

VI. Institutional Roles

Government, at the federal, state and local levels has an essential role to play in accelerating solar energy development. The following is a brief description of what each level of government can do to promote solar systems.

A. Federal Government

The chief role that the federal government can play is to create the same kind of incentives for solar energy as the government has created for traditional energy sources. This means *tax credits for solar equipment* of the type now enacted in the National Energy legislation, and increased subsidization of solar through *low-interest loan and grant programs*. One such proposal, the Solar Bank Bill, would create a revolving low-interest loan fund to supply 3%, 30-year loans to solar purchasers. The federal

government should also create additional *business and investment tax credits* for commercial purchasers of solar equipment. These tax proposals will begin to create parity for solar in the federal energy subsidy picture. Other energy sources have traditionally been much more heavily subsidized by the federal government than solar. For example, the DOE has recently estimated that the value of federal subsidies to nuclear, coal and oil over the last 60 years have *exceeded* $130 billion.

The federal government also has an important role to play in *demonstrating* solar energy. It should greatly expand its solar demonstrations and should increasingly administer the demonstration program through state and local government units rather than managing the program centrally out of Washington. By decentralizing DOE will create spin-off benefits in the form of new solar enthusiasm and expertise at the state and local level. The HUD Solar Hot Water Initiative, the only state-administered federal solar grant program to date, has already built this type of solar constituency in the energy offices of the states which manage the program.

The federal government should greatly *expand the use of solar and conservation in government owned and government subsidized buildings*. The Administration should strongly support the Solar Transition Act which would require federal agencies to "solarize" a larger and larger percentage of their new and existing buildings every year.

B. State Government

State governments can play important information and advocacy roles in the development of solar energy. State government should establish special groups or task forces, within their Energy Offices or separately, to disseminate solar information and to reduce barriers to the utilization of solar systems, e.g. discriminatory utility rates, restrictive state building codes, lack of solar rights, and restrictive trade licensing programs which increase the cost of solar installation.

The state solar groups could also work for the passage of state fiscal incentive programs, such as a state income tax credit, a state property tax exemption, and a sales tax exemption for solar owners.

C. Local Government

Local governments can do much to promote solar development. They can promote solar school and municipal buildings as well as solar housing projects. With their long-term, low-interest financing, cities and towns often can take advantage better than the private sector can. Local governments can also create local solar utility districts and zoning districts, and enact ordinances guaranteeing access to sunlight for solar users.

VII. Commercialization

Numerous studies, addressing the commercial development of solar power have been conducted during the past eight years. Without exception, these studies project substantial growth in this market during the next fifty years. It has been an equally unanimous conclusion that such growth would come about only with considerable pump priming on the part of the government to offset high current initial costs. The studies to date deal largely with solar water and space heating and to a lesser degree with the less economically attractive photovoltaic power.

The fundamental problem with solar energy is its near term economic viability. Although most recognize the long term need to exploit solar energy, there is no clear picture of the necessary measures to move in that direction. In a free market influenced only by economic factors, solar energy would not come into prominent use until either acute shortages occured in the less costly energy forms or until the prices of alternate forms rose to levels which are close to

the long term price of solar energy as perceived in the market place. In other words, a transition would not occur until crisis or near crisis conditions existed. It is concluded by most analysts that the lesser of two evils is to look to the federal government to lead the way and through a variety of methods, e.g., gas price deregulation, tax incentives, and R & D subsidies, modify the economics to stimulate the solar market.

A second problem which presently exists is the perception of solar system unreliability. This results from the apparent poor quality of installation and consequent high failure rate in recent years in ERDA demonstration projects. This is not an inherent problem of solar energy and is correctable in time with the development of standards based on increased operational experience.

A third problem which has to date been resistant to solution is the lack of sensitivity to the nation's energy problem. There has not been a great deal of support for conservation and the notion that one must accept some small sacrifice now to avoid a disaster 15 to 20 years from now.

Another educational deficiency relates to the concept of life cycle costing. From a financial standpoint solar energy is characterized by high initial costs and (assuming minimum maintenance requirements) very low operational costs. This again is a pay-now-and-benefit-later concept. Mortgage financing similar to that employed in the purchase of homes should help to eliminate this problem.

A. The Development of the Direct Solar Energy Market

Early studies conducted by TRW[1], Westinghouse[2], and G.E.[3] provide a pessimistic forecast of solar market potential prior to the year 2000. They are characterized by sales estimates in the order of $1 billion, energy contribution of less than 1/4 quads[4], and less than 2 million solar installations nationwide. These studies predated the oil embargo and their modest projections are largely attributed to that fact. Later studies have projected substantially higher rates of growth. Scott[5] forecasts a cumulative number of 10 million units by the year 2000, and a number of others project growth rates between the Scott estimates and those of the early studies.

A recently released report from the Council on Environmental Quality[6] forecasts that if the will to do it is present, that solar technology can provide 23% of the U.S. energy need by the year 2000, of the total, direct solar (heating and cooling, intermediate temperature systems and photovoltaic) would represent 11%. A breakdown by conversion technology is shown in Table 8 on the following page.

This report admittedly presents a very accelerated market development and probably represents a 100% success view of the future incentives which provide the driving force for the accelerated market development.

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[1]TRW Systems Group, *Solar Heating and Cooling of Buildings*, Prepared for the National Science Foundation, NSF/RA/N-74-022A, May 31, 1974.

[2]Westinghouse Electric Corporation, *Solar Heating and Cooling of Buildings*, prepared for National Science Foundation, NSF-RA-N-023D, May 1974.

[3]General Electric Corporation, *Solar Heating and Cooling of Buildings*, prepared for the National Science Foundation, NSF-RA-N-,—May 1974.

[4]The total energy demand in 2000 is estimated to be approximately 100 quads.

[5]Scott, Jerome E., *Solar Water Heating — Economic Feasibility, Capture Potential, and Incentives*, prepared for the National Science Foundation, APR 75-18330, February, 1977.

[6]Council on Environmental Quality, *Solar Energy Progress & Promise*, April, 1978.

Table 8
CEQ Estimates of Maximum Solar Contibutions to U.S. Energy Supply
Under Conditions of Accelerated Development
[Units: quads per year of displaced fuel (a)]

	1977	2000 (b)	2020 (b)
Heating and Cooling (Active and Passive)	Small	204	5-10
Thermal Electric	None	0-2	5-10
Intermediate Temperature Systems	None	2-5	5-15
Photovoltaic	Small	2-8	10-30
Biomass	1.3	3-5	5-10
Wind	Small	4-8	8-12
Hydropower	3	4-6	4-6
Ocean Thermal Energy Conversion	None	1-3	5-10

Total U.S. energy demand in 1977 was 76 quads. Estimated total U.S. energy demand is from 80 to 120 quads for the year 2000 and from 70 to 140 quads for the year 2020.

(a) A quad is a quadrillion or 10^{15} BTUs. Electricity is converted to equivalent fuel that would have to be burned at a power plant to supply the same amount of power. The conversion rate used here is 10,000 BTU per kilowatt-hour.

(b) The estimates in these columns are not strictly additive. The various solar electric technologies will be competing with one another, and their actual total contributions will be less than the sum of their individual contributions.

Source: Council on Environmental Quality, *Solar Energy: Progress and Promise*, April, 1978.

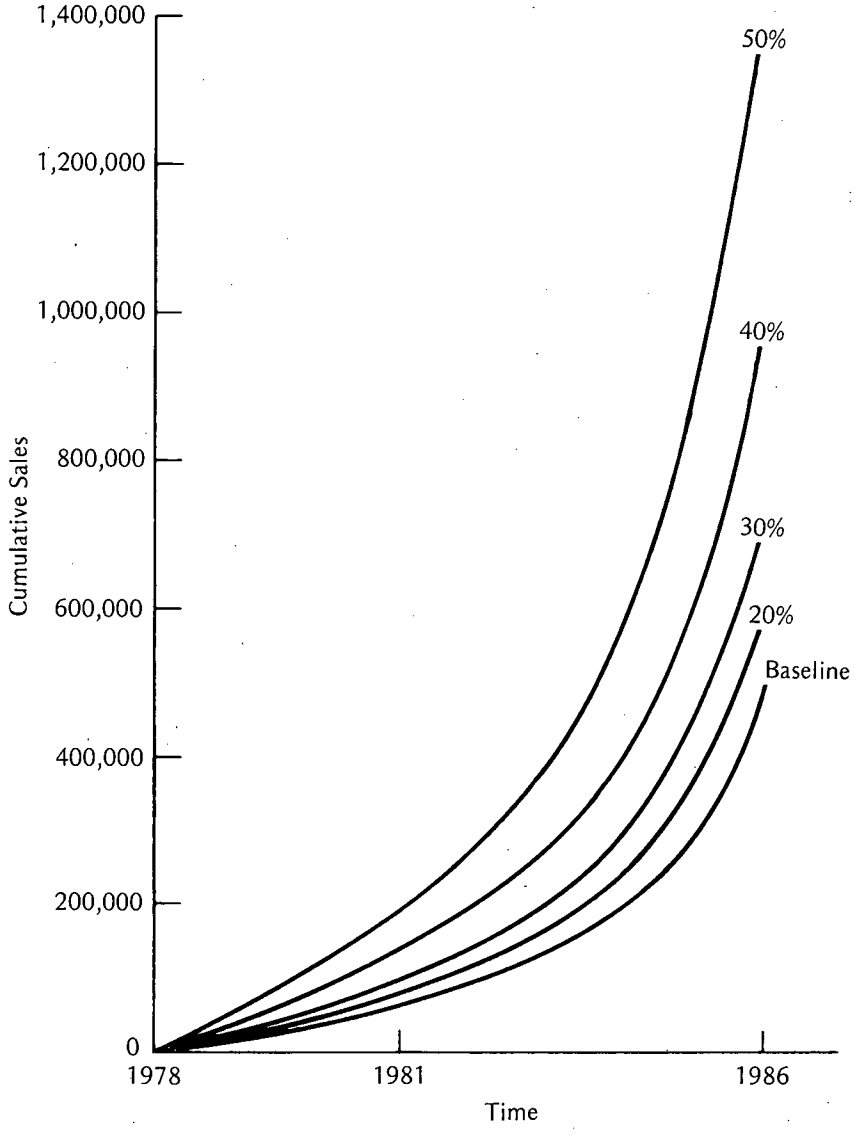
B. Impact of Incentives on Market Development

It is virtually a given, that without federal support, commercial development will proceed at a slow pace until impending disaster forces action. The extent and nature of the most appropriate federal support is yet to be defined. A number of studies have been conducted to address this issue. RUPI finds that front end subsidies (grants, tax credits, or rebates) are the most effective in terms of stimulating the purchase of solar energy systems. A 40% tax credit is estimated to induce a 100% increase in installations by 1986 (Figure 3).

It is clear from the RUPI study that increasing the magnitude of the tax credit will increase the number of purchases at an even faster rate. For example, a 20% tax credit will, according to the RUPI model, result in 20% more units by 1982, while a 50% tax credit will increase the sales by 167%. This is hardly surprising behavior. When one considers that a solar water heater costs about three times as much as a conventionally fueled one, it is expected that small reductions in effective price would make little difference in quantities sold, but as the price difference is narrowed, substantial sales increases would be expected.

Table 9 presents another set of results from the RUPI study, comparing a variety of incentives with respect to their ability to increase sales by 50% and by 100%. The grant,

FIGURE 3
Non-Refundable Tax Credit
Existing Homes—Water Heating



because of the immediacy of payment, appears to be the most influential form of incentive. The low interest loan is the least effective incentive examined in the study. It is important to place the magnitude of a significant government subsidy in perspective. Loferski[1] estimates a cost of $90 billion to outfit 20% of the 9 million housing units in the Northeast region with solar space heating. If such installations were subsidized at the 50% level $45 billion in federal funds would be required. This represents 10% of the annual federal budget (1977). If the outlays were spread over 20 years, .5% of the annual federal budget would be devoted to providing solar energy to the Northeast. Of course, there

[1]Loferski, J.L., *Potential of Solar Heating in the Northeast*, June 1978.

Table 9
Incentive Level Needed to Achieve 50% and 100% Increase
(In Cumulative Sales by 1982)

	Incentive	Incentive Level Needed to Increase Sales by 50%	Incentive Level Needed to Increase Sales by 100%
	Non-Refundable Tax Credit	20.2%	27.9%
New Homes: Hot Water and Space Heating	Refundable Tax Credit	20.0%	26.5%
82 Baseline = 14,700 total units			
Baseline + 50% = 22,050 total units	Grant	18.2%	25.4%
+100% = total units	Loan	3.5% interest rate: 15 years	-*
	Non-refundable Tax Credit	33.8%	45.5%
New Homes, Hot Water	Refundable Tax Credit	32.9%	44.5%
982 Baseline = 64,300 total units			
Baseline + 50% = 96,450 total units	Grant	27.0%	39.2%
+ 100% = 128,600 total units	Loan	1.66% interest rate; 20 years	-*
	Non-Refundable Tax Credit	31.1%	41.0%
Existing Homes, Hot Water	Refundable Tax Credit	31.0%	40.5%
982 Baseline = 138,600 total units			
Baseline + 50% = 207,900 total units	Grant	30.0%	39.0%
+100% = 277,200 total units	Loan	.15% interest rate 20 years	-*

*According to projections, loan cannot achieve 100% increase by 1982.

Source: RUPI, Inc., Cambridge MA *Federal Incentives for Solar Homes—An Assessment of Program Options* November, 1977.

would be a partial tax offset due to the GNP stimulation resulting from the new economic activity which would result. Whether this magnitude of subsidy is an appropriate price for accelerating the transition to solar power is a key policy question the lawmakers must address.

C. Solar Energy and Jobs

A significant fraction of the cost of solar heating installation is the result of high labor content. Although there appears to be low capital intensity in collector fabrication, the bulk of the labor required is in the installation process. Skilled craftsmen, plumbers, sheetmetal workers, and electricians are required for proper installation.

There does not appear to be a shortage of the required labor force in the New England area. In fact, if a major effort (of the scale suggested by the Council on Environmental Quality) were undertaken, unemployment in this region very likely would be substantially reduced.

D. Public Acceptability

There is presently a shortage of market research data reflecting public attitudes

toward direct solar energy systems. A few studies have been conducted and though they were limited in scope and depth, their findings are worth mentioning here.

In the report *An Attitudinal Study of the Market for Solar Devices*[1], the following findings are presented.

> About 1.1 million American residences would have home and hot water heated with solar energy by 1985 if the total cost averaged $20/month more than the cost of heating with fossil fuels, and initial costs were no barrier. An additional 7.2 million homes would have hot water alone heated with solar energy by 1985 if the total cost was $5 a month more. These are fairly favorable cost assumptions under current conditions.
>
> Almost half (44%) of potential homeowners surveyed would prefer to have their living spaces and hot water heated with solar energy if the total cost averaged $20 per month more than conventional heating and initial costs were no barrier. Although interest runs high, for various economic and technical reasons, only about 1 in 75 American families may have both their home and water heated with solar energy by 1985.
>
> Any development that makes solar energy cost-competitive with fossil fuels for home heating will increase the level of market penetration. Another key to how quickly Americans will have solar homes is how fast builders and developers use solar energy in new homes and can assure good performance.

The Scott report cited above was based on a survey of consumer attitudes in two cities. He developed a consumer decision making model which represents what could be a valuable tool in assessing public attitudes. It is interesting to note that the Scott study projected much higher market penetration than any other studies reviewed.

In all probability, with the proper marketing and advertising approach and with favorable economics through government subsidy, solar power development will not be inhibited by negative public attitudes.

VIII. Systems Integration

A. Application of Alternative Technologies

Because of the intermittent nature of energy from sunlight, solar thermal and solar electric systems must have energy storage systems associated with them. In active solar thermal systems and in solar electric systems, economic studies indicate that the optimum size system stores only one or two days supply of energy for the dispersed site. Widespread introduction of active solar thermal and solar electric systems into the territory served by an electric utility would, therefore, be accompanied by the simultaneous introduction of a substantial storage capability into that same territory. Integration of this storage capability with the utility could help in load levelling. Storage systems would be filled by the utility during the present low demand period (midnight to 6 A.M.). In the case of dispersed electrical energy storage, the utility might be interested in renting the storage system from individual owners so that it can extract the energy during peaks in demand.

Utilities are understandably concerned about dispersed installations which do not have adequate storage associated with them, since such systems would have a high demand for energy from the utility during the low insolation periods. However, there are no currently accepted designs of active solar thermal or solar electric systems which do not include some energy storage capability.

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[1]Decisions & Designs, Inc. McLean, VA., *An Attitudinal Study of the Home Market for Solar Devices*, prepared for Federal Energy Admin., Washington, D.C. TR77-5-53, September, 1977.

B. Suitability of Resource for Conversion to Meet Current End Use Demands

Solar energy can be converted into the low grade thermal energy needed to heat buildings by both passive and active solar thermal systems. Higher temperature thermal energy of the type needed for commercial (e.g., laundries) and industrial applications can be produced by concentrator systems. This high temperature thermal energy can also be used to operate absorption type air conditioners.

Solar electric energy when produced by solar cells is of the direct current type. Economic converters exist for transforming d.c. to a.c. power with an efficiency in excess of 90%. This makes it possible to continue using standard a.c. appliances.

C. Compatability with Other Technologies and Utility Systems

As indicated above, solar thermal and solar electric systems can help the utility with load levelling, thus reducing the need for new energy generating plants. If solar systems are combined with wind and biomass systems, the load levelling is even more effective because the wind often blows when the sun does not shine, and the combustion of biomass can be coordinated with the availability of wind and solar energy. Utilization of all of these sources will reduce, though not eliminate, the need for conventional fossil fuel and nuclear energy sources.

Wind/Hydro/Tidal/Wave Subcommittee

I. Introduction

Some wind and hydro electric energy can be used in site-specific direct work projects such as pumping water, resistance or heat pump thermal heating, or driving factory machinery. However, widespread use of these raw energy resources is probably best accomplished by conversion to electrical energy that may be conveniently transported, bought, and sold utilizing existing utility transmission networks. These energy sources may be developed by small industries, private entrepreneurs or municipalities. Although each installation would provide small amounts of energy, the combined impact of such sites would be significant.

Potential developers would need assurance of a fair market for their product or, in some cases, the availability of backup power supply. The viability of widespread use of wind and hydroelectric systems may be inhibited if utilities and Public Utility Commissions do not establish reasonable regulations regarding interconnection requirements and pricing policies.

The major advantage of wind and hydroelectric systems is that they utilize renewable natural resources and are not currently faced with widespread societal opposition. The major disadvantages lie in the variability of the resources; the necessity that systems be designed to withstand the extreme vagaries of nature; and the presently higher capital cost for new construction of wind and hydro plants compared to conventional thermal systems. The economics of these two renewable energy systems will become more favorable as the prices for conventional fuels rise, as expected, faster than the general inflation rate.

II. Wind Energy

Wind energy is abundant and widespread; however, wind characteristics vary considerably across locations. The mean annual wind speed of most New England sites is in the range of 8 to 12 mph with a few coastal locations and high elevations recording 13 to 15 mph.[1] The best sites for

[1] Energy Research Group, *New Energy Sources*, 1976.

wind generators are those that experience mean annual wind speeds of 12 mph or more. High winds can be destructive to equipment and velocities less than 12 mph are probably uneconomic.

The output of a windmill varies greatly with windspeed. A 100 foot diameter machine theoretically can be designed to produce 15 KW at 10 mph, 100 KW at 20 mph, and 260 KW at 30 mph. However, for economic reasons such a machine would probably be designed to attain its maximum rating at about 30% above the mean annual wind speed for the site.

There are approximately 20 commercially available small wind turbines with rated capacities of 2 KW to 15 KW. A typical 10 KW unit will provide approximately 11,000 KWH per year for a site with a mean annual wind speed of 12 mph.[1] This corresponds to average annual residential energy requirements exclusive of space heating and air-conditioning. If the mean annual wind speed were only 10 mph, a similarly rated unit would only deliver about 60% as much energy per year.

Larger wind turbines of 100 KW rating or greater would generally be used in conjunction with electric power networks or perhaps for an industrial or commercial application. Prototype units of 2,000 KW rating are under construction, and larger units are in the design stage. These wind turbines have blades in the 250 to 350 foot range, and for electric power network applications could be located in "farms" which might contain 100 such units suitably spaced to avoid interference, providing a total capacity rating of up to 200 MW.

Small wind turbines have been utilized for hundreds of years, and a commercial market for them existed in the United States in the 1930's before the formation of the Rural Electrification Administration. The small systems are comparatively safe and reliable, with manageable maintenance requirements. Further development will improve the small machines. Large wind energy systems, however, are still in the "first generation" development stage and present uncertainties concerning capital costs, energy costs, capacity factor and reliability.

Wind generators pose safety problems that must be considered. The risk of personal and property damage as a consequence of thrown blades can be reduced by locating machines in remote areas. The risk of continued power input into a downed transmission line may be reduced through proper protective circuitry.

Environmental problems that must be considered include the visual impact upon rural landscapes, interference with migratory bird populations, and radio and T.V. signal interference.

Many of the problems can be alleviated if small standard units of high reliability are utilized. The widespread use of 50 foot machines that can be connected to power company distribution circuits may offer the best initial use. Standardization would encourage the economies of mass production. Small size would reduce adverse visual impacts and permit the use of less expensive materials. Widespread and dispersed use would tend to diminish energy fluctuations. The small size may make it attractive for small businesses or entrepreneurs to construct units and sell surplus energy.

Utilities would not need to add energy storage facilities or reserve capacity because of wind machines until and unless they became a signficant increment of capacity. It would have taken 75,000 wind machines of 10 KW capacity to supply 1% of New England's electrical energy needs in 1977.[2]

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[1] Estimate provided by Mr. Dan Schiff, Research Consultants, Inc.

[2] NEPOOL estimate as reported by Northeast Power Coordinating Council:

	Peak Demand	Energy
NE 1978	15800 MW	82700 GWH
Wind Units*	120 MW	825 GWH
%	0.8%	1.0%

* 75,000 units of 10 KW capacity, expected capacity credit at 16% of installed.

III. Hydroelectric Capacity — Conventional

New England has a developed hydroelectric capacity of 1500 MW.[1] Most of the large, economically attractive sites have been utilized to nearly their full capability. However, an improvement in capacity, energy output, or both may be economically justifiable and achievable at some existing sites by:

- An increase of dam height and storage
- The installation of additional generators to reduce spillage during the spring runoff or at other heavy flow periods
- The installation of more efficient turbine-generators
- The conversion of some facilities to partial pumped-storage use

The potential undeveloped capacity of the region is uncertain. Estimates range from 1200 MW to 3300 MW.[2] A major portion of this capacity is the proposed 830 MW Dickey Lincoln Project in Maine. As planned, this federal project would flood an area of 88,000 acres to create a vast storage reservoir. The storage accumulated primarily during the spring runoff would be used during other periods for peaking power purposes and produce about 1.0×10^9 KWH per year at a capacity factor of about 14%.

A number of potential projects of medium size are under consideration. Examples include a Great Northern Paper Company development of about 40 MW on the Penobscot River and a 25 MW to 75 MW development on the Kennebec River proposed by Central Maine Power Company (CMP).

Much of the undeveloped capacity is available from hundreds of individual sites that can accommodate small machines and produce a modest amount of energy. The development and redevelopment of some of these small hydro sites is underway or being considered. Most of these sites have little storage and would generate run-of-the-river energy.

The Dickey Lincoln Project is currently under review and has met widespread public opposition. Cost-benefit analysis results are imprecise and the environmental analyses are subject to dispute. The Great Northern Project, opposed by environmentalists and "white water" canoeists, has been shelved. The CMP project does not appear economically attractive at this time, but may be in the future.

Many of the smaller projects are presently uneconomic to develop. Construction of new dams and reservoirs is very costly, although life-cycle costing may show them to be more attractive than earlier analyses. New developments also face potential opposition from environmental interests and may have severe social impacts if human settlements are relocated.

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[1] Existing hydro electric installations

	Capacity	Ave. Annual Energy	Cap. Factor
Federal Power Commission	1491 MW	5935 GWH	45.4%
Corps of Engineers	1427 MW	5719 GWH	45.7%
NEPOOL*	1274 MW	4385 GWH	39.3%

* Electric utility industry only and adverse flow year.

[2] Potential undeveloped capacity at existing and new sites:

	Capacity	Ave. Annual Energy	Cap. Factor
Federal Power Commission	3304 MW	7267 GWH	25.1%
Corps of Engineers*	1543 MW	7499 GWH	55.5%
New England Federal Regional Council	1805 MW	3201 GWH	20.2%

* additional potential at existing sites only
** additional potential at new sites only

Redevelopment of existing inactive dams can be economically attractive at the present time. A number of small stations have been reactivated already with little or no government assistance. Further redevelopment can probably be spurred by federal assistance in providing up-front study costs. Such projects are generally environmentally benign if they are operated as run-of-the-river plants. In some cases they may meet opposition from lakefront owners or others within the impacted communities. Many of these concerns may be alleviated with proper operation of plants to assure adequate water supply for recreational and water quality needs.

With public support and government assistance perhaps an additional 1500 MW[1] of capacity could be developed. At an estimated average capacity factor of 30%, such development would yield about 4 billion KWH/year, an amount of energy equivalent to that generally available from a 600 MW thermal electric unit. This would represent about 5% of New England's current annual electrical energy use.[2]

IV. Tidal Power

Over the last four decades tidal projects that could utilize the enormous tidal fluctuations and flows of the Bay of Fundy have been studied. United States studies have primarily centered around a joint project with Canada that would utilize both Cobscook Bay and Passamaquoddy Bay. The project as originally planned had a capacity of 500 MW. Some studies[3] estimated that it could be constructed to a maximum capacity of 1000 MW with 2.1 x 10^9 KWH annual energy yield. It was never constructed primarily because each of the several studies indicated it was not economically justifiable. Recently the Canadian government completed its own comprehensive study of tidal power potential in the Bay of Fundy. Based on its findings, Canada has notified the United States that it is not interested in the project.

The Canadian study[4] involved 18 sites considered more attractive than Passamaquoddy. Among these only two were identified as potentially economically viable over the life of the units. The most ambitious project would have a capacity of 3800 MW and yield of 12.6 x 10^9 KWH annually. The study conclusions are worthy of note:

1. Tidal power, in its most economic role, would displace fossil-fueled energy production. Although a tidal plant would eliminate some fossil-fueled generation from the Maritime utilities expansion programs, it would neither eliminate nor reduce the need for nuclear generation.
2. The reassessment has conclusively demonstrated the fundamental economic feasibility of tidal power and the technical and economic feasibility of its integration into the projected generation supply systems of the Maritime Provinces.
3. Because the minimum investment would be about 3 billion (dollars) and because this would result in an inordinate financial burden being placed upon utility customers in the early years, financial feasibility of a tidal power plant would be conditional upon substantial direct participation by governments which would enable raising of the necessary capital and maintaining the cost of service to utility customers at annual levels not exceeding those which would be incurred by an optimal generation expansion program without tidal power.

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[1] Potential represents upper bound of physical potential, does not include feasibility or economic analysis. Estimate of 1500 MW at 30% capacity factor intentionally optimistic. Includes 830 MW Dickey-Lincoln Project, 390 MW at 8 sites of 25 to 80 MW, and 280 MW aggregate of hundreds of small sites .2 to 1 MW. See also Supply Committee Report.

[2] New England electrical energy use 1977—76.3 x 10^9 KWH. See the Electric Council of New England, *Electric Utility Industry Statistical Bulletin*, 1977.

[3] Corps of Engineers, *Passamaquoddy Tidal Power Project*.

[4] Bay of Fundy Review Board, *Reassessment of Fundy Tidal Power*, 1977.

The Army Engineers have turned their study efforts to Cobscook Bay.[1] Since this project would be far smaller than the rejected Passamaquoddy joint venture (less storage and an available tidal range of 18 feet vs. 40 feet), it is very unlikely that it will ever prove to be economically justified.

A small tidal project of 4 MW that would utilize the natural contours of Half Moon Cove within Cobscook Bay has been proposed by the Passamaquoddy Tribe. This project may have regional and social merit, e.g. employment and income impacts, that outweighs purely economic considerations.

Tidal power productions cannot be scheduled to meet system demands. Other forms of power generation must be operated to complement tidal systems. If sufficient system flexibility does not exist, it may be necessary to construct additional pumped storage facilities to fully utilize the energy available from a tidal project.

V. Pumped Storage[2]

Pumped storage hydro facilities simply store electrical energy produced during low demand periods for use during high demand periods. They consume 115 KWH of energy for every 100 KWH produced. In addition to load leveling they constitute a ready capacity reserve that can be quickly placed in service in the event of an electrical system emergency. A more recent innovation in energy storage is the use of gas turbine compressors that store high pressure air in salt dome cavities. These systems can be designed to burn fuel during the generation and permit increased capacity and operational flexibility.

At present New England has two large hydro pumped storage projects in operation. None are under construction. The amount of pumped storage capacity that can be constructed is far greater than the foreseeable need.

System load factors can be improved by other means that may make the near term need for added pumped storage unnecessary. Examples include time of day or off-peak rates, heat storage systems and interruptible loads. However, the need for additional pumped storage could be accelerated if widespread use is made of intermittent energy resources such as tidal, wind or solar power.

VI. Ocean Thermal Gradient and Wave Power[3]

Both of these possible options would use a low grade energy resource and are presently compared to other alternatives discussed above.

Because the waters off the New England coast have thermal gradients of less than 40°F and the shoreline is considered a valuable recreational asset, it is unlikely that either of these energy resources would ever be used in the region other than on an experimental basis.

An ocean thermal plant operating with a 40°F gradient would have an efficiency of less than 2%. Therefore, its capital cost for equipment could be about twenty times more than a conventional power cycle. The necessity to mount these units on platforms or barges far offshore would increase the cost disadvantage by perhaps another order of magnitude.

All proposed wave system schemes require a massive commitment of vast stretches of valuable shoreline which would meet public opposition.

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[1] Corps of Engineers *Tidal Power Study—Cobscook Bay Maine.*

[2] New England River Basins Commission Report.

[3] Energy Research Group, *New Energy Sources,* 1976.

Capital/Financing Subcommittee

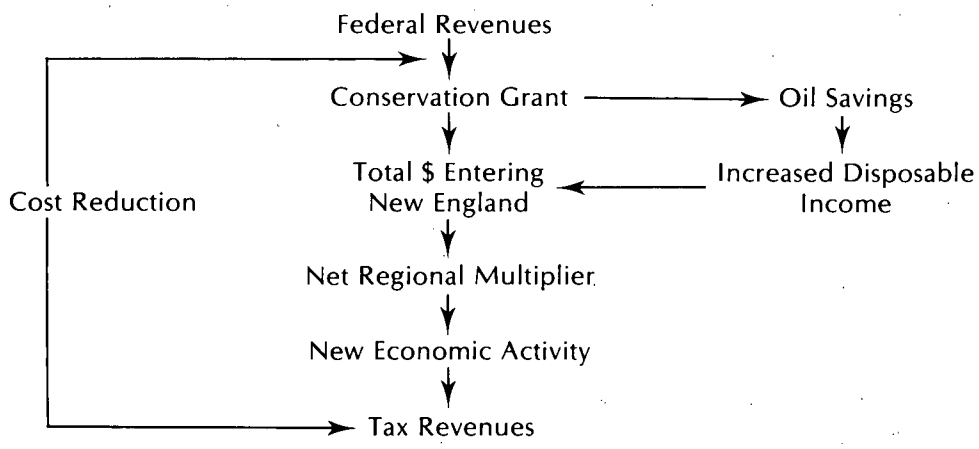
I. Overview

The Capital/Financing Subcommittee has focused its attention on identifying the most effective governmental financial incentives for stimulating the utilization of renewable energy systems. The subcommittee discussed the use of the investment tax credit (ITC), and accelerated depreciation for energy related investments. In general, it was felt that a doubling of the ITC and discretionary use of accelerated depreciation would stimulate both the supply and demand side of the alternate energy industry, and that simultaneous stimulation would achieve a greater rate of market penetration than stimulating the demand side alone. For example, consumers in both the commercial, industrial and the residential sectors would be prompted to make investments in conservation much faster by a mix of incentives. Manufacturers would more quickly gear up and promote their products if they are assured of a lower cost of capitalization (ITC) and quicker recovery of their investment in production plant and equipment (accelerated depreciation). The results of such incentives would range from conservation, to material and energy recycling (heat), to primary generation or co-generation of energy from non-fossil fuel sources. For the consumer, the grant is the most efficacious device because reimbursement would be more timely (4 to 6 weeks) than a tax exemption or credit, although the credit also might be quite effective (e.g. California 55% solar tax credit). A balanced governmental program must include investment tax credits and accelerated depreciation for capital intensive alternate energy systems, loan guarantees, low interest loans, dividend and capital gains tax exemptions for small manufacturers; and credits, rebates and, most preferably, direct grants to users of decentralized residential systems.

The subcommittee next explored the relationship between government financing of renewable energy systems and the local and the national economic impacts of such financing. The principal conclusion of this discussion is that public financing schemes ultimately cost less than is generally recognized. Evaluation of the secondary impacts, or "ripple effects", of all financing schemes should be incorporated into the policy formulation process. To illustrate, these impacts and their interrelationships are presented in a simplified form in Figure 4. A government decision

Figure 4

Secondary Impacts of A Federal Energy Conservation Grant Program



to provide some form of conservation grant to homeowners channels federal dollars into the New England region. In addition to this direct dollar inflow, the resulting oil savings frees additional disposable household income, the bulk of which remains in the regional economy. Expenditure of these resources is compounded by a regional multiplier, which in turn generates new economic activity and tax revenues. Additional revenues may then be applied to reduce the public burden of continued financing of the conservation grant.

II. Example: A Federal Conservation Grant

The following recommendation was designed to illustrate some of the subcommittee's major propositions.

A. Recommendation

The subcommittee recommends the creation of a federal grant program to property owners aimed at reducing total BTU consumption in residential units. The grant should be tax deductible and cover 50 percent of the costs of retrofitting the average New England dwelling unit to an optimal level measured in terms of the highest net present value of the investment attainable within a five year payback period. The grant should take the form of reimbursement of expenditures on materials which have been defined as fossil-fuel conserving. In conjunction with the program, the implementing state agency should disseminate a list of optimal purchase strategies according to the present value and payback period of the savings for various prototype dwelling units.

B. Rationale

The recommendation attempts to achieve an overall reduction in heating and cooling load requirements in existing residential units in a manner which maximizes the individual property owner's flexibility and inventiveness. It is designed to supplement existing market forces and federal incentives by providing seed money for presently marginal economic investments; complete financing for high payoff investments by low income households; and partial funding for middle income owners wishing to achieve an optimal level of retrofit. Underlying the program are two basic assumptions: (1) program benefits will partially offset the costs of implementation; (2) reduction of fossil, especially imported, fuel consumption has a social benefit over and above that which accrues to the individual homeowner.

C. Economic Framework

A 25-50 percent grant represents the minimum level of subsidy necessary to achieve a significant level of market penetration. A 1977 RUPI study[1], for example, concludes that a 20% tax credit for solar heating would increase sales by 20% above a baseline case (no credit) by 1982, whereas a 50% credit would produce a 167% increase. Solar water heating, furthermore, is a "lumpy" investment which, unlike many basic conservation measures, cannot be purchased in increments. In addition to a 50% grant, the present recommendation proposes a grant which guarantees the property owner reimbursement within one month of purchase as compared to the delayed reimbursement schedule generally associated with a tax credit. This, plus the level of subsidy, should insure effective market penetration. A payback period of 5 years reflects the average mobility rate of the American household. We recognize that a major disincentive to many energy conserving home improvements is the lengthy payback period which, despite a favorable present value and cost/benefit ratio, discourages the property owner interested in recouping his investment within a reasonably short time. A

[1]RUPI, Inc. *Federal Incentives for Solar Homes—An Assessment of Program Options.* Cambridge, November, 1977

recent study of weatherization in Maine[1] suggests that optimal (highest present value) energy conservation measures for a variety of housing prototypes falls within a payback range of 2.4—3.5 years. These measures include storm windows, and wall, floor and ceiling insulation improvements. Alternative energy, e.g. solar installations, which do not meet this criterion will receive little or no support from the proposed program. This, however, is *not* inconsistent with its major goals of rapid adoption of measures with the highest return on investment and neutrality with respect to the selection of methods to conserve fossil fuels.

D. Energy Savings

Existing studies of energy conservation suggest that a 20-40% reduction in the residential heating/ cooling load is feasible with an expenditure of less than $2000/unit, and that the first $1000 can make a significant contribution. It is the most basic conservation measures—storm window, caulking, weather-stripping, insulation—which the proposed grant would favor given the current economics of solar space and water heating, the major alternative within the scope of the present grant program. Examples of pertinent studies include:

Nova Scotia[2]: The provincially administered, federally funded tax deductible grant of $350 for insulation, caulking and weatherstripping is projected to reduce energy consumption by 20-40%. Approximately 125,000 units, or 50% of the housing stock in the province, has been retrofitted to some degree since the program was initiated in April, 1977. First priority is assigned to upgrading basement insulation, followed by ceiling and wall insulation. Most grant recipients have spent less than $1000, and a majority have spent under $500.

New England Regional Commission[3] (NERCOM): NERCOM has assisted 70 community action agencies in the winterization of 27,000 low-income homes since FY 1976-77. Agency officials estimate an average energy saving of 25% in heating fuels, or about 300 gallons annually in an oil heated home.

State of Maine[4]: Based on engineering parameters, a Harvard study projects a 41% reduction in Maine's residential energy consumption if all housing in Maine were upgraded to weatherization levels similar to those of newly constructed housing. This may be interpreted as the average savings for four prototype units which collectively comprise 58% of the state's housing stock.

Based upon these findings, a 25% energy savings/unit after basic retrofit appears to be a reasonable estimate.

E. Secondary Impacts

Based upon the relationships depicted in Figure 4, we may estimate the secondary impacts of the proposed program using the following assumptions:

Total housing units in New England (1970): 3.3×10^6
Percent retrofitted under grant program: 25% or $.825 \times 10^6$
Average cost of optimal retrofit: $2000
Amount of grant: .50 x $2000 = $1000

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[1]Harvard University, Department of City and Regional Planning. *Energy Conservation in Maine: Weatherization Improvements to the Existing Housing Stock.* Cambridge, June, 1977.

[2]Telephone communications with John French, Nova Scotia Energy Council, September, 1978.

[3]Urban Systems Research and Engineering. *Impact of the New England Regional Commission's Low Income Weatherization Project.* Cambridge, August, 1978.

[4]Harvard University, *op. cit.*

Average tax rate on incremental income: 13%
Regional multiplier: 2.03
Program duration: 5 years
Average annual oil bill of participating household: $500
Percentage of additional disposable income retained in the region: 80%

Under these assumptions, the program impacts would amount to the following:

Gross cost to the federal government: $82.5 x 10^6
Average annual cost to the federal government: $165 x 10^6
Additional disposible income retained in the region $82.5 x 10^8
Multiplier effect: $1757.5 x 10^6
Additional federal tax revenues derived from the region: $87.1 x 10^6
Net cost to the federal government: $737.9 x 10^6
Barrels of oil saved: approximately 4.9 million/yr.

In summary, without considering the local and state revenue impacts anti-inflationary benefits and employment impacts, we estimate at least a 10% reduction in gross costs to the federal government attributable to increased tax revenues from New England. The subcommittee views this type of comprehensive economic assessment, presented here in simplified form, as indispensible to the formulation of rational energy policy.

Jobs Subcommittee

The Jobs Subcommittee was created to explore the relationship between energy production/use and employment creation. Toward this end, a public fact-finding hearing was held in Portland, Maine on October 10, 1978 at which a diversity of organizations provided expert testimony. This testimony and a number of related studies form the basis of the subcommittee report and the recommendations which follow.

EMPLOYMENT IMPACTS OF ENERGY USE AND PRODUCTION[1]

I. Introduction

The production and use of energy profoundly affect the employment opportunties in every sector of the national economy. Any governmental action—regulatory, executive or legislative—which impacts energy production and its use creates both direct and indirect employment effects. When viewed collectively, governmental decision-making and the annual expenditure of billions of dollars are tantamount to an implicit employment policy with profound economic repercussions. Yet, despite these relationships, national energy policy to date, as one observer has noted, "has concerned itself with control, allocation, price, and profits, but utterly fails to take into consideration its impact on the human factor of production."[2]

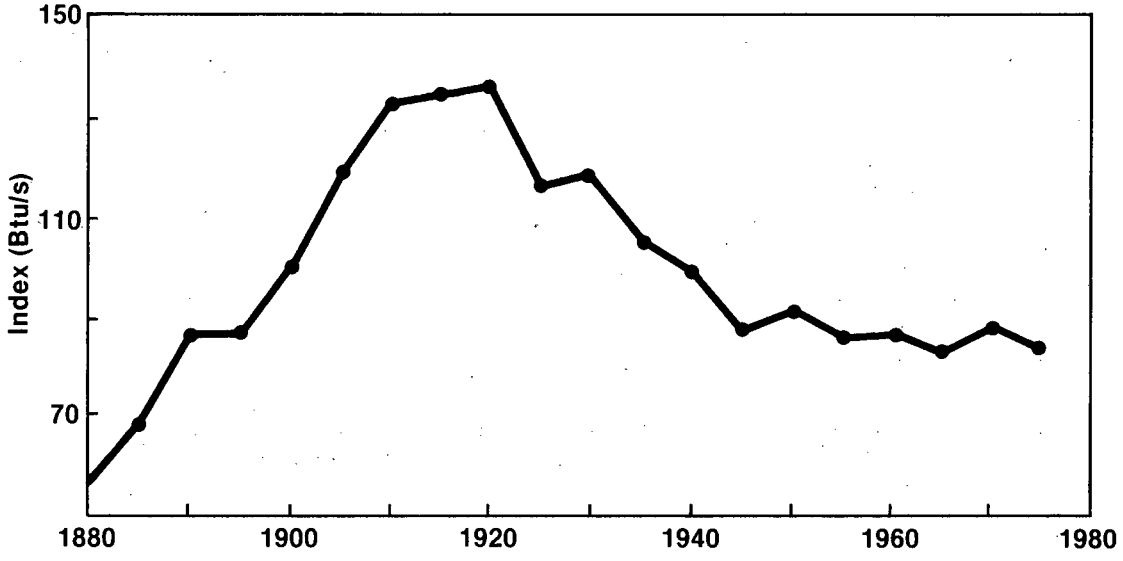
This report examines various aspects of what recently has been termed the "jobs and energy" issue. Following the lead of numerous recent studies, we will argue that: (1) the conventional wisdom concerning energy utilization and economic welfare must be reconsidered in light of recent experience; (2) that energy production systems vary greatly in the job-creation potential;

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[1]The Subcommittee on Jobs gratefully acknowledges the assistance of the New England Regional Energy Project (NEREP) for its financial support of the New England Jobs Study referenced herein, and the comments on an earlier draft of this report by John Stutz of the Energy Systems Research Group (ESRG).

[2]Statement of William W. Winpisinger, Hearings of the Joint Economic Committee, U.S. Congress, on "Creating Jobs Through Energy Policy," March 15-16, 1978, p.164.

FIGURE 5
Energy Consumption per Unit of GNP
1880–1975



This index of United States energy consumption per unit of gross national product (GNP) between 1880 and 1975 reveals three distinct periods: 1880-1920, when energy consumption rate grew faster than GNP; 1920-1945, during which growth in energy consumption rate was slower than growth in GNP; and 1945-1975, when there were several short-term fluctuations with no persistent trend up or down, displaying a close relationship between energy consumption and GNP. Source: Data for the 1880-1950 period are from *Energy in the American Economy, 1850-1975.* Baltimore: Johns Hopkins Press, 1960. Data for the 1955-1975 period are from "The Energy/Real Gross Domestic Product Ratio," Bureau of Economic Analysis Staff Report (U.S. Dept. of Commerce), prepared by Jack Alterman. The Alterman data were adjusted by linking to series used for the 1880-1975 period.

Source: EPRI Journal, May, 1978

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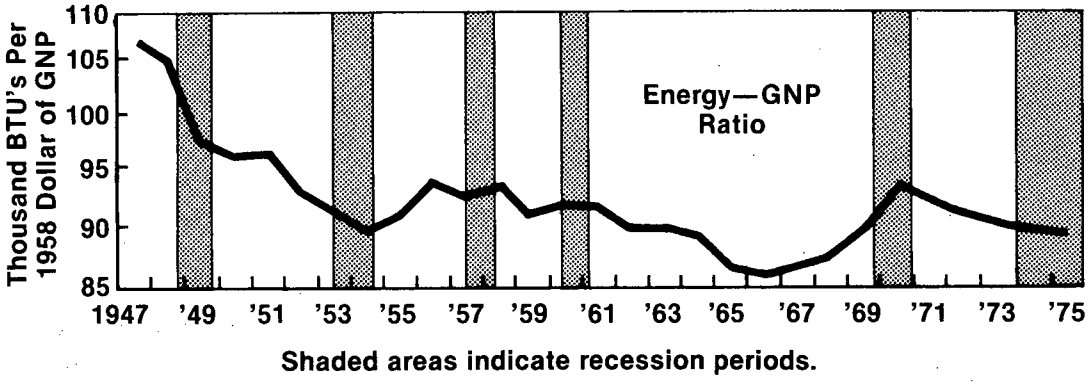
and (3) that governmental actions at both the federal and state levels must incorporate these variations in the formulation of regulatory, fiscal and developmental policies.

We begin by examining historical and future trends in the relationship between economic growth and energy consumption, using the cases of Western Europe for comparative purposes. Next, the labor intensiveness of conventional and alternative energy systems—including conservation—are evaluated with special emphasis on the recent Long Island and New England studies. Finally, we conclude with a number of policy recommendations which, in short, call for a drastically increased level of sensitivity to the employment implications of federal and state energy policies.

II. Historical Trends

Over the last century, the ratio of BTU/unit of gross national product (GNP) has undergone rather dramatic shifts (Figure 5). From 1880-1920 energy consumption grew faster than GNP; from 1920 through World War II, the ratio declined, and in post-war period, the ratio has remained remarkably constant. A closer examination of the post-war trends in the BTU/GNP ratio (Figure 6)

FIGURE 6
Energy Consumption per Unit of GNP
1947-1975



Shaded areas indicate recession periods.

Source: John G. Myers, "Energy Conservation and Economic Growth—Are They Compatible?" *The Conference Board Record*, February, 1975 and Bureau of Mines Press Releases.

Table 10
Average Annual Growth Rates for Prices of Capital, Labor, Energy, and Other Material Inputs to Manufacturing, 1947-71

	Price[1]
Capital	0.8
Labor	4.3
Energy	2.1
Materials	1.8

[1] These growth rates are for prices expressed in current, not constant dollars. The wholesale price index for all industrial commodities grew at an average rate of 2 percent per year in this period.

Source: M. H. Ross and R. H. Williams, "Energy and Economic Growth," a report to the Joint Economic Committee, U.S. Congress, August 31, 1977, p. 16.

reveals an uneven decline through 1967, followed by an increase to 1970 and a steady, though modest, decline to the present. Thus, it is only during the last three decades that, consistent with conventional wisdom, energy and economic growth have increased at approximately the same rate. The long-term trends, however, tend to neither support nor refute this proposition. Economic growth has occurred with and without a commensurate increase in energy consumption.

With the bulk of potential efficiencies in major energy forms realized by 1950, it appears that relative factor prices have played a major role in halting the decline of the BTU/GNP ratio since 1945. This is illustrated in Table 10, which indicates the growth rate for prices of factor inputs in the manufacturing sector from 1947-1971. Energy prices have increased at approximately half the rate of labor, the input most frequently substituted for energy. Historical trends further suggest that low cost of capital is associated with the subsititution of energy for labor by encouraging activities

Table 11
Per Capita Energy Consumption and Per Capita Gross Domestic Product, Nine Developed Countries, 1972

Country	Per Capita GDP (dollars)	Per Capita Energy (million BTU)	Energy/GDP ratio (thousand BTU/$)	Index Numbers (U.S.=100) Per capita GDP	Per capita Energy	Energy/GDP ratio
United States	5,643	335.5	59.5	100	100	100
Canada	4,728	336.6	71.1	84	100	120
France	4,168	133.1	31.9	74	40	54
Germany	3,991	165.6	41.5	71	49	70
Italy	2,612	95.7	36.6	46	29	62
Netherlands	3,678	188.1	51.1	65	56	86
United Kingdom	3,401	152.9	45.0	60	46	76
Sweden	5,000	213.4	42.7	89	64	72
Japan	3,423	116.6	18.1	61	35	57

Note: The hydro and nuclear component of primary energy consumption is converted into BTU's on the basis of fuel inputs into fossil-fueled power plants, assuming 35 percent efficiency. Foreign GDP's are expressed in dollars, using a real purchasing-power basis of comparison rather than market exchange rates.

Source: J. Darmstadter, J. Dunkerley, and J. Alterman, *How Industrial Societies Use Energy: A Comparative Analysis* (Baltimore: Johns Hopkins University Press for Resources for the Future, 1977).

which are *both* large capital and energy users.[1] Capital and energy, in other words, have been relatively inexpensive and jointly substituted for labor. Thus, close correlation between energy and GNP seems at least partially attributable to this substitution effect.

While the close correlation between energy consumption and economic growth since World War II is undeniable, the frequently inferred causality between the two variables is unwarranted. While it is probably true that energy *prices* have facilitated overall economic growth (especially in the energy intensive industries within the manufacturing sector), it does not automatically follow that current levels of energy demand are necessary to achieve such growth and, more generally, to sustain levels of welfare currently enjoyed in the United States. Darmstadter *et. al*[2]. in a cross-sectional study comparing North America, Western Europe, and Japan, found a substantial variation in the energy/GNP ratio (Table 11). France's ratio is approximately half that of the U.S. and most other European countries score below 75 on the energy/GNP index.

Variation across countries is related to a variety of explanations which fall within two broad categories: (1) compositional or structural differences such as size, population patterns, and housing preferences, (2) energy intensity differences that characterize given energy-using processes, e.g., fuel consumption per passenger mile and the efficiency of various manufacturing processes. Darmstadter *et. al.* estimate that the first type accounts for 40 percent of the variation across countries and the second type for the remaining 60 percent. From a policy standpoint,

[1]M.H. Ross and R.H. Williams, A Report to the Joint Economic Committee, U.S. Congress, "Energy and Economic Growth," August, 1977.

[2]Joel Darmstadter, Joy Dunkerley and Jack Alterman, *How Industrial Societies Use Energy: A Comparative Analysis*, Baltimore: John Hopkins Press, 1977. Also see Ross and Williams, *Op. Cit.*, pp. 32-37.

energy-efficiency differences are most easily addressed because they do not require behavioral modifications on the part of the consumer. In any case, a variety of explanations must be considered, including smaller cars and homes, and, perhaps most important, energy price controls. For whatever reason, comparable levels of welfare have been achieved with significantly less per unit energy consumption and with unemployment rates substantially below those in the U.S. We conclude, therefore, that the causal relationship commonly imputed to recent energy consumption/economic growth trends is based upon an over-simplification of the complex relationships among a variety of socioeconomic and technological variables characteristic of modern industrialized nations.

III. Predicting the Future

For a variety of economic, technological, and institutional reasons, past trends in energy/job relationships appear to offer little guidance in predicting the future. First, it is likely that the relative cost of energy and labor will undergo a major shift in the next decades. Government subsisides to the development of conventional energy forms,[1] together with price ceilings on oil and natural gas, also have contributed to artificially low energy costs. At the same time, capital investment incentives in the form of accelerated depreciation and tax credits have disfavored the utilization of labor in the production process. Despite the subsidies, however, the price of conventional energy forms continues a decade-long trend that began in the late 1960's. Even prior to the oil embargo, industrial electricity costs, after decades of decline, began an upward spiral as a result of environmental requirements to burn low sulfur coal and to install pollution control devices (Figure 7). Nuclear and oil-generated power costs also have increased sharply due to rising fuel costs and the diminution of opportunities for improving the efficiency of steam electric power plants.

Insofar as the future costs of capital energy increase more rapidly than labor, then substitution of labor for energy and capital may occur. The degree of substitutability, of course, varies significantly across industrial and economic sectors. However, at least three recent studies indicate that significant substitution is feasible without severe economic dislocation and loss in the overall level of production.[2] In comparing the outcomes of low (1 percent) and high (3.4 percent) energy growth scenarios, Hudson and Jorgenson estimate that substitution effects would produce 4.5 million extra jobs and 40 million barrels/day oil savings, while reducing total GNP over the twenty-five year period by only $120 billion. This amounts to .048 percent of a billion dollar GNP/year which the U.S. already has surpassed. The recent New England Energy Policy Alternatives (NEEPA) study tends to corroborate this finding for the New England region. A simulation of the impacts of a concerted conservation effort indicates that for every one percent increase in Gross Regional Production per capita, energy demand will increase by 0.5%.

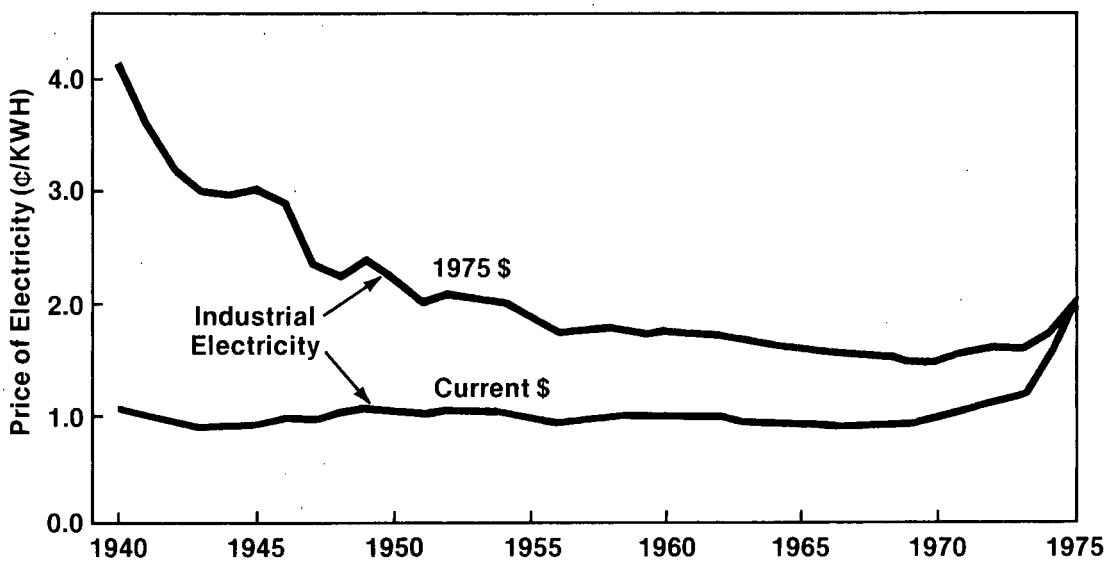
A second trend which will tend to alter historical energy/GNP relationships is the ongoing structural changes in the U.S. economy. As services and light, especially high technology, manufacturing continue to displace basic materials processing industries, energy consumption per dollar of GNP and per labor/year will decline. This is illustrated in Figure 8, which depicts the direct and indirect energy requirements of each dollar purchased in a sample of product categories. Personal services, selected light industries and non-durable goods are the least energy intensive, whereas heavy materials processing industries require most energy per dollar of output. Overall a crude composite services/goods energy ratio is about 1:3.

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[1]According to one estimate, totaling over $100 billion since World War II. See Battelle Northwest Laboratories, *An Analysis of Incentives Used to Stimulate Energy Production.*

[2]Ernest R. Berndt and David O. Wood, "Technology, Prices and the Derived Demand for Energy," *The Review of Economics and Statistics*, 57, p.259, August, 1975. Edward A. Hudson and Dale W. Jorgenson, "Economic Analysis of Alternative Energy Growth Patterns, 1975-2000," Appendix F in *A Time to Choose: America's Energy Future*, the final report of the Energy Policy Project of the Ford Foundation, Ballinger, 1974. Massachusetts Energy Office, "New England Energy Policy Alternatives Study," October 1978, p.6.

FIGURE 7
Price of Industrial Electricity
1940-1975



Electricity prices for industrial customers in current and constant (1975) dollars. The price deflator was the wholesale price index for industrial products. Electricity prices in current dollars were obtained from the Edison Electric Institute.

Source: M.H. Ross and R.H. Williams, "Energy and Economic Growth," A Report to the Joint Economic Committee, U.S. Congress, August 31, 1977, p. 11.

Although some energy savings will accrue as a result of structural changes, the total impact of such change is frequently overstated and quite modest in comparison to the potential offered by energy conservation measures. Gilmer[1] estimates that when both direct and indirect effects are calculated, a projected shift of four percentage points in the gross domestic product (GDP) by the year 2000 will save only 1.5 percent in total energy needs. This compares to a 15 percent savings attainable through conventional conservation measures. Structural changes in the U.S. economy will be supplementary, rather than a major, force in reducing energy consumption rates in the U.S. during the next decades.

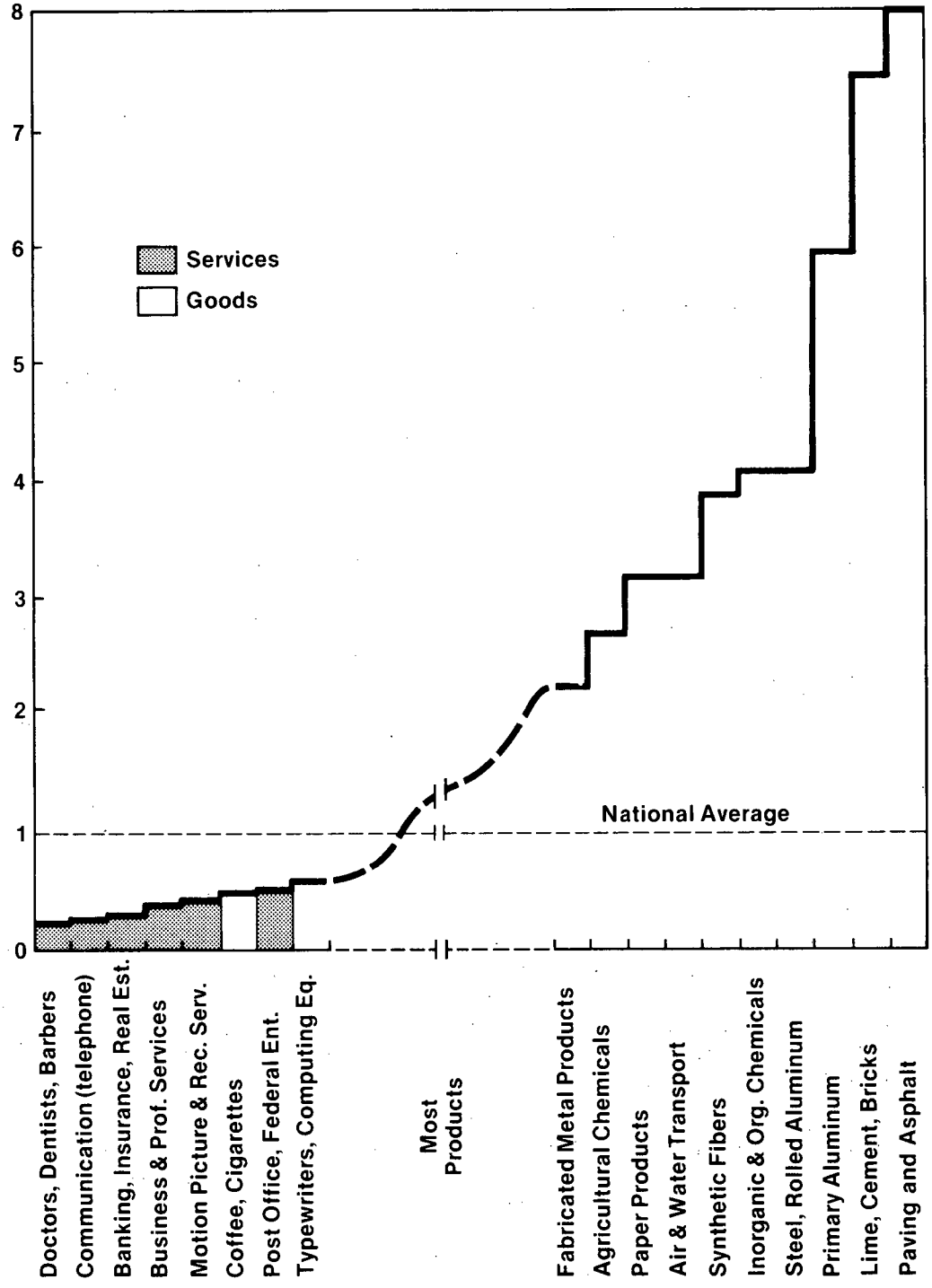
In summary, over time we can expect a gradual decline in the energy consumption/GNP relationship based solely on a comparative factor prices and structural changes in the national economy. When further allowances are made for industrial and commercial conservation measures induced by rising energy costs,[2] it seems even more likely that energy consumption in the future will serve as neither a determinant nor an indicator of economic well-being.

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[1]Robert W. Gilmer, "Services and Energy in U.S. Economic Growth," Institute for Energy Analysis, Oak Ridge Associated Universities, December, 1977.

[2]See Ross and Williams, *Op. Cit.*, pp. 44-51 for an excellent discussion and estimates of these savings. These authors estimate an overall savings of 40 percent in energy use over the next two decades, using a package of proven, cost-effective technologies.

FIGURE 8
Total Energy Consumption Associated with Each Dollar of Product Purchased (1963-67 average) for Various Product Categories



Source: Based on data contained in Robert A. Herendeen and Clark W. Bullard III, "Energy Costs of Goods and Services," Center for Advanced Computation, University of Illinois, November, 1977.

IV. The Employment Impacts of Energy Substitution

While a decline in energy inputs per dollar of product is virtually certain, we cannot assume that labor shares will increase commensurately. Although the service and high technology sectors are relatively labor intensive as compared to the processing of basic materials, the opportunities for substituting capital for energy in the former are substantial. Consider the ongoing capitalization of many traditionally labor intensive services: electronic devices which replace bank tellers, Centrex telephone systems which displace operators and computerized switching and billing systems which displace clerical workers. In fact, it is difficult to identify any service sector activity which is not susceptible to heavy capitalization, and the trend witnessed in the last decade is probably irreversible.

For this reason, identification of the labor intensiveness of *specific* manufacturing and service sector activities is essential and should form an integral part of employment-related policy formulation. This will become evident in a subsequent section concerning the jobs impact of alternative energy strategies. At this juncture, it is sufficient to note that a multitude of opportunities for skilled craftsmen—electricians, carpenters, roofers, sheetmetal workers, etc.—can be tapped through an intentional commitment to a jobs-generating energy policy which emphasizes end-use efficiency and conservation.

Nonetheless, there is no simple solution to channeling energy substitution in the traditional manufacturing sector toward increased labor utilization in other activities, and a thorough investigation of this question is outside the scope of this report. One generalization, however, is worthy of mention. Government's longstanding favoritism toward both energy and capital in the form of fiscal and research subsidies has weakened labor's competiveness vis a vis these alternative factor inputs. We earlier noted that labor price increases between 1947 and 1971 were double those for energy and over five-fold greater than price increases in capital. The outcome of this trend is that the cost share of labor in U.S. manufacturing has increased by over 5 percent since 1947, while capital and energy cost shares have remained virtually constant (Table 12). While it is difficult to isolate and weigh all the specific determinants of these trends, we can be certain that the governmental subsidies in all their various forms—e.g. accelerated depreciation, investment tax credits, research and development support, depletion allowances, price ceilings—have made a major contribution to labor's relative costliness.

The policy implications are clear. If labor is to compete equitably with capital in capturing the factor shares lost by high energy costs, governmental policies must allocate to labor resources a level of subsidy at least equal to that accorded capital resources. Policy makers, in other words, must alter their view of programs such as manpower training and subsidies for new hirees from one of short-term pallative measures to one of permanence, legitimacy and equity. Only in this fashion will labor receive its fair share of those resources redirected to alternative factor inputs as a result of escalating energy costs.

V. Employment Impacts of Alternative Energy Systems

We have dismissed the conventional linkage between energy consumption to overall economic well-being, argued that the energy/gross national product ratio will continue its downward trend of recent decades and suggested that the historical governmental subsidies to capital and energy ought to be extended at equal levels to labor resources.

From this use-oriented discussion we now turn to the employment impacts of energy *production* systems and, specifically, to one central concern: the variation in employment impacts associated with alternative supply options, each of which is capable of satisfying the projected demands of a set of consumers during a specified time period. Included within the range of

Table 12

Cost Shares for Capital, Labor, Energy, and Other Intermediate Materials — U.S. Manufacturing, 1947-71

	Capital	Labor	Energy	Materials
1947	0.051	0.247	0.043	0.659
1948	.058	.277	.051	.613
1949	.046	.259	.051	.644
1950	.050	.248	.046	.656
1951	.050	.255	.045	.650
1952	.049	.267	.045	.640
1953	.047	.268	.044	.641
1954	.056	.272	.048	.624
1955	.053	.265	.045	.638
1956	.046	.269	.046	.639
1957	.050	.272	.048	.630
1958	.060	.273	.048	.619
1959	.062	.273	.046	.619
1960	.058	.277	.046	.619
1961	.059	.278	.046	.616
1962	.056	.283	.045	.616
1963	.055	.280	.045	.620
1964	.055	.283	.044	.618
1965	.055	.280	.041	.624
1966	.055	.284	.040	.622
1967	.054	.286	.041	.618
1968	.053	.289	.040	.614
1969	.054	.290	.040	.616
1970	.053	.298	.043	.606
1971	.047	.289	.045	.619

Source: E.R. Berndt and David O. Wood, "Technology, Prices and the Derived Demand for Energy," *The Review of Economics and Statistics*, 57, p. 259, August 1975.

potential options are efficiently-related conservation measures, that is, those which do not entail major changes in personal lifestyles.[1] Examples of these types of measures are housing insulation and improved furnace, appliance and engine efficiencies. Excluded from consideration are changes such as a major shift to bus and rail transportation, and a reduction on the number of kitchen appliances in the average household. Our focus then, is the comparison of employment impacts of alternative supply mixes, including efficiency-related conservation measures, which are capable of satisfying the nations or region's energy demands during a specific time period. We first consider a Long Island and New England study and subsequently review supporting evidence from a number of related research efforts.

[1]Our focus is on those conservation measures which either alter the "task definition" or improve the "second-law efficiency" through technological improvement. See Ross and Williams, *Op. Cit.*, pp.38-41. Lifestyle changes offer an enormous job-creation potential, especially in the transportation sector. These, however, are excluded from this review to underscore the wealth of employment opportunities associated with the most feasible conservation options. See Bruce Hannon, "Energy, Labor and the Conserver Society," *Technology Review*, Vol. 79, No. 5, March/April 1977.

VI. The Long Island Study

Last fall, the Council on Economic Priorities (CEP) released preliminary findings of a comprehensive analysis of future energy supply options for the 900,000 households forecasted for Long Island, New York by the year 2020. The figures in this section reflect those early findings and according to CEP, most have been changed. The reader should view these figures as indicative of general trends, the direction and order of magnitude of which have been retained in the final report scheduled for publication in Spring, 1979. The study focuses on the comparative costs and benefits associated with two specific options: (1) the construction of an 1150 MW nuclear plant, and; (2) the implementation of a package of three solar energy, 30 conservation and 12 appliance efficiency measures. All of the conservation and solar measures are proven technologies, e.g. attic and wall insulation, storm windows, solar hot water heating, overhangs and shading, and improved furnace and air conditioner efficiency.

The CEP developed four prototype households based upon surveys of the housing stock to determine the condition, need and cost of the various conservation measures. After determining the region's conservation opportunities and costs, an input-output analysis was performed to estimate the direct and indirect employment impacts of implementing the various measures over a 40 year period. The same procedure was utilized for the analysis of the proposed nuclear plant: a cost analysis was conducted to estimate direct cost requirements for construction and operation of the plant as well as the indirect regional employment and income effects.

The study's major findings may be summarized as follows:[1]

1. Savings associated with the conservation/solar package total 74 percent or 116,700 million KWHs— of the output of the nuclear plant. Since the local utility does not base its projections on end-use needs, no determination of the amount of displaced base, intermediate and peak load capacity can be determined. However, the conservation/solar option could translate into a net reduction of up to $7.5 billion in consumer electric bills in 1976 dollars, assuming a zero real escalation rate for the price of electricity. This compares to lifetime utility bill payments of approximately $9.5 billion for the output of the plant.

2. Household disposable income could increase by up to $15 billion ($19 billion in electricity cost savings in 1976 dollars minus $4 billion in implementation costs) under the conservation/solar scenario. Since most of these resources are shifted from the capital intensive utility sector to the more labor intensive consumer goods/service sector, regional employment would experience a gain of 565,000 labor years (Table 13). When this figure is added to the direct and indirect impacts of on-site maintenance and construction, total *net* labor years created is approximately 315,000. This compares with a total of 59,000 labor years resulting from the nuclear scenario, or *over five times as much employment creation under the conservation/solar option.*

3. For every million dollars of household expenditures in the regional (and national) economy, 50 labor years are created. For an equal expenditure spent on by utility companies, 24 labor years are created.

4. The cost of conservation measures to reduce peak load in the electric system is $275 per KW.

The Long Island analysis, in summary, concludes that a feasible conservation/solar policy can reduce, and perhaps eliminate, the need for additional nuclear capacity, substantially increase disposable income, and generate five times the employment opportunities in the Long Island

[1]Statement of James Benson, Public Hearing of the New England Energy Congress, Jobs Subcommittee, Portland, Maine, October 10, 1978. Also see Benson's testimony before Joint Economic Committee, *Op. Cit.*

Table 13
Job Creation Potential Under Two Supply Scenarios for Long Island[1]
(Labor Years)

Conservation/Solar		
Direct (on-site)	78,000	
Indirect resulting from on-site expenditures	112,000	
Indirect resulting from increased disposable income	565,000	
Lost in utility and fuel oil sectors	- 300,000	
Cost of implementation[2]	- 140,000	
Total	315,000	315,000
Nuclear		
Nuclear (on site)	21,000	
Indirect resulting from on-site expenditures	38,000	
Total	59,000	- 59,000
NET GAIN UNDER CONSERVATION/SOLAR SCENARIO		256,000

[1] Subject to revision in final report
[2] Cash out of pocket for materials, labor and operation and maintenance

Source: Statement of James Benson, *Op. Cit.*, revised in January, 1979.

region. Although these conclusions are, of course, contingent upon the assumptions of the model, it appears that the direction, if not the magnitude, of the conservation/solar advantage would be sustained under any revised analysis.

VII. The New England Study[1]

A follow-up to the Long Island study recently was completed for the New England Energy Congress. Time constraints required the utilization of portions of the engineering and economic data base developed for the Long Island study. For example, parameter estimates which determine the effects on oil, gas and electricity consumption of the various conservation and solar measures, the direct installation and maintenance jobs, and the estimates of materials requirements were left unchanged. The Long Island estimates of 3.4 percent retrofit of existing dwelling units to solar hot water, 15 percent for new units, and 50 percent passive solar space heating for new units were also retained. In contrast, the fuel cost and mix assumptions, housing growth projections and the retrofit potential of the housing stock were adjusted to reflect New England conditions. Nevertheless, the findings reported below must be viewed as tentative and non-exhaustive because only a limited number of scenarios were considered. With these caveats, we proceed to examine the results of the New England Study.

A summary of annual energy savings, cumulative cost savings and regional employment impacts of separate conservation and solar scenarios is presented in Table 14. When compared with the 1972 energy consumption per dwelling unit, a 40 percent overall reduction is achieved.

[1]Richard A. Rosen and John K. Stutz, "The Employment Creation Potential of Energy Conservation and Solar Technologies: The Implications of the Long Island Jobs Study for the New England Region," The Energy Systems Research Group, Boston, October, 1978.

Table 14
Conservation and Solar Scenario Results for New England, 1985 and 1993

Annual Energy Savings in 10^{12} BTUs

Fuel:	Gas	Oil	Electric
1985:			
Conservation	12.8	266.4	39.2
Solar	1.0	7.2	1.6
1993:			
Conservation	17.0	422.8	57.0
Solar	1.3	14.4	3.3

Cumulative Billions of Dollars

	Fuel Cost Savings	Labor Cost of Measures	Total Cost*
1985:			
Conservation	7.74	4.82	9.92
Solar	.26	.97	1.27
1993:			
Conservation	28.07	8.13	16.73
Solar	1.06	1.09	2.43

Cumulative Regional Employment Impacts in Thousand Person-Years

	Direct	Indirect*	Total (per billion BTU saved)	Yearly cost @10% fixed Charge Rate in $/Million BTU saved
1985:				
Conservation	200.5	241.7	1.4	3.11
Solar	22.2	34.9	5.8	12.97
1993:				
Conservation	337.8	407.2	1.5	3.38
Solar	42.5	66.8	5.7	12.79

* Scaled from CEP study - Table 12, p. 120-121, and Table C, p. 145.

Source: Richard A. Rosen and John K. Stutz, *The Employment Creation Potential of Energy Conservation and Solar Technologies: The Implications of the Long Island Study for the New England Region,* The Energy Systems Research Group, October, 1978, p.25.

The electricity savings alone eliminates the need for two 1100 MW nuclear plants (operating at 60 percent capacity factor), and gas and oil savings exceed electricity savings by seven times. The fossil fuel savings of an additional 280 x 10^{12} BTUs is a major additional benefit.

Through 1985, the conservation scenario costs $9.92 billion, $4.85 billion of which is labor cost. Fuel savings per year total $7.74 billion and increase at $2 billion annually, thereby paying for the entire investment (exclusive of finance charges) within nine years. Conservation costs by 1985 would be $3.11 per 10^6 BTU as compared to $4.55 projected for oil in 1985 (assuming a 3 percent

escalation rate). By 1987, the conservation scenario will have paid for itself (exclusive of finance charges) and the cumulative fuel savings by 1993 total $28.07 billion, assuming a 3 percent real escalation rate.

In comparing the conservation scenario with nuclear plant construction, the study estimates a projected cost of $2.8 billion exclusive of financing, of which $.4 billion are labor costs. Electricity costs total $.352 billion annually. By 1993, when the conservation scenario will have saved consumers $11 billion in reduced fuel bills over investment cost, the nuclear plant will have produced less energy and will have cost consumers $3.5 billion.

In terms of job creation, by 1985, the conservation scenario generates direct employment of 200,500 labor years and 338,000 labor years by 1993. The indirect impacts are 242,000 and 407,000 labor years by 1985 and 1993, respectively. In comparison, the nuclear plants by 1985 generate 13,400 and 26,350 direct and indirect labor years, or one-eleventh of those created by the conservation scenarios.

The solar scenario produces only a limited impact on electricity consumption, i.e. an 8 and 16 percent electricity savings by 1985 and 1993, respectively. Per BTU, the solar scenario cost four times as much as conservation, but employs four times as many people. By 1993, the scenario costs $2.43 billion and saves $1.09 billion in energy for a net cost of $1.34 billion.

In summary, the New England study's findings tend to reinforce and strengthen, the major findings of the Long Island study: on a per unit electricity basis, a conservation/solar path creates vastly more—perhaps as much as 11 times as many—labor years in the region as compared to the nuclear option and, at the same time, generates a substantial lifetime savings to the consumer.

Although the New England study represents only a first and partial attempt to evaluate the full range of employment-energy relationships in the region, we can safely assume that future analysis will reaffirm the substantial employment advantages of the conservation/solar alternative.

VIII. Additional Evidence

We have emphasized the Long Island and New England studies because of their relevance to our central concern—the comparative jobs impact of alternative supply scenarios to meet regional energy demands within a given time frame. In a more cursory fashion, a number of related studies reviewed by Grossman and Daneker[1] are worthy of mention in view of their consistency with Long Island and New England studies:

1) A Federal Energy Administration study of the impacts of insulation, thermostat and furnace improvements in 34,372 residences would yield 487,000 jobs over seven years, including 122,000 in manufacturing and 366,000 in local installation. Of equal importance, the jobs created would be for the low to moderately skilled and concentrated in urban areas where unemployment problems are most acute.

2) An American Institute of Architects conservation program for new and existing buildings would create one half to more than a million new jobs through 1990.

3) A Federal Energy Administration Task Force conservatively estimated that 3-4 million labor years of direct jobs will be needed by the year 2000 for solar energy development and implementation.

4) A Critical Mass study estimates that the labor requirements for producing a unit of solar energy are 2 and 1/2 time greater than a unit of nuclear energy.

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[1]Richard Grossman and Gail Daneker, "Jobs and Energy," A Report of Environmentalists for Full Employment, Washington, D.C., Spring, 1977.

Table 15

Changes to Increase Employment and Decrease Use (U.S. Economy; 1974)

	New jobs per quadrillion new BTU (saved) (940,000)
Changing from:	
Plane to train (intercity)	930,000
Throwaway to refillable beverage containers	750,000
Car to train (intercity)	700,000
Owner-operator truck to class 1 freight train	675,000
New highway construction to health insurance (federal)	640,000
Car to bus (intercity)	330,000
Car to bus (urban)	210,000
New highway construction to personal consumption	200,000
Car to bicycle	200,000
Plane to car	160,000
Plane to bus	140,000
Electric to gas stove	160,000
Electric to gas water heater	120,000
Electric commuter to car	110,000
Electric to gas clothes dryer	100,000
Frost-free to conventional refrigerator	60,000
Plush (25 appliances) to moderately-equipped (16 appliances) kitchen	30,000
New highway construction to railroad and mass transit construction	30,000
Present to increased home (oil heat) insulation	15,000
Moderate to spartan (4-appliance) kitchen	10,000

Source: Statement of Bruce Hannon before the Joint Economic Committee, U.S. Congress, Hearings on "Creating Jobs Through Energy Policy," March 15-16, 1978, p. 57.

To this list we add an analysis of a number of conservation measures which, in contrast to the above studies, would require some degree of lifestyle changes (Table 15). These figures reveal what is possible in the way of job creation through a more aggressive governmental intervention to expand employment opportunities while reducing energy consumption.

The savings reflect the direct and indirect energy and employment impacts associated with each change, including those resulting from the respending of freed up income normally expended on fuel costs. Perhaps the outstanding feature of Table 15 is the preponderance of transportation mode-related measures, historically the most difficult to induce or mandate [See the Transportation Report on page 291 of this volume for further treatment of this issue]. Hannon notes that the thrust of his analytical approach is supported to some extent by the aggregate behavior of the U.S. economy in 1974, when new jobs were gained at a rate of 940,000 per quad reduction in demand, although real compensation and GNP also declined by 1.6 and 2.9 percent respectively. As in other studies reviewed earlier, the magnitude of Hannon's estimates outweighs the data limitations and conceptual shortcomings of the modeling techniques utilized. Once again, the rich job creation potential of conservation measure appears to be indisputable.

Finally, the NEEPA study of the economic impacts of energy conservation and alternative electric generation scenarios enforces the findings of all of the above studies. Among its major findings, is an estimate that cost effective conservation measures in New England "can create as many as 50,000 new jobs, increase production by $2 billion and reduce energy costs by $1.4 billion annually by 1985."[1]

[1]Massachusetts Energy Office, *Op. Cit.*, pp. 5-6

IX. Conclusions and Recommendations

This analysis has shown that: (1) the conventional wisdom which causally links energy consumption and economic growth is misleading and unsupportable; (2) relative factor prices have been distorted by uneven subsidies and that have disadvantaged labor vis a vis energy and capital; (3) the historical relationship between energy and economic growth will diminish in the future as a result of technological and structural changes in the national economy; (4) that conservation is overwhelmingly the most effective job creator among all energy strategies.

The capacity of integrated governmental policy to simultaneously address unemployment and energy supply issues has been hampered by fragmented decision-making and shortsighted policy formulation. To incorporate job creation potential in the formulation of fiscal and regulatory policy, and to begin to exploit the jobs potential of conservation and solar strategies, we propose the following recommendations:

1. *A jobs impact analysis of all energy policies,—including fiscal, regulatory and research/development—should be mandatory for all federal and state agencies. This analysis should be used as a criterion in program selection implementation and funding, as well as licensing and siting of new power generating facilities.*

2. *Existing weatherization programs should be greatly expanded to fully exploit the employment creation potential of conservation measures. Conservation incentives in the National Energy Act also should be increased for the same purpose. The federal government should make a large scale, and long term commitment to fund locally administered job training programs in the conservation and alternative energy area.*

3. *A comprehensive study of historical subsidies to energy, capital and labor should be undertaken to determine the effects of subsidization on the relative costs and utilization of labor in the national economy, and what measures are necessary and available to correct existing imbalances.*

4. *Special government support should be provided to insure the access of low-income people to energy conservation and renewable energy-related jobs. Such measures include support of (a) community energy corporations (b) an expansion of manpower training programs in the energy areas (c) provisions in government procurement and regulatory practices to expand low-income job opportunities (d) expanded public works programs.*[1] *Existing restrictions on federally sponsored programs should be eliminated to facilate the long term viability of energy-related enterprises.*

Rarely is a solution to two problems as pressing as energy scarcity and job creation so clear-cut, feasible and effective. Energy consumers who ultimately finance generating facilities and partake in the many localized costs and benefits associated with their construction and operation, are entitled to a full disclosure of the economic impacts of alternative energy strategies. The conclusions of this report suggest that the public interest—especially the unemployed and underemployed—would benefit immensely from an immediate, sustained and massive federal, state and local commitment to conservation in all sectors of the national economy.

Systems Integration

I. Introduction

It is generally agreed that there are specific benefits to be gained from the accelerated use of alternative, renewable energy sources in New England. These benefits include a reduced

[1]See the statement of David Dayton, Public Hearings of the New England Energy Congress, *Op. Cit.*, for a full discussion of these and other alternatives to achieving this objective.

dependence on oil, a reduction in the regional balance of payments deficit, a potential decrease in unemployment, greater self-sufficiency in the event of major energy supply disruptions, etc. These benefits, of course, must be balanced against the costs of the alternatives, with proper consideration given to the question of existing subsidies for conventional energy supplies. It is this cost/benefit accounting which must determine the optimum level of deployment and penetration of the alternatives, and should guide government policy on the alternatives.

Given that some level of penetration by the alternatives is desired, the question of integrating the alternatives into the existing energy supply system becomes a question of overcoming the initial resistance to such chances by demonstrating that the technology does work, and by eliminating inequities in regulatory or economic policy. Also, the development of an infrastructure necessary for the successful deployment of the alternatives must be encouraged and a smooth transition from conventional to alternative sources must be planned. This leads us to consider four objectives as the primary goals for the alternatives.

1) Economic policies must be directed at giving parity to alternatives; that is, subsidies must be eliminated or equalized.

2) Regulations or policies which discriminate against the alternatives must be changed.

3) The alternatives which are attractive but have not been satisfactorily demonstrated in the context of our energy systems must be so demonstrated.

4) Particularly for demonstrated technologies, assistance must be directed to the development and maturation of the supply markets.

The paragraphs below address a few of the issues discussed at the subcommittee meetings. A comprehensive study of systems integration was clearly beyond the capabilities of the subcommittee, but the issues discussed below do represent a broad spectrum of the problems that must be dealt with. These issues were discussed from the perspective of meeting the systems integration challenge and achieving the objectives outlined above.

II. Heating

Energy consumption for home heating accounts for nearly one third of the total energy consumption in New England. The dominant source of heat is the use of distillate oil in central heating systems, which are meeting heating demands in generally underinsulated houses. The needs of this rather homogeneous sector are best met by a multifaceted approach including both conservation and the use of alternative heat sources. As an example of a program which could address this problem, the following programs were suggested, but not unanimously endorsed as recommendations.

A. The BTU Grant

1) *Amount: $500*

2) *Eligible Grantees:* All owners of residential property plus tenants of non-participating landlords.

3) *Forms of Grant:*

a) "Energy Stamps" redeemable at retail outlets for materials proven capable of reducing fossil-fuel-generated BTUs (pre-certified):

i) insulation

ii) caulking

iii) storm windows

iv) solar collectors

v) greenhouse materials

vi) water-saving shower heads

b) Reimbursement for owner-built systems using non-certified materials according to previously approved plan.

c) Special low-income pilot projects in which local agencies provide federally-funded audit, materials, and installation ($500 ceiling lifted for these projects).

B. Tax Credits:

Expand the tax credits provisions of the National Energy Act to include passive and other innovative systems.

C. Demonstrations

1) *The 200,000 Person Program*

a) Eligibility: Any New England resident would be eligible for a two-grant program to be carried out in every district of 200,000 population (some 65 in the region). One grant for new residences, one for retrofits.

b) Amount: $50,000 for new house, $10,000 for retrofit.

c) Conditions:

i) Design should minimize reliance on fossil fuels. Special consideration for designs confronting peak-load problems; use of wood as auxiliary fuel encouraged for rural zones; food-production capabilities encouraged.

ii) Decision by state (VT, ME) or intra-state (Western Mass) official juries.

iii) Structures open to public for first four years, then sold on open market. U.S. gets grant amount plus interest, if any. Designer gets rest.

2) *Model Villages*

At amount to be determined later, a regional jury would help choose winners of contest for two new-from-the-ground-up villages of 500 persons, one urban and one rural. Designs should emphasize community scale energy systems.

III. Electricity

There are a variety of alternative, renewable techniques for producing electricity. These include wind, hydro, tidal, wood combustion, photovoltaics and solar thermal electric. By 1985 only wind, hydro and wood combustion are likely to play even minor roles in New England. Two distinct possibilities are available for utilizing these technologies. The first is that utilities will begin to use them in conjunction with existing generating capacity. Such is the case with the Burlington Electric wood-fired plant and with a few small hydro sites, although substantial changes in utility expansion plans, which favor large central-station nuclear plants, are not expected. Dispersed, non-utility applications are the second possibility. In this context, the problems of integrating these systems with the existing utility network becomes preeminent.

The interfacing problem referred to here is not so much a technical problem as a regulatory and institutional problem. Utility regulations are geared towards the large producers and towards companies whose sole purpose is the generation, transmission and sale of electricity. As such, they discriminate against dispersed, non-utility applications of any kind which must be connected to the grid if favorable economics are to be achieved. This problem is as severe for industrial cogeneration as it is for using alternatives. In fact, cogeneration with wood is one of the most attractive of near-term opportunities for utilizing renewable resources.

A. Use of electricity for back-up of solar heating systems.

Those utilizing solar energy for heating and other purposes present potential problems to the utilities providing back-up energy. Some have expressed the concern that greater use of solar energy, even though it would reduce the consumption of non-renewable energy supplies, could have negative impact on utility load factors, perhaps resulting in the need for construction of additional generating facilities. It has been suggested that all those asking for back-up to distributed energy systems should, consequently, be charged a special rate for this serivce. However, such a policy may not be necessary or desirable, particularly if it discourages such systems due to high back-up electricity costs.

The call for establishment of special rates for all customers using a utility as back-up for solar systems is based on the assumption that all customers within this broad category will have essentially the same, unfavorable patterns of back-up energy use, which would tend to increase the utilities' peak loads. This, however, is not necessarily the case. First, users of distributed solar systems will not always require back-up at times of a utility's peak load. For instance, with summer-peaking utilities as we now have in most of southern New England, highest solar back-up needs would come in the off-peak season, winter. Even in northern areas, the coldest days of the year, and therefore the peak loads, will tend to coincide with clear weather which will minimize back-up energy use. Also, solar domestic hot water systems will operate quite effectively in summer, thereby reducing summer peaks in southern New England. With winter peaking utilities, however, solar space and water heating systems would tend to result in increased back-up demand in cold winter periods, thereby driving up the system peak load and worsening the load factor. However, it is possible to greatly reduce this problem by proper system design. In particular, since thermal storage devices are generally integral parts of all solar heating systems, the back-up electric heating system could be designed to use only off-peak electricity, thereby further reducing the utilities' weather sensitive peak. Several northern New England utilities have encouraged electrical thermal storage heaters for just that reason.

It should be noted, however, that solar-users and other customers are not encouraged to shift their energy use to off-peak periods by traditional rate structures which base rates mostly on volume of use rather than time of use. These rates give users little specific information with regard to the marginal costs of providing service at different times of day and in different seasons. Conventional rates did make sense in the period previous to the late 1960's when new technology and economies of scale kept the cost of new electrical supply lower than that of older sources, and prices were consequently not sensitive to peak demand. A more attractive rate system, given the current electrical supply situtation is a schedule of rates that reflect in some detail the costs of generation capacity, distribution capacity, fuel and other factors. A number of public utility commissions, including ones in New England, are looking at or have enacted requirements for rate structures based on peak load and time of service pricing. The National Energy Act has provisions which require state commissions to consider such rates and allows the federal Department of Energy to intervene in rate proceedings to argue on behalf of such structures and related load management techniques.

It is clear that, in the long term, these changes will tend to encourage off-peak use of electricity and a shift from peak to off-peak use. This encouragement will have the effect of stimulating the use of thermal storage systems or other systems using off-peak power, including the appropriate use of electricity as a back-up to solar heating systems. With this incentive, optimum solar system designs will develop that best match the requirements of both the user's and utility's systems. In the long term, these changes may prove beneficial to the region. Should solar energy develop without such an incentive for efficient design, the results on the utility, and therefore on the region, could be detrimental.

The picture in the short-term is not so clear. Certainly, the penetration of solar in the near term will be so small as to have a negligible impact on utility service. However, the terms of electric service for the solar user, particularly the price, will have a substantial impact on the development of solar energy and on the subsequent benefits to the region of using a renewable energy source, and will influence tremendously the types of solar design that are researched, demonstrated and commercialized. Much of the influence and impact will occur before the proposed rate reforms have been fully considered and instituted. Thus, the initiative in this situation lies with the region's utilities, and with state and federal legislative and regulatory bodies. If a conservative "wait and see" policy is adopted whereby solar users are charged for service at a high rate or even at rates for the corresponding general classes of customers, then much of the opportunity provided by this initiative will be lost. Rather, programs to encourage, through equitable prices, information and other mechanisms, the use of off-peak designs for electric back-up of solar systems would stimulate both solar energy development and utility load management, and should be instituted soon.

B. Integration of dispersed, small-scale wind and photovoltaic systems with utility the grid.

Many of the problems evident in the issue of electric back-up for solar heating systems are also relevant to the issue of integrating small-scale wind and photovoltaic systems with the utility. In particular, the intermittent nature of the resource means that utility interconnection will be needed unless dedicated electrical storage is provided. As such storage is quite expensive, the utility is obviously the first choice for a back-up system, and utility pricing policy will therefore have a substantial impact on the development of these technologies. Unfortunately, without storage, these solar electric technologies do not offer the same load management opportunities as do solar heating systems with thermal storage. In fact, as the number of these systems increases in a utility's service area, the risk to the utility of a no wind or no sun period of time increases. This risk can be reduced in a variety of ways, such as encouraging dedicated electrical storage, by installing system-wide storage (such as pumped hydro), or by using various load management techniques at the dispersed generating site (thermal storage or load curtailment) or in the utility grid (curtailable rates, load cycling, etc.). Also, the risk will be reduced if a variety of complimentary systems are developed simultaneously, e.g., wind/hydro or wind/photovoltaics (in areas where the wind tends to blow when the sun doesn't shine), and if the dispersed systems are spread throughout the region rather than concentrated in one particular area. With these caveats, then, wind and photovoltaic systems should be considered in the same light as solar heating systems with respect to obtaining back-up power for the site.

There is one other significant difference between decentralized solar heating and solar electric technologies, and that is that when more electricity is produced at the site than is being used, it can be fed into the utility grid. This cannot be done from low

temperature thermal solar systems with known technology. This capability for supplying electricity to the utility is perhaps the most interesting and potentially most beneficial characteristic of wind and photovoltaic systems. To the extent that this "surplus" of electricity can reduce oil consumption by the utility or can reduce the need for expensive new generating capacity, the region will benefit. However, the problems of integrating these two diverse systems, that of the utility and that of the dispersed generator, have not been solved. Technically, there is very little problem in plugging dispersed generating equipment into utility grid. Through the use of synchronous inverters or induction generators, the power can be properly matched, and equipment is available that can provide adequate system control, monitoring and safety. Nevertheless, there is considerable uncertainty about the effects of dispersed generation on the utility. Technical problems and risks may arise if a significant portion of the utility's energy is being generated by small, independent, dispersed generators. Also, the temporal patterns of electricity generated by the dispersed systems is unknown and may or may not influence the utility's system peak load. Hopefully, some of the dispersed capacity will always be operating when the utility system load peaks, and therefore it will replace the need for new capacity in the system. Fortunately, these problems will not be serious for some time to come and there is ample time for study.

Another basic problem related to solar electric systems is determining the value of the surplus electricity sold to the utility. The price that the utility is willing to pay for this power will have a substantial impact on the development and acceptance of wind and photovoltaic technologies. The value of that power to the utility depends on what fuel source it is replacing, on the costs of transmission, and on the value of the capacity, if any, that the unit replaces. Pricing, therefore, is a very complex question. In the near term, until the number and power of dispersed systems becomes significant, the utility and its customers risk incrementally less if the value of this purchased electricity is estimated incorrectly. However, the potential wind or photovoltaic user risks are higher, since prices may well determine whether his system is economical or not. A price which is accidentally set too low will discourage investment in wind and photovoltaics and may therefore have significant negative impacts on the development of these renewable resources. If the price is set too high, that is, above the actual value to the utility, investment in the dispersed systems will be encouraged, at a small additional cost to the utility users. The mistake can easily be corrected before the costs become significant because data will be available from the early systems. This encouragement of wind and photovoltaics would not result in adopting an "uneconomic" technology, because increased investment is expected to result in significantly lower production costs for these technologies, and although the price paid for excess electricity might have to be reduced, the new systems could be expected to meet these more stringent economic conditions.

C. Recommendations resulting from this discussion (Proposed)

This subcommittee recommends that utilities institute positive programs to encourage development of solar heating systems with off-peak electric back-up, including, if possible, time-of-day or otherwise attractive and equitable rates for such back-up power. In addition, state and federal legislative and regulatory bodies should support and supplement these programs, and should include this issue in deliberations relating to rate reform.

This subcommittee also recommends that utilities encourage development of dispersed, small-scale wind and photovoltaic systems by adopting time-of-day or equitable rates for both providing back-up electricity and purchasing excess electricity. In addition, state and federal legislative and regulatory bodies should support and

supplement these programs, and should include all the relevant issues in deliberations relating to utility rate and other regulatory reforms.[1]

IV. Wood Supply

Despite the recent interest in wood energy in New England, a wood energy supply system has not developed, with the exceptions of isolated areas where wood waste is common and of the cordwood market for home heating. Such a supply system will be very important for a number of reasons. First, wood energy will not be adopted by most potential users unless an adequate and consistent supply can be assured. Second, the resource is dispersed and is owned largely by many individuals with relatively small parcels. Therefore, there is no natural connection between the resource and the potential market. Intermediate jobbers and wholesalers are essential to the successful development of the resource. Third, there is currently very little assurance that the resource will be harvested in an environmentally acceptable manner. A supply network will provide a point of leverage for requiring that wood resources not be simply stripped for quick profits. Finally, a supply network will serve to stabilize the price for wood energy, both within local areas and across the region. The confusion over wood energy costs will thus be reduced and the attractiveness of wood energy will be increased.

Developing a mature supply network with the desired characteristics will not happen overnight, although the development should occur largely as a response to increasing demand. In fact, the first and fourth functions mentioned above, adequacy of supply and stability of price, can be assured simply by encouraging competition. This may actually turn out to be not so simple, as the FTC investigation of the wood stove industry points out, but should not be a significant problem on the supply end. As demand develops for wood energy, supply competition should also develop, and the goals should be achieved.

However, establishing connections to the many small woodlot owners and providing for environmentally sound harvesting practices is not so easily assured. Both the resource and the woodlot owners will require protection from unscrupulous harvesters and from more subtle dangers as well. The best method of providing this protection is probably to educate the owners, as their self-interest will be with proper timber management and obtaining a fair price for their wood. The only mechanism currently available for this function is the County Extension Service of the U.S. Department of Agriculture, which provides forestry advice to woodlot owners. The advantages provided by this existing program would be hard to match with any new programs. For the above reasons, the Extension Services for forest management should be expanded, perhaps with a mandate to reach all of the woodlot owners, or a requirement that all woodlot owners file a management plan with their county forester. The service should include education on multiple use management, harvesting techniques and environmental protection, contracts for wood sales, etc. Expansion of the extension service should begin immediately, as it is even now in short supply to many who need it.

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NEW ENGLAND ENERGY DEMAND COMMITTEE

DELEGATES

Paul H. Bedrosian
Energy Coordinator, Environment & Economic Impact Office, Environmental Protection Agency-Region One, Boston, MA—government

R. Murray Campbell (Chair, Industrial Subcommittee)
Consulting Engineer, Stone & Webster Engineering Co., Boston, MA—industry and manufacturing

Thomas F. Eastler
Associate Professor of Environmental Geology, University of Maine, Farmington, ME—educators

Marian J. Ego
Former President, Association of Massachusetts Consumers, Boston, MA—consumers

John G. Fleming (Chair, Transportation Subcommittee)
Principal, John Fleming (Resource Management Consulting), Woodbury, CT—small business

D. Dickinson Henry (Chair, Residential Subcommittee)
Deputy Director, Scientific Staff, Massachusetts Audubon Society, Lincoln, MA—environmentalists

Nancy Floyd Morsbach
Assistant to the Commissioner, Vermont Public Service Board, Montpelier, VT—government

John H. Neely (Chair, Commercial Subcommittee)
Energy consultant and attorney, Salem, MA—unaffiliated

Gaylord M. Northrop (Committee Vice Chair)
Vice President and Director, Environmental Systems Division, Center for the Environment & Man, Hartford, CT—R&D

Terrence J. Quinn
General Vice President, Connecticut State Labor Council, Uncasville, CT—labor

Jeffry W. Raynes
Assistant Managing Director, Maine Oil Dealers Association, Yarmouth, ME—small business

Samuel Seely
Professor of Electrical Engineering, University of Rhode Island, Kingston, RI—educators

Peter M. Stern
Vice President, Corporate and Environmental Planning, Northeast Utilities, Hartford, CT—utilities

George Sterzinger
Director and Staff Economist, New England Regional Project, Burlington, VT—low income

Mary B. Sullivan
Vice Chairperson, Connecticut Energy Advisory Board, Riverside, CT—unaffiliated

Nikos Tzimopoulos
Daniel Webster College, Nashua, N.H. and Southern New Hampshire Services, Manchester, NH—low income

Gerald B. Taylor
Vice President, Engineering & Planning, Connecticut Natural Gas Corporation, Hartford, CT—utilities

Roberta Ward Walsh
Consumer Affairs Officer, U.S. Department of Energy-Region One, Boston, MA—government

Niels West (Committee Chair)
Associate Professor of Geography and Marine Affairs, University of Rhode Island, Kingston, RI—educators

Robert West
Professor, Fletcher School of Law and Diplomacy, Tufts University, Medford, MA—educators

STAFF RESEARCHER

Norman Stein
Deborah Bleviss
Technical Consultant

EXECUTIVE SUMMARY

The accomplishments of the Demand Committee during the past nine months are reflected in the brief executive summary which follows. The summary is organized in eight parts, the first of which discusses the demand for energy as it presently exists. This is followed by a short section describing the charter of the committee and the approach which was selected to accomplish its objectives. Summaries of the Demand Estimation Subcommittee and the four end use sectors (Residential, Commercial, Industrial, and Transportation) then follow. The final section comments on the overall goals that have guided the committee's work and notes several caveats concerning the findings that resulted.

Current Energy Demand

New England in 1975 consumed nearly three quadrillion BTUs of energy. Approximately 30 percent of this (790 trillion BTUs) was consumed by the residential sector, and another 30 percent of the total was consumed by transportation. the commercial sector is another large energy consumer, using over 650 trillion BTUs, while the fourth sector—industry—consumed about 390 trillion BTUs.

With a population of about 12.5 million, New England consumes only 30 million BTUs per capita in the industrial sector versus 100 million per capita nationally. Also, New England's transportation consumption is about 60 million BTUs per capita versus about 85 million BTUs per capita nationally. Overall, per capita energy consumption in the region is 20 percent below that of the nation as a whole. (All sectoral data include heat loss).

About 80 percent of New England's energy demand is met by petroleum products—for transportation, home, commercial, and industrial space heating, hot water, boiler water heat, and electrical power generation. Almost all of New England's petroleum supply comes from foreign sources, leaving New England's homes, industry, commerce and transportation highly vulnerable to foreign oil costs and supply fluctuations.

Clearly, the challenge faced by the Demand Committee included estimating future energy demand, recommending ways to reduce demand, and designing means for alleviating New England's dependence on oil.

Approach

The Demand Committee chose to form four subcommittees, covering the four classical demand sectors: residential, industrial, commercial, and transportation. The initial task of each subcommittee was to develop an historical perspective of New England's energy demand and then to make preliminary estimates of demand to 1985.

A major effort was made to develop a series of recommendations for each sector, which were discussed by the entire committee, then endorsed, rejected, or relegated to further study. The Demand Committee's organizational structure reflects the charge which the committee set for itself. Briefly, this may be summarized as follows: to assess the short-term energy demand (1985) under conditions of no new legislative or programmatic inputs other than those already proposed or mandated and then to develop recommendations which would significantly reduce future energy demand.

After the release of the *Preliminary Report*, two joint Energy Congress committees were established. The first committee was charged with the task of synthesizing all of the recommendations of all six Energy Congress committees which addressed residential energy topics. The report of this committee, the "Residential Package," follows the report of the Conservation Committee. The second joint committee, with membership consisting of delegates from both the Demand and Conservation Committees, addressed transportation issues. The Conservation/Demand Transportation report immediately follows this committee's report.

Both of these joint committees successfully integrated and elaborated upon issues which might not otherwise have been addressed by the Energy Congress. A number of important recommendations resulted from these deliberations and were adopted in part or in toto by the respective Demand Subcommittee and eventually by the full Demand Committee.

The Demand Committee report not only reflects the contributions made by the joint committees but also the input of private citizens and organizations received during the individual state hearings and the Energy Congress Convention in December. The committee's findings, conclusions, and recommendations have benefitted immensely from these interactions. It is the committee's hope, given the degree of consensus it achieved among its diverse membership, that the report and accompanying recommendations will serve as a foundation for the development of future energy-related federal and state legislation.

Demand Estimation Summary

Following the completion of the Demand Committee's *Preliminary Report* in December, a majority of the committee members felt that a comprehensive demand estimate covering all four traditional end-use sectors was needed. As a result a Demand Estimation Subcommittee was set up for the purpose of integrating the individual sector demand estimates. Because of its overall

importance, the Demand Estimation Report precedes the four end-use sectors and is summarized below.

In discussing the region's total energy consumption it is clear that significant changes have taken place between 1960 and the last year (1977) for which complete data is available. In assessing the total demand, the period 1960-1985 has been divided into three time frames. In the first, a pre-Arab oil embargo period extending from 1960 to 1972, total demand grew at a rate of 3.5 percent per year. During the second period, which ran from 1973 to 1975 and included the embargo, New England's energy consumption dramatically declined by an average 3.8 percent in each of the two years. The total energy demand for the third period under examination, between 1975 and 1985, has been estimated to grow at an annual rate of 1.5 percent per year. This estimate is strongly affected by the continuation of federally mandated programs, primarily those related to gasoline engine efficiencies.

The state of the art of energy projections is not a well developed discipline. These estimates may move in either direction depending upon population shifts, economic changes and behaviorial attitudes toward energy use including increased emphasis on conservation.

The demand for electricity is estimated to grow more rapidly during the 1975 to 1985 decade compared to other forms of energy. The assessment of electricity is complicated by the great changes that have taken place since the early 1970's and the concurrent absence of an historic record of sufficient duration. Consequently, several sets of figures have been presented.

New England's electric demand during the pre-Arab oil embargo period grew at an annual rate of 7.6 percent. However, one should note that for the period 1972-1977, the rate of growth was only 2.9 percent. The growth rate declined in relative terms, to an annual average 1.6 percent growth between 1972 and 1975, with the industrial sector declining by 1.8 percent and all other users growing by 2.8 percent. The two following years (1976 and 1977) saw a resurgence of electricity demand, with increases in both the industrial sector and other users (comprising the residential, commercial, and the transportation sectors) of 5.2 percent and 3.9 percent respectively.

For the purposes of comparison the committee projected past rates for consumption of electricity thru the period 1975-85 which are noted in the text of the report. However, because the committee did not have time to adequately address conservation measures that would affect electrical consumption, there is no significant degree of validity that is attached to our projected 1975-85 electrical consumption growth rate.

The demand for electricity is not totally dependent on market conditions. It is also affected by numerous state and federal regulatory agencies. Because the consumption of electricity was one major area affecting energy demand which has not been assessed thoroughly by the committee, we urge any further Energy Congress efforts to examine this critical area of energy use.

The Demand Committee did not feel accurate overall or sectoral projections for the period 1985-2000 could be made but felt that vigorous implementation of proposed recommendations continued beyond 1985 could reduce the 1975-1985 projected 1.5 percent growth rate. Such vigorous implementation of both Energy Congress recommendations and other newly formed recommendations directly impacting electrical consumption would likely result in a continued decline of the post-1985 growth rate of electricity below the projected 1975-1985 rate.

Residential Summary

Twenty-nine percent of New England's total energy use is consumed by the residential sector. As much as 75 percent of residential consumption of oil and natural gas is used for space heating. The Residential Subcommittee set out to determine what kind of reductions in this use of

energy could be made between now and 1985, and now and the year 2000. Due to the generally poorer quality of the housing stock used by low income people, the subcommittee emphasized programs that would improve heat efficiencies and increase conservation practices for the housing stock used by the low income population.

The Residential Subcommittee's report is organized into the following six sections: recommendations; population projections; a review of existing federal and state legislation; a survey report on housing stock; the report of the subcommittee on low and moderate income consumer impact; and recommended areas for further study. These sections are summarized below.

The 35 recommendations of the Residential Subcommittee cover the areas of: homeowner subsidy provisions, weatherization program improvements, building codes, tenant protection, low income, low and moderate income, phantom taxes, demonstration programs, and passive solar and conservation legislation. The second section of the subcommittee reports addresses the issue of regional population growth through the year 2000. The subcommittee forecasts an increase from 12.3 million persons in 1977 to 14.5 million persons in the year 2000. However, the subcommittee notes that this population projection might be too high. The subcommittee's projections also estimated a continual decline in the number of persons per household. A third task undertaken by the subcommittee was a review of existing federal and state legislation affecting the residential sector in New England.

Fourth, major attention was given to assessing New England's housing stock. Using the REFORM computer model owned by the New England Regional Commission, with program variables provided by the Massachusetts Audubon Society to more closely fit current experience, the committee estimated a base case for housing stock in New England today. Once this was established, the staff calculated the conservation potential in the sector based upon improved weatherization and improved heating system efficiencies. Four weatherization options were examined that called for an increased investment from $250 - $1000. By weatherizing optimally, the Energy Congress/NERCOM/Audubon model estimates that more than 50 percent of all energy consumed for heat may be saved.

Three heating system efficiency options were also examined. Option 1 called for all households to start a maintenance program at a cost of $30 annually per unit (presently it is believed that 50 percent of New England households are already under a heating system service contract). Option 3 calls for an investment of either $350 or $1850 per household, dependent on whether one had a gas or an oil heated home. Finally, Option 2 urged the same investment as Option 3 but for only half the households. It should be noted that by improving heating system efficiencies to their fullest extent, fuel savings of better than 30 percent may be achieved.

The weatherization cases and heating system efficiency cases were then combined to give a total of 12 possible options, the least expensive of which would cost $549 per unit and save 18 percent of all energy used for heat. Finally, assuming limited levels of weatherization, three possible fuel mix cases were chosen and their impact projected to the year 2000. The conclusions drawn from these models strongly suggest that heating fuel consumption would drop between 1978 and the year 2000.

The fifth section of the residential report consists of the work done on low and moderate income consumer impact. After the *Preliminary Report* was released, a special subcommittee was formed to address these issues. The report of this group is presented in three parts: a consumer study; an essay on the Low Income Weatherization Program; and a discussion of "phantom taxes."

The consumer study, authored by the Grier partnership and entitled "The New England Energy Consumer," reviews statistical data on energy consumption patterns in the region and concludes as follows:

1) New Englanders pay more than residents of any other region for oil.

2) Electricity is also more expensive in New England than other parts of the nation.

3) New England's housing is among the oldest in the nation. Well over half of its homes were built before 1940.

4) New England's climate is among the coldest in the nation.

5) The low income New Englander is paying an average 29 percent of their income for energy; those with cars pay even more.

The second component of the consumer impact report is an essay on the Low Income Weatherization Programs in New England. Recommendations were developed as part of this work. The report urges the continuance of the Emergency Assistance Program for low income consumers at a funding level of $200 million. Further, an increase of the authorization level for the Weatherization Program from $200 million to $960 million annually is also urged, with a goal of weatherizing 500,000 low income owner occupied homes nationally per year (30,000 in New England) so that all such homes are weatherized by 1988.

The third section of the consumer impact report reviews portions of a 1978 letter from the National Association of Regulatory Utility Commissioners to the U.S. Congress on the issue of "phantom taxes." Phantom taxes result when utilities include charges in the rate base but actually pay less than the amount assessed. The committee's conclusion is that those sections of the IRS code which allow for "phantom taxes" be repealed.

Finally, the last section of the residential report recommends that the five following areas be researched:

1) Heat loss characteristics of New England housing stock,

2) Conservation potential of electricity demand,

3) Energy Policy and Conservation Act (EPCA)/Energy Conservation and Production Act (ECPA) conservation goals,

4) Energy education,

5) Low Income energy costs

Commercial Summary

Between 1960 and 1975, the commercial sector consumed 20 percent of the total energy used in New England. The proportion of that 20 percent which was electric consumption grew increasingly throughout the period, from 5 percent in 1960 to 13 percent in 1975.

The annual demand growth rate in the commercial sector grew by 3.6 percent during that period. It is projected to drop to a growth rate of 2.5 percent for 1975-1985. This estimate reflects the fact that commercial demand dropped significantly during the Arab oil embargo and has not returned to the historic rate of 3.6 percent. Beyond 1985, it is estimated that the region's demand in the commercial sector will continue to decline in relation to the implementation of the recommendations passed by the committee.

Finally, the committee notes that the commercial sector has consumed a fairly constant fraction of total demand since 1960. Even in 1973-1975, when total demand dropped significantly, commercial consumption fell in step and the fraction remained constant. If this trend were to continue, this would indicate that all actions designed to conserve energy or reduce total demand in any or all sectors might be matched by a corresponding effect in the commercial sector.

Industrial Summary

The Industrial Subcommittee examined the changing nature of New England industry, although no attempt was made to assess each separate industry because temporal data of sufficient quality was not available. What is clear, nonetheless, is that the different growth rates for electric and non-electric consumption that characterize other end-use sectors also prevail in the industrial sector. The analysis conducted by the subcommittee suggests that this overall trend will continue in both the short and long term, although perhaps not at the same rates as in the immediate past.

Among its major findings, the subcommittee notes that an extensive study of the electric cogeneration potential in New England could improve the prospects for one of the most important conservation opportunities affecting overall industrial energy demand. Further, the Industrial Subcommittee recognizes that productivity and product cost determine the region's ability to compete and that energy use reduction must be tempered with consideerations of overall cost effectiveness of the production process. It was felt that those industries which have not yet conserved energy by operational changes (as opposed to capital intensive changes) provide the greatest potential for conservation. Additional conservation which is dependent on capital input for changes to buildings and equipment will provide less dramatic savings and will take place over a much longer period.

Finally, while only indirectly related to energy consumption, it is felt that the existing energy siting process is both inefficient and costly and should be improved without reducing socio-environmental safeguards.

Transportation Summary

Extensive efforts were made by the Transportation Subcommittee in identifying and assessing the demand structure of the four most consumptive transportation modes: auto, truck, rail, and air. The following issues were given particular attention: 1) maximizing the efficiencies of each of the four modes and 2) determining how shifts from less efficient to more efficient modes could be encouraged.

When possible, attempts were made to quantify the energy reduction potential of the various recommendations that were put forth. While some of these depended upon direct and indirect governmental support, others infer dramatic changes in the country's residential, commercial, and industrial land use patterns.

The estimated 1985 transportation demand in New England is expected to equal 830×10^{12} BTUs, reflecting virtually no growth compared to the level of consumption in 1975. This represents a significant reduction in the overall transportation growth rate compared to past decades. This estimate is strongly influenced by federally mandated higher efficiencies in gasoline engines between now and 1985. Improved engine efficiency standards implemented beyond 1985 would have additional significant impact on reducing energy demand, despite an increase in the region's inventory of cars and trucks.

In 1975 the airline industry consumed 8.6 percent of the region's transportation energy budget, a share likely to grow at an annual compound growth rate of 2 percent. By 1985, the industry is projected to consume approximately 10 percent of the region's transportation energy budget.

The final area which the Transportation Subcommittee addressed concerning the possibility of stimulating transportation modal shifts, primarily resulting in increased reliance on bus and rail transportation both within cities (mass transit) and between cities (Amtrak and Conrail). An effort to quantify the energy savings that would result from such actions led the committee to conclude that a major public commitment would be needed to realize the significant conservation potential of modal shifts.

Conclusion

As noted earlier, New England's dependence on imported oil places the region in a highly vulnerable position. In terms of both the security of its supply and the price it must pay, New England suffers a relative disadvantage vis a vis the rest of the nation.

Charged with the responsibility of addressing these problems from the demand side of the energy equation, the committee identified two basic strategies: directly reducing the demand for energy and increasing the efficiency of energy use. The recommendations passed by the committee reflect these strategies and can be separated into two functional groups. The first group consists of conservation measures designed to directly reduce demand. The second group consists of a variety of legislative programs and actions, and technical and economic incentives, which, if implemented, should result in significantly greater efficiencies in the region's traditional consumption of energy.

The benefits derived from reducing demand are enormous. Dependence on imported oil is lessened, total expenditures for energy decline, and scarce natural resources are preserved. The benefits derived from using existing and alternative energy supplies more efficiently are also considerable. Not only does more efficient use of energy result in lower overall consumption and, in turn, reduced oil imports, but efficiency measures are often attractive, cost-effective investments.

Finally, several caveats must be noted. First, the committee found that significant problems exist concerning the availability of data by end-use sector. The quality, and in some instances, the total unavailability of data make estimates of future energy usage precarious at best. The committee supports at a very minimum the development of a national data base broken out by geographical area, end-use sector, and time. Furthermore, it was the sense of the committee that a regional effort should be mounted to continue the work already started in estimating energy demand broken out by the geographical and socio-economic characteristics of New England. The committee acknowledges that these problems of data availability seriously compromised the demand estimates in the commercial and transportation sectors.

Second, while the demand estimates made by the Demand Estimation Subcommittee considered the energy consumed in generating electricity, they did not consider the energy required in the manufacturing of goods that are produced in New England but are sold elsewhere. Similarly, the demand estimates did not consider the potentially even more important variable of energy consumed in other regions to produce goods that are sold and used in New England. Because of the region's declining role as a producer of heavy industrial products, this may on balance seriously understate the region's true energy demand. This is an area that should receive attention in any follow up efforts.

Third, the committee notes that extensive efforts were made to coordinate the demand estimates with the work conducted by the Supply Committee. Where discrepancies exist between the estimates provided by the Demand Committee and the estimates on which the Supply Committee is basing its fuel mix projections, efforts should be made by any follow up organization of the New England Energy Congress to reconcile these differences.

DEMAND COMMITTEE RECOMMENDATIONS

Residential

I. Homeowner Subsidy Provisions

1) *Expand the present Internal Revenue Service (IRS) tax credit provisions to include:*

   A) *Eligibility: any homeowner*

   B) *Systems: Parts and labor from a well-publicized, comprehensive list of home improvements of demonstrable utility in reducing the existing use of non-renewable fuels for space heating and hot water: insulation, storm windows, weatherstripping, active solar, passive solar, wood stoves, replacement of boilers and furnaces, etc.*

   C) *Terms: refundable credit for 30% of first $4000, 20% of next $8000. Maximum credit of $2800 for all above provisions.*

2) *Expand the solar and conservation loan programs in the National Energy Act (NEA) to include:*

   A) *Eligibility: households with incomes up to $25,000.*

   B) *Systems: Parts and labor from a well-publicized, comprehensive list of home improvements of demonstrable utility in reducing the existing use of non-renewable fuels for space heating and hot water: insulation, storm windows, weatherstripping, active solar, passive solar, wood stoves, replacement of boilers and furnaces, etc.*

   C) *Terms: subsidized loans at the most favorable government interest rate, up to $8000 per family unit.*

II. Weatherization Program Improvements

3) *Amend the Energy Conservation and Production Act (ECPA) to authorize labor as an allowable expenditure.*

4) Comprehensive Employment Training Act (CETA) Labor[1]

   Continue implementation of the weatherization program at the local level by Community Action Agencies (CAAs). CAAs may utilize private contractors or undertake weatherization activities directly. Where a private contractor is used, CAAs should encourage use of CETA labor by contractors and the hiring of workers previously trained in weatherization activities under the CETA program. In CAA-run programs, CETA labor should be used only as supplemental labor, whose utilization will be determined by the number of slots available, skills required, and other administrative considerations. CAAs will be encouraged to hire such CETA workers as may be reasonably expected to be permanently hired by private sector employers after their training program is completed.

5) *Remove the restrictions of a $100 ceiling on making incidental repairs to a dwelling unit which are necessary to make installation of weatherization materials effective.*

6) *Amend the ECPA to increase maximum expenditure per dwelling unit to $1920, with maximum permissible expenditures in the following categories:*

   $800 - labor
   800 - materials
   320 - administration and related expenses

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[1]Two committee members voted against this recommendation.

Within these categories, local program operators are given maximum flexibility to determine the optimal expenditures and appropriate mix of weatherization measures.

7) *Coordinate the Housing and Urban Development (HUD) rehabilitation funds to be used in conjunction with federal weatherization programs.*

8) *Increase the authorization level for the weatherization program from $200 million to $960 million annually (constant 1978 dollars) with a goal of weatherizing 500,000 low-income owner-occupied homes nationally per year (30,000 in New England), so that all such homes are weatherized by 1988.*

9) *Establish a separate program to weatherize rental units.*

10) *Amend the ECPA to establish that the primary purpose of the weatherization program is to lower fuel bills paid by low-income persons, and establish a standard of optimal weatherization to carry out this purpose.*

11) *Amend the National Energy Conservation and Policy Act (NECPA) to require the documentation of savings achieved for dollars spent through the Weatherization Program.*

III. Building Codes

12) *Minimum Thermal and Lighting Standards*

A) *Establish minimum thermal and lighting standards for all states in the New England region to insure that each state's standards, mandated under the ECPA, effectively induce conservation.*

B) *Provide monetary support for programs to train building inspectors to enforce the thermal and lighting standards.*

13) *Prohibition of Electric Space Heating*

Prohibit the installation of electric space heating in all new buildings unless it can be shown that the use of this heating fuel is less expensive than other fuels over the lifetime of the building concerned.

IV. Tenant Provision

14) *Establish a program through the state energy offices to address the needs of tenant-occupied buildings providing for:*

A) *An expanded utility-audit program to cover multi-family units; with the cost of the audits going into the commercial rate base.*

B) *Mandatory retrofit requirements for multi-family units; if the requirements are not met, the building owner would be disallowed from deducting the property taxes on that building from his federal income tax.*

C) *Write-off of retrofit costs on income tax, amortized over three years.*

D) *A loan program for owners of multi-family unit buildings with below-market interest rates to provide the front-end money for retrofit; such a program would be established in the State Energy Management Plan (SEMP).*

V. Consumer Protection

15) *Require that all states develop a mandatory licensing program for installers of weatherization materials, alternative energy equipment, and fossil fuel heating systems with the following provisions:*

A) *That the licensing boards have adequate consumer and industry representation,*

B) *That the licensing boards establish a mechanism to air and investigate consumer grievances, and*

C) *That the licensing boards establish the goal of increasing rather than decreasing industry competition.*

16) *Require an appropriate national standards board to develop standard performance testing methods for weatherization materials, alternative energy equipment, and fossil fuel heating systems.*

17) *Amend the Federal Trade Commission Act to include affirmative disclosure (truth in advertising) in advertising for energy products with the following provisions:*

A) *That an energy product must be labeled to indicate whether it has been tested, and what its performance level is.*

B) *That advertisements for an energy product include whether or not it has been tested, and what its performance level is.*

C) *That false and misleading statements, specifically with regard to the amount of energy savings that can be realized by using a certain energy product, be prohibited.*

18) Truth in Energy

Require building owners and/or energy suppliers to furnish to all prospective leasees or purchasers of a building or apartment disclosure statements of the total annual energy consumption of the relevant unit for the previous three years, broken out by month.

VI. Low-Income Demand

19) Emergency Assistance Program

A) *Allocate $200,000,000 (based on 1976-1977 energy prices) for the next fiscal year for this program.*

B) *Revise the regulations of the current program to remove negative incentives, such as those that make non-payment of bills a condition for program eligibility.*

C) *Base the eligibility for emergency assistance on 150 percent of federal poverty levels.*

D) *Establish a formula to determine the level of individual payments to eligible households based upon age, household income (adjusted for cost of living), and the regional household energy requirements.*

20) *Urge all public service or utility commissions in New England to adopt the National Energy Act (NEA) guidelines on termination of electric or gas service.*

21) *Allocate a portion of the $1.5 billion photovoltaic demonstration money to multi-family assisted housing.*

22) Intervention

Use federal funds to support offices of low-income counsel to protect the interests of "the most vulnerable segment of utility consumers...to avoid potential tragedy."

VII. Low-Income and Moderate-Income Demand

23) Rate Design

Set rate structures through the state public utility commissions which encourage conservation.

24) Phantom Taxes

Repeal Sections 46(f) and 167(1) of the IRS Code of 1954 so that the choice between the use of "flow-through" or "normalization" methods of accounting by utilities subject to state regulation is restored to the state regulatory commissions.

VIII. Demonstration Program

25) *Establish a competitive design program which provides for state administration of federal grants to individuals and builders, with emphasis on public information and public access. Structures must include some provision for reducing the reliance on fossil fuels, such as use of regional renewable resources, active and/or passive solar design concepts, conservation measures, or food-production capabilities.*

26) *Promote technical demonstrations of residential applications of such developing systems as photovoltaics, wind systems, and district heating, within existing Department of Energy (DOE) programs.*

IX. Other Passive Solar and Conservation Legislation

27) *Require all lending institutions to consider operating and maintenance (O & M) costs in addition to principal, interest, taxes, and insurance (PITI) in evaluating the debt service capability of prospective buyers under all federal housing programs, e.g., FHA, FMA, Section 8, etc.*

28) *Urge state and federal governments, through their respective regulatory authority, to encourage lending institutions to expedite the processing of loans for investment in energy efficient structures; such structures may use new and innovative designs.*

29) *Continue and expand the existing HUD passive design competition with special emphasis on, and incentives for, region-specific designs used by builders of residential housing.*

30) *Provide incentives to encourage the professional education of builders, contractors and architects in passive design concepts, and to include such concepts in the professional examination process.*

31) *Encourage the DOE to pursue the tankless heater testing program currently in progress and determine the seasonal efficiencies of units in the marketplace as well as establishing minimum seasonal efficiency standards for the future market.*

32) *Require that all new gas appliances and gas space heating be pilotless and that all current gas units that use pilot lights be retrofitted upon resale.*

Commercial

33) *Establish locally operated federally supported review processes to insure that all new commercial buildings are designed and built to provide for cost effective conservation, prudent fuel choice, and desirable operational flexibility, without imposing undue regulatory burdens.*

It is felt that conventional thermal and lighting standards are not sufficient. Both overall building performance standards and analysis of life cost of energy systems should be considered as possible regulatory tools. Both could be tested for effectiveness and efficiency in pilot programs on governmental buildings.

34) *Focus a proportional share of government efforts to promote or require energy conservation upon new construction and existing structures in the commercial sector.*

35) *Develop programs to promote the use of energy audits and provide incentives to businesses to use these audits.*

36) *Impose more stringent regulatory requirements upon large new buildings rather than small ones.*

37) *Encourage the design of new commercial buildings to provide as many retrofit options as possible.*

Many energy options which are now little used may play a major role in the future. Examples are roof-top solar collectors, electric heat pumps, and district heating systems.

38) *Expand educational and technical assistance programs to benefit the commercial sector.*

39) *Make available to leasees of real property on the same basis as owners any benefits, tax or otherwise, intended to promote conservation in the commercial sector.*

40) *Apply comparable incentives and penalties to encourage conservation to all entities in the commercial sector, whether profit-making, not for profit, or governmental.*

INDUSTRIAL

41) *Assess the probable impact of cogeneration.*

42) *Study the adoption of cost effective innovations in industrial energy-using equipment both in terms of its impact on regional energy usage and in terms of the improvement of the competitive position of regional industry.*

43) *Develop regulatory reform to enable an expeditious and rational assessment of the energy facility siting process so that reliability of supply, environmental, economic, safety, and other factors can be adequately assessed while protecting all legitimate interests.*

TRANSPORTATION

I. Automobile

44) *Maintain existing fuel economy and emission standards for automobiles through 1985.*

45) *Develop more stringent fuel economy standards beyond 1985, with a goal by the year 2000 of 34 MPG or the technological optimum for the new automotive fleet, providing such standards do not adversely impact the emission standards of the Clean Air Act.*

46) *Improve light truck (under 8500 pounds) fuel economy by:*

A) *Mandating more stringent light truck (under 8500 pounds) fuel economy standards for model year 1981.*

B) *Authorizing the National Highway Traffic Safety Administration (NHTSA) to develop progressively more stringent light truck fuel economy standards through 1985.*

C) *Authorizing the NHTSA to consider light truck fuel economy standards beyond 1985.*

47) *Enforce the 55 mph speed limit, with no exemptions.*

48) *Continue car pool and van pool programs administered at the state and local levels, and provide funding for such programs.*

49) *Direct the Secretary of the Department of Transportation to enforce more stringently the requirement of a "comprehensive, coordinated, cooperative" (3-C) planning process (23 U.S.C. S134) when reviewing urban transportation funds, including the requirement of an Energy Impact Statement.*

50) *Require the Environmental Protection Agency (EPA) to cut off highway funds if a state submits an inadequate transportation element of a state implementation plan (S.I.P.) to improve air quality in non-attainment areas [42 U.S.C. S7506(a)]. Failure to develop transportation plans that minimize energy consumption should be interpreted as a violation of both of these statutes.*

51) *Provide substantial support for research and development of alternative sources of transportation energy such as gasohol, which do not have significant adverse environmental impacts.*

52) *Authorize the Department of Energy to maintain an emergency plan for rationing.*

II. Trucks

53) *Increase the federal research into improved efficiency in trucks. Fuel-saving improvements through technological development, such as aerodynamic design changes and engine modification, should continue, and results of such research should be available to truck operators, both large and small, through the Department of Transportation.*

54) *Encourage the Interstate Commerce Commission to give high priority to energy conservation in its reexamination of trucking regulations, especially those affecting routing and rate structures.*

III. Trains

55) *Continue the Northeast Corridor Improvement Project (NECIP) and make every effort to achieve the original performance goals of the project.*

NECIP has been the crucial legislative issue regarding intercity rail passenger service affecting the New England region, and it is essential that the project be completed.

56) *Study the feasibility of restoring and improving the inland route so that the major population centers of Hartford, Springfield, and Worcester can be serviced by fast rail.*

57) *Encourage integrated rail/truck service (truck on freight car) to achieve the most energy efficient transportation services. Regulatory reform should be undertaken to remove any unfair advantages for one mode, and to promote optimum interface between rail and truck services.*

58) *Fund Amtrak sufficiently to enable it to provide routes, timetables, and fare structures that will attract ridership.*

Other forms of transportation (air, highways) receive government subsidies that are vastly larger than those received by passenger railroads. Also railway passenger and freight operations are conducted by two separate corporations, removing the possibility of subsidizing passenger service out of freight revenues. Realizing that few, if any, other countries operate deficit-free passenger service, and finally, in view of the need to conserve energy by providing a viable passenger railway service, we have recommended the above.

IV. Air

59) *Revise Airline Flight Procedures*

Tighten cruising and landing procedures (through the Federal Aviation Administration) to reduce airline fuel consumption. While maintaining noise and safety standards, specific operational changes should include: 1) reduced airline cruising speeds, 2) revised airport descent profiles, and 3) reduced delays when planes are on the ground.

60) *Provide NASA with adequate funding to research improved aircraft engine efficiency.*

There are a number of significant design and technological changes still in the research and development stage that could improve aircraft energy efficiencies in the 1990's. These include new engine designs and body designs that reduce weight and drag. NASA, which has the primary research and development responsibility, should be provided adequate funding to continue this work.

V. Modal Shifts

61) *Eliminate the "Contract Authority" which allows the Federal Highway Administration to obligate authorized highway funds prior to appropriation of the funds.*

Once obligated, the authorized funds must become a debt of the federal government. Most other federal programs must negotiate the legislative process twice before the expenditure of any funds: once to authorize a program and set maximum federal funding limits for a period of years in the future, and a second time actually to appropriate the authorized funds. Until the authorized funds are actually appropriated, the program cannot be implemented.

Since all other transportation projects (long-term public transportation planning) cannot use "Contract Authority", they are at a distinct disadvantage to highway planning. Therefore, the funding structure for all transportation systems must be put on an equal footing if transportation planning is to be based on merit rather than funding availability.

62) *Consider energy conservation and alternative transportation modes in the planning and construction of projects funded from the Highway Trust Fund. In particular:*

A) *All highway categories incorporated in the Federal-Aid Highways Act should be opened up to allow funding of alternative transportation modes.*

B) *Money from the fund should be allowed to be used for operations and maintenance of transit systems under the same restrictions that now apply to Urban Mass Transportation Act (UMTA).*

C) *When a locality decides to replace a planned interstate highway segment with a*

mass transit project, it should be funded with Highway Trust Fund monies, not with UMTA appropriations of general revenues.

D) *In planning highway transportation projects, analysis of energy consumption should be one criterion for evaluating the project, much the same as environmental, social, and aesthetic impacts.*

E) *Congress should not authorize any deficit spending of the Highway Trust Fund.*

63) *Encourage the substitution of communications services for personal transportation. The technologies and services which can substitute for personal transportation should be encouraged and expedited.*[1]

64) *Develop a national land-use planning act. Vigorous implementation of such an act could result in a significant energy savings over the long-run because of the interrelationships of energy, land-use, and transportation.*

65) *Encourage the use of bicycles as an alternative mode of personal transportation and institute efforts to increase the safety of this mode. In particular:*

A) *Existing bikeways programs should be expanded, but with the recognition that most bicycle traffic takes place on existing streets and along high-volume routes.*

B) *Secure parking facilities for bicycles should be provided wherever they can encourage their use or increase their convenience. Secure parking facilities and provisions for transporting bicycles on mass transit modes should be provided.*

C) *Use of bicycles on major traffic routes should be expedited, particularly at overpasses, bridge crossings, dangerous intersections, etc., and bicycles should be considered in all phases of transportation planning.*

D) *Public education is needed and should be directed to both the cyclist and the motorist, with the purpose of increasing bicycle safety.*

E) *The Department of Transportation or another appropriate authority should undertake a study of the potential for and problems of bicycle, moped, and other low-power vehicle transportation.*

66) *Expand and improve intracity and intercity bus service as a substitute for the automobile and for short air flights (under 400 miles). The highest priority items should be:*

A) *Studying existing problems of improving intermodal connections, such as more efficient rail-bus connections.*

B) *Upgrading the available facilities and services to make this mode more attractive.*

C) *Upgrading the vehicle fleet with newer, more comfortable, and more energy efficient buses.*

D) *Providing frequent and reliable express service along major routes, and encouraging ridership.*

67) *Develop policies to discourage the use of the automobile in urban areas where there are public transit services. These should include:*

A) *Increases in parking fees in congested areas, and provision for increased tolls in rush hour.*

B) *Promotion of auto-free zones, limitations on parking facilities in certain areas, and provision for parking along major mass transit routes.*

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[1]One committee member voted against this recommendation.

C) *Upgrading of traffic law enforcement, particularly in congested and high-flow areas, more stringent penalties for parking violations, and greater emphasis on collection of fines.*

68) *Investigate the potential in specific metropolitan areas of light rail as well as bus service, as an alternative to the automobile.*

DEMAND ESTIMATION REPORT

I. Defining New England Energy Requirements and Uses

Demand for energy in New England is satisfied in three fundamentally different ways. First, primary energy (such as wood and electricity produced by hydro and nuclear generating plants) is produced in New England and delivered to customers located in New England. Second, primary energy (such as coal, crude petroleum, and natural gas) is produced and processed outside New England, then transported into the region and delivered to New England customers. Third, primary energy is produced, processed, and delivered to customers outside New England who, in turn, transform the energy into goods and services which are subsequently transported into the region and delivered to New England customers. New England produces within the region only a very small part of the energy it consumes; it is a net importer of energy from both the second and third supply-sources described above.[1]

We will concentrate attention on New England requirements and uses of energy supplied in the first and second ways, excluding the indirect demand for "embodied" energy in the goods and services imported into this region. We will, moreover, measure those requirements and uses in terms of energy products in the form in which they are delivered to New England users (such as cut and dried firewood, gasoline, distillate, and other petroleum products) rather than in their primary form before processing (such as crude petroleum as delivered to refineries). Defining energy demand in this way enables us to match our measurements and projections most easily and most closely with the energy magnitudes of interest to those studying the supply of energy in New England: it corresponds to the sales of energy materials to New England customers by the supply enterprises and agencies of the energy industry. These definitions and exclusions also match those of the Federal Energy Data System (FEDS) of the U.S. Department of Energy; historical (actual) data appearing in the report of the New England Energy Congress (NEEC) Demand Committee have been taken from the FEDS Statistical Summary of February, 1978, unless otherwise specifically indicated. Consumption of wood as fuel follows data supplied by S.H. Clark Associates.

Not only is New England poorly endowed with domestic sources of the energy it consumes, it also must rely on facilities outside New England for most of the processing and transformation of primary energy into products in the form demanded by users. There is, however, one important exception: electricity generating plants located in New England transform petroleum, coal, and

[1]We have estimated that in 1975 the total final demand for energy by end-users in New England was about 4.3 quads of British Thermal Units (4.3×10^{15} BTU). This accounts for consumption by the end-users of wood, coal, petroleum, natural gas, and electricity generated by hydro and nuclear plants; it includes the energy delivered directly to the end-users as well as energy delivered to intermediate users (located both within and outside New England) who, in turn, supplied that energy to New England customers embodied in the goods and services consumed in the New England region. Of this grand total 4.3 quads, about .2 quad BTU was consumed outside New England in such energy sector uses as petroleum refining and natural gas transmission; an additional 1.3 quads BTU was transformed outside New England into other goods and services that were transported to New England and delivered to end-users in this region. As noted in the text, we have excluded this 1.5 quads BTU of indirect energy purchases by New Englanders from our inspection of energy requirements and uses in New England, and from our projections of future energy requirements. In fact, in 1975 New England was a net importer, directly and indirectly, of 4.1 quads BTU of primary energy from the energy surplus regions of the United States and the rest of the world.

natural gas into electricity for delivery to utility customers. More than 60 percent of electricity sold to New England users is generated in this way by thermal generating plants also located in New England (with the balance, just under 40 percent, generated by hydro and nuclear plants also located in New England). This transformation of primary energy materials (most of which are imported into New England) into electricity requires the consumption of fuels whose heat-value greatly exceeds the "intrinsic" heat-value of the electricity produced, and constitutes one of the significant internal uses of energy in New England. It is, therefore, included in our measures of energy requirements and uses in New England.

II. New England's Energy Balance in 1975

As a base point for our inspection of the demand for energy, we present the requirements for energy and uses in 1975, the most recent year for which relatively complete and internally-comparable data are available to us. Table 1a. and 1b. show data for New England in 1975, taken without modification from the FEDS Statistical Summary. Table 1a., "Primary Commercial Energy Sources," shows the total requirements of New England in 1975 satisfied by supply of customer-delivered products derived from coal, petroleum, natural gas and firewood plus hydro and nuclear production of electricity (measured by the amount of fossil fuels that would have been required to generate the electricity actually supplied by New England nuclear facilities.) Each of the energy sources is shown in units of the heat value (in BTU x 10^{12}) of the materials so different kinds of energy may be compared directly and aggregated. This table also shows the conversion of coal, petroleum products, and natural gas into electricity. The row titled "Electr. Generation" shows the amount of each fuel consumed in New England thermal plants (plus the hydro-nuclear generated electricity delivered to utilities for sale to customers); the row titled "transformation loss" measures the heat loss of electrical generation—the excess of the heat value of the fuels compared with the heat value (at 3412 BTU per kilowatt-hour) of the electricity produced. In 1975, 510 trillion BTU were consumed in this way, as heat loss of electrical generation in New England, but note that 178 trillion BTU of this total is the hypothetical loss that would have been incurred if the electricity generated at hydro-nuclear plants had been (contrary to the fact) generated in thermal facilities. The actual sales of electricity to customers by utilities appears in the column "Hydro/Nuc." for the row "Consumption: Other"; it represented 228 trillion BTU in 1975, measured net of heat loss, i.e. at the intrinsic heat value of electricity of 3412 BTU per Kilowatt-hour. This same row of Table 1a. also shows the amount of each other source of energy supplied to New England users for all purposes other than to generate electricity.

Table 1b. headed "Commercial Energy Uses," shows the consumption of each kind of energy by the sectors of the New England economy which have been studied by the Energy Congress Demand Committee, and the total uses of energy in New England in 1975. The transformation losses associated with electrical generation, described in the paragraph above, are shown in the first row of Table 1b. The 1975 uses of energy by the Residential, Commercial, Transportation, and Industrial sectors of the New England economy are shown in the next four rows, and the sum of all energy uses in the fifth row. In addition, a small part of these energy materials were consumed in New England for non-energy purposes, and these are included in the totals presented in the sixth and seventh rows of Table 1b. More complete details on the distribution of petroleum products to New England users in 1975 appear at the bottom of Table 1b, again expressed in units of the heat values of the products (BTU x 10^{12}).

New England arrived at the structure of energy requirements and uses shown in Tables 1a. and 1b. at the close of a decade of rapid growth in energy demand and of significant "switching" of energy sources. An appreciation of these trends may be gained by inspecting Tables 2a. and 2b., presented in the same format as we have described for the year 1975, showing "New England Growth Rates, 1965-1975." The entries in these two tables are the annual percentage rates of growth over the decade preceding 1975, for each of the sources of energy and for each use in New England. The sectoral rates of growth show, for example, the relatively great importance of the

Table 1a
Primary Commercial Energy Sources
New England: 1975 (BTU x 10^{12})

	Primary Commercial Energy Sources						Total	
	Coal	Crude	Petro. Prod.	Nat. Gas	Hydro/Nuc.	Total	Wood	Energy
Production Imports	—	—	—	—	—	—	—	—
Exports Bunkers	—	—	—	—	—	—	—	—
Stock add. (+)	—	—	—	—	—	—	—	—
Requirements = Apparent Consumption	40	71	2148	267	258	2784	11	2795
Electr. Generation	-35	—	-443	-3	-258	-739	—	—
Consumption:								
Transformation loss	24	—	306	2	178	510	—	—
Other	6	—	1704	264	228	2202	—	—

Table 1b
Commercial Energy Uses
New England: 1975 (BTU x 10^{12})

	Commercial Energy Uses					Wood	Total Energy
	Coal	Petrol.	Nat. Gas	Elec.	Total		
Trans. Losses Energy Sector	24	306	2	178	510	—	510
Households	1	393	146	90	629	6	635
Commercial	*	379	64	74	517	—	517
Transport	—	786	1	*	786	—	786
Industrial	5	148	54	65	272	5	277
All Energy Uses	30	2011	266	407	2713	11	2724
N.B. Non-Energy Uses	—	Asphalt 38 Feedst. 33	—	—	—	—	71
Total Uses	30	2081	266	407	2784	11	2795

Petrol, Products Used:	Electr. Utilities	Residential	Commercial	Transport	Industrial	Total
Gasoline	—	—	3	646	2	651
Distillate-Ker.	—	377	191	26	15	608
Diesel	11	—	—	29	7	47
Residual	432	—	183	19	110	744
LPG	—	16	2	1	15	33
Jet	—	—	—	65	—	65

Table 2a
New England: Growth Rates 1965-1975
(%)

	Primary Commercial Energy Sources						Total	
	Coal	Crude	Petro. Prod.	Nat. Gas	Hydro/Nuc.	Total	Wood	Energy
Production Imports	—	—	—	—	—	—	—	—
Exports Bunkers	—	—	—	—	—	—	—	—
Stock add. (+)	—	—	—	—	—	—	—	—
Requirements = Apparent Consumption	-18.1	-1.3	2.2	3.8	18.3	1.8	-2.8	1.8
Electr. Generation	-17.5	—	11.9	-14.3	18.3	5.2	—	—
Consumption:								
Transformation loss	-18.1	—	11.4	-14.9	17.7	4.7	—	—
Other	-20.0	—	0.7	4.5	6.1	1.3	—	—

Table 2b
New England: Growth Rates 1965-1975
(%)

	Commercial Energy Uses						Total
	Coal	Petrol.	Nat. Gas	Elec.	Total	Wood	Energy
Trans. Losses Energy Sector	-18.1	11.4	-14.9	17.7	4.7	—	4.7
Households	-17.7	-0.8	3.7	7.4	0.9	-3.9	0.9
Commercial	na	-0.9	9.4	8.4	0.6	—	0.6
Transport	na	3.2	na	na	3.2	—	3.2
Industrial	-19.7	-1.3	2.8	2.7	-1.1	-1.4	-1.1
All Energy Uses	-18.4	1.8	4.0	9.7	1.9	-2.8	1.9
N.B. Non-Energy Uses	—	-1.3	—	—	—	—	-1.3
Total Uses	-18.4	1.6	4.0	9.7	1.8	-2.8	1.8

rapid expansion in transportation uses of petroleum, the role of rising demand for electricity in the residential and commercial sectors, and the degree to which new nuclear-hydro generating capacity offset the potential rise in demand for petroleum to fire thermal electricity generating plants in New England. These data also show some persisting patterns of substitution, or "switching" among fuels sources in the 1965-75 decade. In general, other fuels were substituted for coal and wood, while electricity and natural gas were substituted for some uses of petroleum products.

Since we have selected 1975 as our base year of comparison—for inspection of past trends of energy demand in New England and for purposes of comparison with future estimates of energy requirements and uses—we should caution readers about the special characteristics of the year

1975. It was, in New England, a year of cyclically very low incomes and economic activity—in fact, the bottom year of the region's worst recession since the 1930's. It was, also, climatically an unusually warm year: it recorded 170 heating degree-days less than the average of all post-war years. We believe that comparisons with a decade earlier are most unlikely to overstate the trend rates of growth which characterized the New England pattern of energy demand in the 1960's and the first-half of the 1970's, including the first two years of adjustment to the shocks of embargo and sharp energy price increases (a trend of increases that began, actually, in 1971). Looking to the future, we must recognize that some increased demand for energy will be attributable to recover from the recession-year 1975—to restock inventories, fuel higher levels of economic activity and employment, and heat our homes at the higher average heating degree days of "normal" New England weather. To interpret the growth rates in the 1965-75 decade, we also note that over that period real per capita income in New England grew at only 1.7 percent annually (compared with 2.2 percent nationwide) and New England real disposable personal incomes grew at 2.47 percent each year (compared with 3.19 percent for the whole United States). Population growth in New England 1965-75 was 0.74 percent per year, below the national rate of 0.97 percent.

III. A Base-Line Projection to 1985

To compare the decades before and after 1975, we expect the economic and demographic setting in New England to change in at least four respects. First, we anticipate a recovery in the rate of New England economic activity in the 1975-1985 decade—from a year of recession to a period of stable growth. Second, we assume there will be a higher growth rate of economic activity in New England and a higher rate of growth of real disposable personal incomes in the 1975-1985 decade as compared with the earlier decade. Specifically, our working assumption is that personal disposable income, in real terms, will grow in New England at the national average of 3.2 percent annually (this corresponds, historically, to a growth rate of projection and overall economic activity of about 2.4 percent annually, a full percentage point above the rate of 1965-75). Third, we project population growth in the New England region for the decade 1975-1985 at just under 0.9 percent each year; this is about the national average, but higher than in the 1965-75 decade. Fourth, our assumption is that the relative prices of energy materials compared with everything else will be about the same in 1985 as it was in 1975; this contrasts with the 1965-1975 decade, when energy prices were declining relatively until 1971, then rose by several sharp steps to a peak in 1974/1975. Comparing the prices of the various sources of energy used in New England, our assumption is once again that the relative prices of 1985 will be about the same as in 1975; this contrasts with the 1965-1975 period, in which (among other things) the price of electricity declined relative to the price of other energy sources.

With full account taken of the cautions expressed about comparisons with the year 1975, and conscious of the changed expectations with respect to the economic and demographic trends in New England, we nonetheless believe it useful to project a base-line set of energy demand estimates for 1985, based on the simple assumption that the growth rates of energy uses in the 1965-1975 decade and the pattern of energy-sources "switching" of that decade persist until 1985. The base-line projections, shown in Tables 3a. and 3b. in the same format as the data for 1975, are not in any sense a forecast, but may serve as a means for making comparisons.

In Tables 3a. and 3b. the growth rates for each sectoral use of energy, and the patterns of substitution among fuels, of 1965-75 have been extended to 1985. The resultant demand for sectoral uses of electricity has been translated into requirements for petroleum to fuel thermal generation with the understanding that all additions to demand for electricity from now to 1985 are likely to be supplied in this way. The 1975 regional average heat rate of electricity generation is assumed to be the same in 1985.

The base-line projections for 1985 show that a very great increase in energy would be used in New England at the end of the hypothetical decade. It shows the powerful influence, contributing to the increased energy use, of the 1965-1975 trend in the transportation uses of petroleum

Table 3a
New England Baseline Projections: 1985
Continuation of 1965-1975 Trends
(in BTU × 10^{12})

	Primary Commercial Energy Sources						Total	
	Coal	Crude	Petro. Prod.	Nat. Gas	Hydro/Nuc.	Total	Wood	Energy
Production Imports	—	—	—	—	—	—	—	—
Export Bunkers	—	—	—	—	—	—	—	—
Stock add. (+)	—	—	—	—	—	—	—	—
Requirements = Apparent Consumption	36	71	3030	442	258	3836	8	3844
Electr. Generation	-35	—	-1114	- 3	-258	-1410	—	—
Consumption:								
Transformation loss	24	—	769	2	178	973	—	—
Other	1	—	1916	439	435	2791	—	—

Table 3b
New England Baseline Projections: 1985
Continuation of 1965-1975 Trends
(in BTU × 10^{12})

	Commercial Energy Uses						Total
	Coal	Petrol.	Nat. Gas	Elec.	Total	Wood	Energy
Trans. Losses Energy Sector	24	769	2	178	973	—	973
Households	*	363	210	184	757	4	761
Commercial	*	346	157	166	669	—	669
Transport	—	1077	1	*	1078	—	1078
Industrial	1	130	71	85	287	4	291
All Energy Uses	25	2685	441	613	3764	8	3772
N.B. Non-Energy Uses	—	Asphalt 38 Feedst. 33	—	—	—	—	71
Total Uses	25	2756	441	613	3836	8	3844

(dominantly, the growth of automotive travel), and in the thermal-generating fuels requirements associated with rising electricity consumption in residential and commercial establishments of New England. The base-line projection shows an increase in total energy requirements in New England at the end of the decade about 1,150 trillion BTU higher than in 1975; of this total increase, more than four fifths is attributable to higher demand for electricity by residential and commercial users and to increased demand for gasoline to fuel automobiles and trucks. As compared with 1975 demand, the base-line projection shows 290 trillion BTU more gasoline, 190 trillion BTU increased use of electricity in homes and commercial establishments, and 460 trillion BTU added heat loss associated with generating that electricity. These potential increased uses of energy in the future, together with the use of petroleum projects and natural gas to heat New England homes and

Table 4a
New England Demand Projections: 1985
Possible Combination of Alternatives[1]
(in BTU × 10^{12})

	Primary Commercial Energy Sources							Total
	Coal	Crude	Petro. Prod.	Nat. Gas	Hydro/Nuc.	Total	Wood	Energy
Production Imports	—	—	—	—	—	—	—	—
Exports Bunkers	—	—	—	—	—	—	—	—
Stock add.(+)	—	—	—	—	—	—	—	—
Requirements = Apparent Consumption	35	81	2500	341	258	3214	18	3232
Electr. Generation	-35	—	-782	- 3	-258	-1078	—	—
Consumption:								
Transformation loss	24	—	540	2	178	745	—	—
Other	*	—	1718	338	333	2389	—	—

[1] Low electricity use; residential space-heating options one/one; "Enforcement-slippage" case for automobile m.p.g. achieved.

Table 4b
New England Demand Projections: 1985
Possible Combination of Alternatives
(in BTU × 10^{12})

	Commercial Energy Uses						Total
	Coal	Petrol.	Nat. Gas	Elec.	Total	Wood	Energy
Trans. Losses Energy Sector	24	540	2	178	745	*	745
Households	*	318	184	127	629	9	638
Commercial	*	457	82	121	660	*	660
Transport	*	829	1	*	830	*	830
Industrial	*	115	71	85	271	9	280
All Energy Uses	24	2258	340	511	3133	18	3151
N.B. Non-Energy Uses	—	Alphalt 48 Feedst. 33	—	—	—	—	81
Total Uses	24	2339	340	511	3214	18	3232

commercial facilities, have been the focus of the Demand Committee studies and recommendations.

IV. New England Energy Demand in 1985

Uses of energy in New England have been changing throughout the decade of the 1970's, introducing alterations in the structure of energy requirements and in the pattern of substitution among energy sources. Particularly in the years since 1973, the introduction of new legislation and regulations, public awareness of the goals and means of conservation, and response to the higher

real costs to users of fuels and power have all effected significant changes in the trends of the 1965-1975 decade which we have employed to present the base-line projections of Tables 3a. and 3b.

In addition, recommendations of the New England Energy Congress are expected to accelerate, intensify, and extend the influences effecting reduction in the growth rate of energy use and the pattern of energy sources to meet the region's energy requirements. The reports of the Demand Committee sectoral studies and review of recommendations identify these added influences and specify the expected impact on energy use in 1985 by residential, commercial, transportation, and industrial sector users.

Tables 4a. and 4b., "New England Demand Projections: 1985" summarize the best guesses we are able to make concerning the level of energy requirements in New England in 1985. These estimates have been built up from the sector-by-sector studies and assessment of the expected impacts of existing influences and NEEC recommendations. In the same format as that used to present the data for 1975, the Tables 4a. and 4b. show our estimate of the most likely use of each source of energy in each sector. A few comments may help in interpreting these figures.

1) Transformation loss and electrical generation: the sectoral demand for electricity sums to an estimate of electricity sales; the 1975 heat rate of electrical generation is assumed to be the same in 1985.

2) Residential demand: the effects of improved weatherization and burner efficiency in residential space heating are described in the report on this sector; our best guess is that savings of distillate and natural gas can be achieved consistent with the first "option" for each source of home-heating fuels savings described in that report. Residential uses of electricity have grown erratically since the price of electricity began to move upward (in real terms and relative to other energy sources) in 1971. Our best guess for 1985 is based on the expectation that electricity demand by households may grow over the next six years (1979-1985) at about the rate of growth of 1971-1977 (3.4 percent annually), but this rate of growth may well decline as new measures for conservation and higher power prices appear in the coming six years. The effects of these influences may be to reduce the growth rate gradually—year by year to lower rates of growth compared with 1975-1977. If this is judged to be likely, the following shows the possible levels of residential demand for electricity in 1985 (to be compared with our "best guess" of 127 trillion BTU):

If we assume the growth of demand 1978-1985:	Electricity sales in 1985 to residential customers (in BTU × 10^{12})	1975-1985 Growth Rate (% per year)
remains at the 1975-77 rate	128	3.57
falls 0.05% each year 1977-1985	125	3.39
falls 0.1% each year 1977-1985	123	3.21
falls 0.2% each year 1977-1985	119	2.85
falls 0.3% each year 1977-1985	115	2.49

3) Commercial demand: we believe there is substantial potential for reducing space-heating and lighting requirements in this sector in the latter 1980's and 1990's; the recommendations of the Demand Committee report work primarily through new construction of public and private structures. In the years immediately ahead, however, we anticipate a reduced rate of demand growth, as compared with past periods, chiefly as a result of a lower rate of expansion of governmental activities in New England.

4) Transportation demand: Very significant effect of legislated higher fuel efficiency standards for automobiles and light trucks, and more modest impact from other

recommended measures for modal shifts and reduced traffic in the 1975-1985 period, are described in the sector report. Several alternative scenarios for fuel-saving are also described in that report.

5) Industrial demand: we expect a continuation of past trends reducing the use of energy in New England industries, with particular influence from the expansion in New England of high technology industries with their characteristic low energy requirement per dollar of output.

Taken in the aggregate, our best guess about the level and the structure of energy demand in 1985 show significant differences when compared with the base-line projections of Tables 3a. and 3b. We expect a significantly lower total level of energy requirements, but about the same overall fuel mix. We expect a much reduced growth of energy demand in the residential and in the transportation sectors. Our studies have shown that the growth rate of total energy use in New England, 1.8 percent annually in the decade 1965-1975, would correspond to a 3.3 percent growth per year (as in the "base-line" projections of Tables 3a. and 3b.) when account is taken of the current requirement to produce all additional electricity by thermal generation. Tables 4a. and 4b. document our reasons for believing that the growth rate of energy use in New England can and very likely will fall to about 1.5 percent annual rate in the decade 1975-1985 if the NEEC recommendations can be implemented to reinforce other influences reducing energy demand in this region.

RESIDENTIAL SUBCOMMITTEE REPORT

Introduction

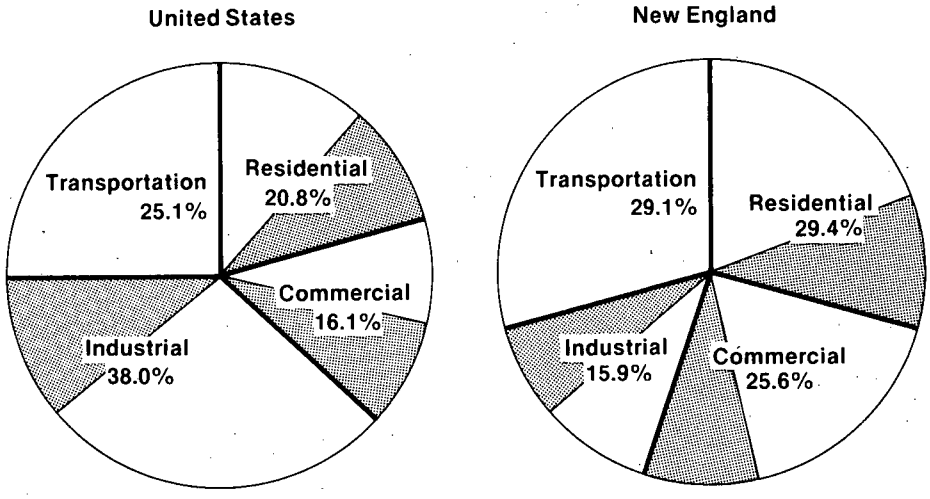
Energy use in the residential sector comprises 29 percent of the total use in New England compared with 20 percent of the total use in the United States. The reason for the proportionately larger residential consumption in New England lies in the heavy heating demand for the region. In fact, 60 percent of the energy used in the residential sector is for heating homes. Oil is the primary type of energy used for this purpose, with gas and electricity contributing in much smaller quantities (see Figs. 1 and 2).

The heavy reliance on these three energy types by the residential sector were of concern to the committee for several reasons. First, oil, gas, and electricity are diminishing resources. (Electricity in New England is largely generated by oil-fired steam turbines and secondarily by nuclear power; both oil and the uranium-235 fuel for nuclear reactors are in limited supplies.) Second, the cost of these energy types is the highest in the country. Third, these energy types are imported either from other regions in the country or from foreign countries, thereby leading to a net flow of capital out of New England. Fourth, the impact on low and moderate income families of rising energy prices is intense. For these reasons, the committee felt it was important to find ways to reduce the overall energy demand and, in particular, the heating demand for these energy types in the residential sector. The goal of the subcommittee was to develop legislative proposals and recommendations which would reduce demand and which could be implemented rapidly on both a national and regional basis.

Unfortunately, time did not allow the committee to perform a thorough analysis of conservation measures which affect electrical consumption. Thus we recommend that further work be carried out in this area.

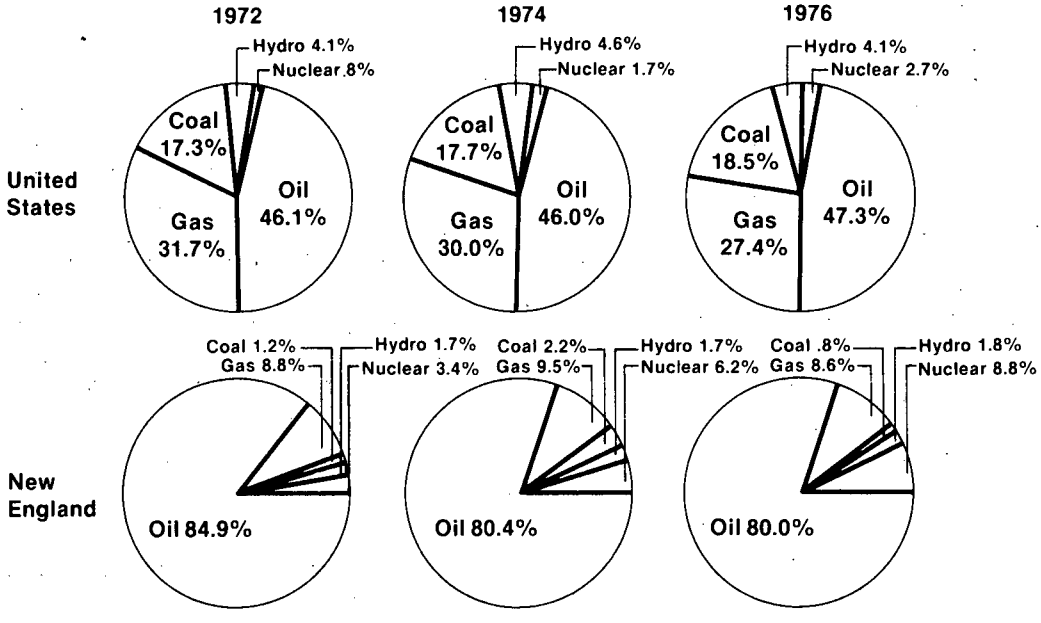
The report itself is broken into five sections. The first section outlines population projections to the year 2000. The demand projections in the early part of this report are based upon these population statistics, though at the time of this writing we feel that these population growth figures are probably high. The housing stock figures given in the third section of this report are different

FIGURE 1
Energy Consumption In 1975
By Sector



Source: DOE-Federal Energy Data System-February 1978
Electricity, U.S. 28.9% and N.E. 26.2%, including generation and transmission losses, allocated to end use sectors as shown by shading.

FIGURE 2
Total Energy Consumption By Source
United States and New England - % Of Total



Sources: U.S.-DOE Monthly Energy Review
N.E.-DOE Boston

from these population figures, and are based on a set of figures which were incorporated in the New England Energy Congress/New England Regional Commission/Massachusetts Audubon Society (NEEC/NERCOM/MAS) Housing Stock Profile computer model.

The data base of the NEEC/NERCOM/MAS model differs from the Federal Energy Data Systems (FEDS) statistical summary source employed elsewhere in the work of the Demand Committee. The units in which home heating fuels are expressed apparently differ from the units in which fuels are measured for presentation employing FEDS data; we have projected future requirements for space heating fuels utilizing results of the NEEC/NERCOM/MAS model, translated into measurement units consistent witb the FEDS data.

The second section of the report lists all the current and pending energy legislation in New England and includes a brief synopsis of the National Energy Act provisions which affect the residential sector. The third section of the report outlines the current housing stock, listing a number of possible retrofit options and projecting the impact of these options to the year 2000. The fourth section examines the impact of energy prices on the low income sector, reviews energy consumption patterns, and describes the various energy programs currently being implemented in this sector. The last section outlines areas in which further studies are needed.

Demand Projections

The total residential consumption in the future will be dependent on the number of households. In turn, the number of households will be dependent on the future population and on the size of the families. Projections of these latter factors indicate a rising population and a decreasing size of the family unit; both will contribute to an increase in the number of dwelling units in New England.

Table 5 displays the population figures, number of persons per household, and number of households through 1977, and projects these numbers through 2000. In 1977 there were 12.326 million people in New England, 444,000 (3.73%) more than in 1970. Population increased at a 0.53% compound growth rate for the period 1960-77. During this same period, the size of families decreased from an average of 3.26 to an average of 2.95 persons per household. The 1985 population is projected to be 13.275 million, an increase of 949,000, or 7.7%. Family size is projected to decrease to an average of 2.60 persons per household.

Current Legislation

The following is a listing of both existing and pending legislation on the state and federal level which affects residential energy demand.

I. Connecticut

Existing Legislation

1) Property tax exemptions for solar and wind systems (until 1991).
2) Sales tax exemptions for solar energy systems (until 1982).
3) Thermal standards for all new and substantially renovated buildings (modified ASHRAE 90-75). Lighting standards are in draft form — Connecticut already has legislative authority to implement lighting standards.

Table 5
Population, Persons Per Household, Households

	1960	1970	1971	1972	1973	1974	1975	1976	1977
Population (Thousands)									
Connecticut	2,544	3,041	3,077	3,080	3,080	3,086	3,095	3,117	3,162
Maine	975	997	1,010	1,026	1,039	1,049	1,056	1,072	1,071
Massachusetts	5,160	5,706	5,768	5,796	5,799	5,793	5,818	5,809	5,839
New Hampshire	609	742	758	774	794	803	818	822	841
Rhode Island	855	951	958	969	967	938	927	927	929
Vermont	389	445	453	460	466	468	473	476	484
New England Total	10,532	11,882	12,024	12,105	12,145	12,142	12,187	12,223	12,326
Persons (Per Household)									
Connecticut		3.26	3.23	3.15	3.10	3.06	3.01	3.02	2.98
Maine		3.22	3.23	3.18	3.13	3.11	3.04	3.01	2.98
Massachusetts		3.24	3.20	3.15	3.09	3.04	3.01	2.95	2.93
New Hampshire		3.30	3.23	3.17	3.13	3.10	3.06	2.98	2.98
Rhode Island		3.26	3.21	3.18	3.10	3.06	2.97	2.93	2.91
Vermont		3.38	3.31	3.24	3.19	3.12	3.08	3.03	3.01
Weighted Average		3.26	3.22	3.16	3.10	3.06	3.01	2.96	2.95
Households (Thousands)									
Connecticut		933	953	977	995	1,010	1,029	1,053	1,061
Maine		303	313	323	332	337	347	356	360
Massachusetts		1,756	1,800	1,840	1,879	1,906	1,936	1,971	1,990
New Hampshire		225	235	244	254	261	267	275	282
Rhode Island		292	298	305	312	307	312	316	319
Vermont		132	137	142	146	150	153	157	161
New England Total		3,641	3,736	3,831	3,918	3,971	4,044	4,128	4,173

(cont.)

	1978	1979	1980	1981	1982	1983	1984	1985	1990	1995	2000
Population (Thousands)											
CT	3,216	3,270	3,326	3,347	3,369	3,391	3,413	3,435	3,534	3,636	3,741
MA	1,083	1,095	1,107	1,115	1,122	1,130	1,138	1,146	1,171	1,196	1,222
MA	5,882	5,926	5,970	6,006	6,043	6,079	6,116	6,153	6,303	6,457	6,614
NH	866	892	918	938	958	978	999	1,020	1,108	1,203	1,306
RI	934	938	943	949	954	960	956	972	992	1,012	1,033
VT	496	509	522	527	533	538	543	549	568	587	607
N.E. Total	12,477	12,630	12,786	12,882	12,979	13,076	13,175	13,275	13,676	14,091	14,523
Persons Per Household											
CT	2.94	2.91	2.87	2.83	2.80	2.76	2.73	2.69	2.61	2.52	2.44
ME	2.95	2.92	2.89	2.85	2.82	2.79	2.76	2.73	2.65	2.58	2.51
MA	2.86	2.81	2.77	2.73	2.69	2.64	2.60	2.56	2.46	2.37	2.27
NH	2.88	2.83	2.78	2.74	2.69	2.65	2.60	2.58	2.45	2.35	2.26
RI	2.83	2.78	2.73	2.68	2.63	2.59	2.54	2.50	2.39	2.37	2.35
VT	2.92	2.87	2.82	2.77	2.72	2.67	2.62	2.57	2.46	2.35	2.24
Weighted Avg.	2.89	2.85	2.81	2.76	2.73	2.68	2.64	2.60	2.51	2.42	2.33
Households (Thousands)											
CT	1,094	1,124	1,159	1,183	1,203	1,229	1,250	1,277	1,354	1,443	1,533
ME	367	375	383	391	398	405	412	420	442	464	437
MA	2,057	2,109	2,155	2,200	2,246	2,303	2,352	2,404	2,562	2,724	2,914
NH	301	315	330	341	356	369	384	398	452	512	578
RI	330	337	345	358	363	371	380	389	415	427	440
VT	170	177	185	190	196	201	207	214	231	250	271
N.E. Total	4,319	4,437	4,557	4,663	4,762	4,878	4,985	5,102	5,456	5,850	6,223

Source: G. Taylor, Connecticut Natural Gas

4) Allowance made for municipalities to include energy considerations in zoning, subdivisions, and other local planning decisions. (Energy considerations include conservation, alternative energy, energy efficient settlement patterns.

Pending Legislation (1979 Session)

1) Oil burner inspection — require completion of a standardized form after inspection.
2) Home insulation levels must be disclosed when advertising a home for sale. R value in the ceilings required for all homes, R value in walls required for new homes.
3) Stricter enforcement of the 55 mph speed limit. Establishment of a uniform penalty.
4) Exempt van pools from regulation.
5) Prohibit the inclusion of Construction Work in Progress (CWIP) in the rate base.

II. Maine

Existing Legislation

1) Property tax exemptions for solar heating equipment for five years after installation.
2) Sales tax exemptions for solar energy systems.
3) Establishment of a state solar hot water program ($16,000 for 44 grants).
4) Consumer protection legislation for insulation.
5) Sales tax exemption for the first 750 KW electricity used.
6) Thermal and lighting standards for public buildings (ASHRAE 90-75).
7) Requirement that no public building or public school in excess of 5,000 square feet be built without first performing a life cycle cost analysis.
8) Voters approved a $10 million bond issue for energy conservation improvements for state-owned buildings and schools.

Pending Legislation (1979 Session)

1) Thermal and lighting standards for buildings other than public buildings. There is presently no statewide code; of 156 municipalities that have some code or regulation, no city or town is known to have energy-related standards incorporated into the code. The State Energy Office is proposing ASHRAE 90-75 and HUD Minimum Property Standards for new and substantially renovated buildings.
2) Appropriate $100,000 for alternate energy projects to be conducted by the state energy office.
3) Prohibit the inclusion of Construction Work in Progress (CWIP) in the rate base.
4) Lower the customer charge for customers of Central Maine Power and Light Company.

III. Massachusetts

Existing Legislation

1) Property tax exemption for solar or wind energy devices.
2) Life cycle cost estimate for all new state and local building construction or additions which add 10% to the gross floor space and whose construction costs exceed $25,000.
3) Requirement that state buildings maximize exposure to the sun.
4) Authorization of state-chartered savings banks, co-operative banks, credit unions, and trust companies to make loans to finance the purchase and installation of solar or wind-powered systems or heat pumps for up to ten years if the loan is secured by a mortgage on the subject real estate. Maximum loans are $5,000 for a savings bank, $12,000 for a co-operative bank, $9,000 for a credit union, and $7,000 for a trust company, if, in all cases, at least $2,000 of such loan is spent on the purchase or installation of the solar and wind system.
5) Sales tax exemptions on alternatives — solar, wind powered or heat pump systems — used as primary or auxiliary power system for heating or otherwise supplying the energy needs of an individual's principal residence.
6) Thermal standards for new and substantially renovated buildings (ASHRAE 90-75) and lighting standards for all new buildings except single family dwellings.
7) Establishment of the Massachusetts Home Mortgage Finance Agency which makes loans to mortgage lenders and banks to contract low and moderate income family rental housing. (Since this entity is a public corporation and receives state funding, it could be required to invest in alternative energy.)

Pending Legislation (1979 Session)

1) Truth in Energy — seller or leasee of a house must furnish a copy of utility bills.
2) Prohibit the inclusion of Construction Work in Progress (CWIP) in the rate base.
3) Require inspections for the installation of wood stoves.

IV. New Hampshire

Existing Legislation

1) Property tax exemptions for solar heating and cooling systems.
2) Requirement that New Hampshire utilities buy back excess power generated by small hydro.

Pending Legislation (1979 Session)

1) Establish thermal and lighting standards for all new buildings based on the Model Code for Energy Conservation (modified ASHRAE 90-75).
2) Prohibit the inclusion of Construction Work in Progress (CWIP) in the rate base.
3) Require inspections for the installation of wood stoves.

V. Rhode Island

Existing Legislation

1) Property tax exemption for solar systems.
2) Requirement that oil produced deliveries be metered.
3) Thermal standards (ASHRAE 90-75) for all new and renovated buildings. Voluntary lighting standards for all buildings.
4) Sales tax exemption on personal property used in exploration for or production of offshore oil and gas.

Pending Legislation (1979 Session)

1) Establish a lighting standard.
2) Require the state to enter into life cycle cost analysis for any building the state intends to purchase or contract.
3) Allow installation of wood stoves in commercial buildings. Presently the Rhode Island fire code disallows the installation of wood stoves in commercial buildings.
4) Prohibit the inclusion of Construction Work in Progress (CWIP) in the rate base.
5) Income tax credit to cover the costs of insulation and solar systems.
6) Resolution: Adopt lower rate structures for off-peak electricity.

VI. Vermont

Existing Legislation

1) Allowance for property tax exemptions for alternative energy systems to be adopted by cities or towns at the annual town meeting.
2) Income tax exemption for renewable energy systems — 25% credit up to $1,000 for residences on the installed cost of the system (until 1983).
3) Establishment of the Vermont Housing Finance Agency which provides low interest loans for energy-related improvements to low and middle income groups.
4) Allowance for cities and towns to appoint a town energy coordinator at the annual town meeting.
5) Allocation of $124,000 to conduct an inventory of the state's forestlands.
6) Requirement of legislative approval for the construction of nuclear plants.

Pending Legislation (1979 Session)

1) Establish thermal and lighting standards for all new buildings based on ASHRAE 90-75.
2) Prohibit the sale or installation of electric resistance heating in all new buildings.
3) Prohibit the inclusion of Construction Work in Progress (CWIP) in the rate base.
4) Appropriate $20,000 to study the potential for wind energy in Vermont.
5) Require all new gas appliances to be pilotless.

VII. Federal

Existing Legislation

1) Public Law 94-163 Energy Policy and Conservation Act. Provides money to each of the fifty states to develop and implement state energy conservation plans. Each state must:

   A) Be designed to save an amount of energy equal to 5% or more of the state's projected 1980 demand, and

   B) Contain programs to establish thermal and lighting standards for new and renovated buildings, right-turn-on-red legislation, energy procurement policies for state and local governments, and a car pooling-van pooling-mass transit program.

2) Public Law 94-385 Energy Conservation and Production Act. Amends previously enacted energy legislation, and provides money to states for implementation of Supplemental State Energy Conservation Plans.

3) National Energy Act of 1978

   A) Requires electric utilities to offer energy audits to their customers to identify appropriate energy conservation and alternative energy measures and to arrange the financing and installation of any such measures.

   B) Extends through 1980 the Department of Energy (DOE) low income weatherization program.

   C) Provides support for loans by the Government National Mortgage Association (GNMA) of up to $8000 for the purchase and installation of solar heating and cooling equipment in residences.

   D) Establishes federally supported home improvement loans by GNMA for energy conservation measures aimed at elderly and moderate income families.

   E) Mandates that DOE establish energy efficiency standards for thirteen categories of major home appliances, including refrigerators and air conditioning units.

   F) Authorizes the Department of Housing and Urban Development (HUD) to establish grants and standards for energy conservation in federally assisted housing.

   G) Authorizes HUD to insure loans for conservation improvements in multi-family housing.

   H) Establishes eleven standards on rate design, including time-of-day rates, which must be considered by each state regulatory agency for their conservation potential and be adopted if the design induces conservation.

   I) Establishes loan programs to aid development of small hydro-electric projects.

   J) Provides for gradual deregulation of natural gas.

   K) Gives a non-refundable income tax credit for residential insulation and energy conservation measures of up to $300 or 15% of the first $2000 expended.

   L) Gives a non-refundable income tax credit for residential installation of solar or wind equipment of up to a total credit of $2200 covering $10,000 of expenditures.

The Housing Stock of New England[1]

Energy use in the residential sector comprises 29 percent of the total use in New England compared with 20 percent of the total use in the United States. The reason for the proportionately larger residential consumption in New England lies in the heavy heating demand for the region. In fact, 60 percent of the energy used in the residential sector is for heating homes. Oil is the primary fuel used for this purpose, heating over seventy percent of all New England households, with gas and electricity contributing in much smaller quantities (20 and 10 percent respectively).

I. The REFORM Model

Since space heating accounts for such a large share of residential demand, the Demand Committee requested that an estimate be made of the heating demand, both today (1978) and in 2000 and how much potential there is for conservation in this area. The REFORM model, owned by the New England Regional Commission, was used for this analysis. This model, first developed by Richard Daifuku, disaggregates the New England housing stock into five basic housing types: single family detached homes, single family attached homes (consisting of 3 units), multi-family low-rise residences (10 units), multi-family high-rise residences (60 units), and mobile homes. Within each of these housing types, the stock is further disaggregated by age and heating fuel used. Table 6 displays the number of housing units that fall within each category of the housing stock. (There are a total of 33 different housing categories.)

Table 6
Projected 1978 New England Housing Inventory
(1000 Units)

Category		SFD	SFA	MFLR	MFHR	MOBILE	
1965-1978	E	198	97	53	21	25	
1965-1978	D	271	173	69	112	73	
1965-1978	M	79	53	21	27	9	
1940-1965	D	586	145	73	0	0	
1940-1965	M	179	45	26	0	0	
Pre 1940 Unins	D	576	315	99	0	0	
Pre 1940 Unins	M	163	95	35	0	0	
Pre 1940 Ins	D	200	123	43	0	0	
Pre 1940 Ins	M	58	36	14	0	0	
Total		2310	1082	433	160	107	4092

Code For Tables 6, 7, 8 & 13

INS - insulated
E - electrically heated
D - distillate oil heated
M - methane gas heated
F - fossil fuel heated
UNINS - uninsulated

SFD - single family detached house
SFA - single family attached house
MFLR - multi-family low rise residence
MFHR - multi-family high rise residence
MOBILE - mobile home

Source: Residential Energy Forecasting Model (REFORM), New England Energy Management Information System (NEEMIS).

[1]The model developed for this analysis has been titled the New England Energy Congress/New England Regional Commission/Massachusetts Audubon Society Housing Stock Profile (NEEC/NERCOM/MAS)

Table 7
Estimates of New England Housing Stock Characteristics

Category	Walls	Ceiling	Ground Floor	% Storm Windows	% Storm Doors	% Weather-Stripping
SFD, SFA, MFLR						
Post-1965						
Electric	R-7	R-15	R-0	60*	60	30
Fossil	R-7	R-12	R-0	45*	50	25
1940-1965	R-3	R-7	R-0	65	65	25
Pre 1940						
Ins. (20%)	R-11	R-9	R-0	70	70	25
Unins. (80%)	R-0	R-0	R-0	70	70	25
MFHR						
Electric	R-4	R-7	—	30*	70	25
Fossil	R-0	R-3	—	20*	70	20
Mobile						
Electric	R-7	R-11	R-11	80*	80	80
Fossil	R-7	R-11	R-11	70*	50	30

* Adjusted for thermopane windows

Source: Massachusetts Audubon Society, February 1979.

II. Today's Weatherization Characteristics

Once the numbers for each housing category are estimated, the question then has to be addressed regarding the weatherization levels of each residence within the category. The REFORM model estimates these levels. However, after talking to insulators, energy auditors and building contractors, staff persons performing the housing analysis came to the conclusion that the REFORM levels are too optimistic. As an example, ground floor insulation is assumed to be in many residences; members of the housing-related industry, however, claim that they rarely, if ever, find such insulation. Therefore, the staff assembled its own estimates of weatherization levels based upon the conversations mentioned previously. These estimates are shown in Table 7 and they were used to calculate an annual heating demand for each type of residence. This demand was then multiplied by the number of units of that residence type to yield the total heating demand for New England, broken out by fuel type used.

III. Conservation Potential

Once the current space heating consumption was estimated, the staff then turned to analyzing the conservation potential in this area. Two means of realizing this potential were studied: increasing the weatherization levels in the current stock, and improving the heating system efficiencies of the stock. To analyze the effect of increasing weatherization levels, the staff developed four improved weatherization programs, referred to as Options 1 through 4, which assumed that each building owner invested a sum of money (which increased with each option) into the weatherization methods which had the most return on his investment. For example, for single family detached dwellings, Option 1 assumed an investment of $250 for both labor and materials, Option 2 of $500, Option 3 of $750 and Option 4 of $1000. (For an "average" house, an investment of $250 would buy storm windows and weatherstripping, $500 would buy ceiling

Table 8

Capital Investment For the Four Improved Weatherization Programs

Weatherization Program	Type of Housing				
	SFD	SFA	MFLR	MFHR	MOBILE
Option 1	$ 250	$ 500	$1,500	$ 5,000	$125
Option 2	500	1,000	3,000	10,000	250
Option 3	750	1,500	4,500	15,000	375
Option 4	1,000	2,000	6,000	20,000	500

Source: Massachusetts Audubon Society, September, 1978.

Table 9

Estimated 1978 New England Space Heating Fuel Demand
Alternative Weatherization Cases

	Electricity		Distillate		Natural Gas		Total	Total Cost	% Savings	Annual Dollar
	KWH (10^9)	BTU (10^{12})	Gals. (10^9)	BTU (10^{12})	Cu.Ft. (10^9)	BTU (10^{12})	BTU (10^{12})	Dollars (10^6)	over Base Case	Fuel Savings (10^6)
NEEC Base	8.5	29	4.1	561	132	132	722	—	—	—
Option 1	8.0	27	3.7	503	118	118	648	900	10	270
Option 2	7.3	25	3.4	458	107	107	590	1600	18	500
Option 3	6.8	23	3.1	419	97	97	539	2400	25	700
Option 4	5.7	19	2.9	389	91	91	499	3600	31	880
Ideal	5.2	17	1.9	257	59	59	333	7500	54	1510

Source: Massachusetts Audubon Society, February, 1979.

insulation, and $1000 would buy wall insulation.) The levels of investment assumed for a building within each housing type are shown in Table 8. A fifth weatherization program, the Ideal Case, was also developed to represent weatherizing to "optimal" standards; that is, R-19 floors, R-11 walls, R-38 ceilings, and 100 percent storm windows, storm doors, and weatherstripping. Options 1 through 4 and the Ideal Case were then run through the REFORM program. Table 9 shows the results of these runs. The estimated fuel consumption is shown for the current "base" case and for each of the improved cases, followed by the cost of and the fuel savings realized by each improved case. One can see that by weatherizing maximally, the REFORM model predicts that more than 50 percent of all energy consumed for heat may be saved.

To analyze the effect of improving heating system efficiencies, the staff first estimated that the current average seasonal efficiency of an oil-heated system is 50 percent, of a gas-heated system is 60 percent, and of an electrically-heated system is 95 percent. (The efficiency of an oil-heated system is assumed to be lower than gas because the former system tends to be older on average, and thus in poorer repair.) Three improvement programs were then developed. Option 1 assumed that each home that does not have an annual heating system service contract (about 50 percent of all New England homes) started a maintenance program, costing an estimated $30 annually; the average efficiencies of gas- and oil-heated systems were estimated to rise to 62.5 and 52.5 percent respectively. Option 3 assumed that all oil-heated homes were retrofitted with new burners and boilers, at a cost of $1850, and all gas-heated homes with stack dampers and pilotless ignition systems, at a cost of $350. Efficiencies were estimated to rise to 80 percent for both gas- and oil-heated homes under this option, an upper limit to what can be realized in New England. Finally,

Table 10

Estimated 1978 New England Space Heating Demand
Alternative Heating System Efficiency Cases

	Electricity		Distillate		Natural Gas		Total	Total Cost	% Savings	Annual Dollar
	KWH (10^9)	BTU (10^{12})	Gals. (10^9)	BTU (10^{12})	Cu.Ft. (10^9)	BTU (10^{12})	BTU (10^{12})	Dollars (10^6)	over Base Case	Fuel Savings (10^6)
NEEC Base	8.5	29	4.1	561	132	132	722	—	—	—
Option 1	8.5	29	3.9	505	127	127	661	50 (annually)	8	120
Option 2	8.5	29	3.2	403	113	113	545	2400	24	520
Option 3	8.5	29	2.6	322	99	99	450	4900	38	860

NEEC Base Efficiency: Gas - 60%; Oil - 50%

Option 1 Efficiency: Gas - 62.5%; Oil - 52.5%. (It was assumed that the remaining homes that do not have an annual heating system service contract, approximately half of all homes, started an annual maintenance program.)

Option 2 Efficiency: Gas - 70%; Oil - 65%. (It was assumed that half of all existing homes were retrofitted to Option 3 standards.)

Option 3 Efficiency: Gas - 80%; Oil - 80%. (It was assumed that all oil-heated homes were retrofitted with a new boiler and burner at a cost of $1,850, and all gas-heated homes were retrofitted with stack dampers and a pilotless ignition system at a cost of $350. These efficiencies are considered uppermost estimates. Some may consider them to be too high.)

Source: Massachusetts Audubon Society, February, 1979.

Option 2 assumed that only half of all present homes were retrofitted to Option 3 standards with the resultant seasonal efficiencies of 70 percent for gas and 65 percent for oil. Table 10 shows the results of this analysis, listing the fuel consumption for the "base" case and the improved cases followed by the cost of and the fuel savings realized by each improved case. (In calculating the cost of the improvement programs, it was assumed that individual units in a single-family attached house had their own furnaces, whereas units in multi-family residences did not.) One should note that by improving heating system efficiencies to their fullest extent, over one-third fuel savings may be achieved.

Table 11 shows the results of combining both the weatherization and heating system efficiency improvement programs. The total fuel consumption is shown above each slash, and the present savings below the slash. The total fuel consumption is less than that for each option alone with maximum savings of more than 70 percent. One should note, however, that the payback for a combination of the two programs is greater than for each of the programs alone because the savings for the combination is less than the sum of the savings realized by each program alone.

IV. Limitations of the REFORM Model

The numbers just described cannot be considered accurately representative of the conservation potential in the residential space heating sector because they were derived from a model rather than an actual sampling. All models tend to simplify reality. For example, there are obviously more than the 33 different types of residential buildings assumed in the REFORM program. In addition, the REFORM program had some problems that could not be corrected. For example, it assumed that insulation levels could not be improved in high rise and mobile housing; however, since the heating demand of each of these housing types account for only one percent of the total demand for the region, this problem was not considered important. The REFORM program also had some problems in calculating the unit heat demand for a given housing type; this problem may cause as much as a ten percent error in the final calculations. In any case, no claim is being made that the figures developed truly predict the conservation potential of the region. They do, however, establish that there is a large potential there.

Table 11
Estimated 1978 New England Space Heating Demand
Combining Alternative Weatherization and Heating System Efficiency Cases

Alternative Heating Systems Cases	Alternative Weatherization Cases				
	Option 1	Option 2	Option 3	Option 4	Ideal
Option 1	594[1] / 18%[2]	540 / 25%	494 / 32%	458 / 36%	305 / 58%
Option 2	490 / 32%	446 / 38%	407 / 44%	377 / 48%	251 / 65%
Option 3	404 / 44%	368 / 49%	336 / 54%	311 / 57%	207 / 71%

[1] Total Energy Consumption (BTUs × 10^{12}) / [2] % Savings over Base Case

Source: Massachusetts Audubon Society, February, 1979

V. Space Heating in 2000

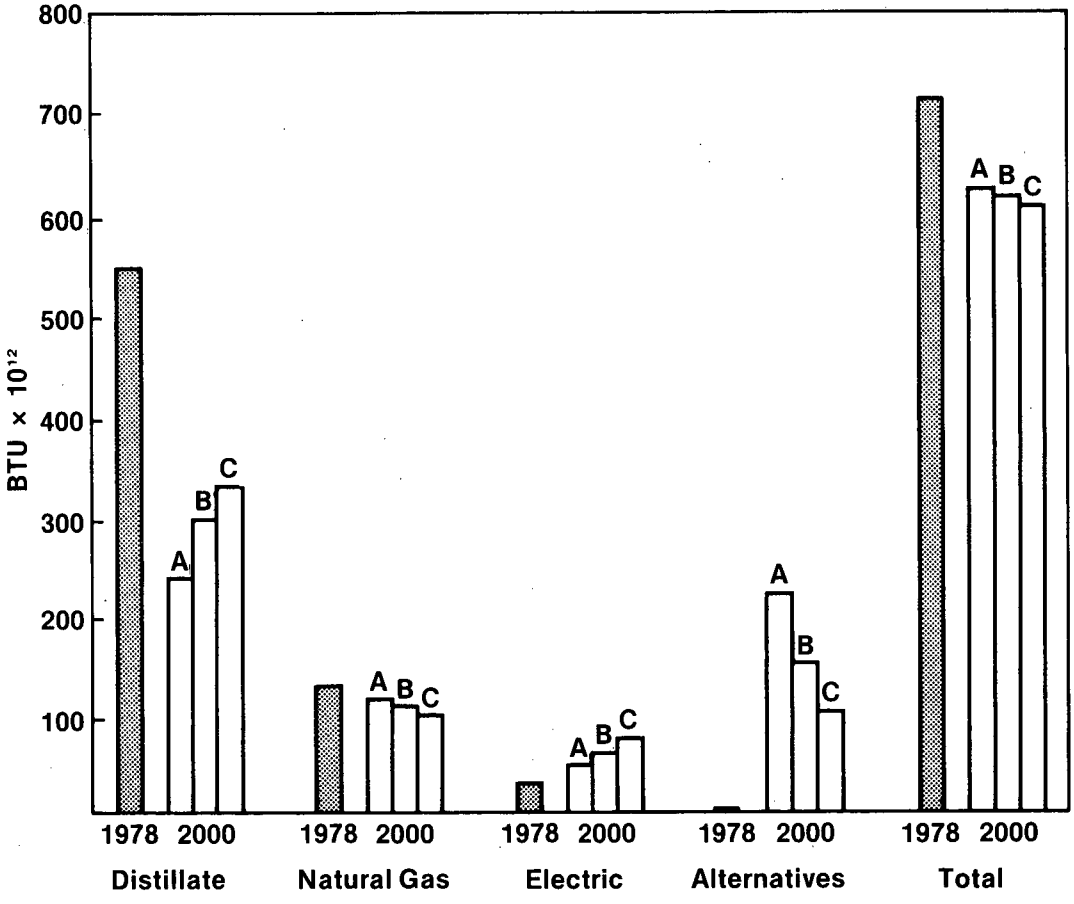
The REFORM model was also used to give the Demand Committee an idea of what space heating in the year 2000 will be like. The results of this analysis are shown both in Table 12 and in Figure 3. Several assumptions went into this analysis. First, the total housing stock was assumed to increase 35 percent between 1978 and 2000 while pre-1978 units decreased at an average of one half percent annually. The character of the 2000 New England housing stock is shown in Table 13. Second, all buildings constructed before 1978 were assumed to be weatherized to Weatherization Option 2 standards. (For example, under this scheme, all single family detached homes would be weatherized with an investment of $500.) All buildings constructed since 1978 were assumed to be weatherized to 1978 building code energy standards, specifically R-24 ceilings, R-11 Walls, R-19 floors, and 100 percent storm windows, storm doors, and weatherstripping. Finally, heating system efficiencies were assumed to rise to 65 percent for gas, 55 percent for oil and remain at 95 percent for electricity; alternative fuels, that is wood and solar, were assumed to have 55 percent efficiencies.

The three cases listed under the 2000 numbers cover three different types of fuel mixes. Case A assumes the successful implementation of Energy Congress proposals, that is increased use of wood, and solar. Case C assumes a large increase in electrical space heating with little use of wood or solar. Case B lies between these two cases.

VI. Implications of 2000 Model

As one can see from both Table 12 and Figure 3, under the model developed for the year 2000, total residential space heating consumption for New England actually *drops* between 1978 and 2000. (The total consumption figures also appear to drop as one moves from Case A to Case C; however, these figures are deceptive because while consumption at home decreases, consumption for the region increases due to the additional fuel that must be consumed at less than 30 percent efficiency to provide the added electricity for space heating mandated in Case C.) In addition, oil consumption drops dramatically, by as much as 56 percent if a Case A future is followed. Electrical consumption for space heating, on the other hand, *grows* by as much as 140

FIGURE 3
Estimated Residential Space Heating Requirements



Refer to paragraph 8 *Implications of 2000 Model* at the beginning of this chapter.

Source: Massachusetts Audubon Society, February, 1979

Table 12
Estimated Residential Space Heating Requirements
1978 vs. 2000

		Electricity		Distillate		Natural Gas		Alternatives	Total
		kwh (10^9)	BTU (10^{12})	Gals. (10^9)	BTU (10^{12})	Cu.Ft. (10^9)	BTU (10^{12})	BTU (10^{12})	BTU (10^{12})
1978		8.5	29	4.1	511	132	132	0	722
2000	Case A	13.8	47	1.8	242	111	111	220*	620
2000	Case B	16.9	58	2.2	299	107	107	150*	614
2000	Case C	21.3	73	2.5	333	98	98	100*	604

* Contribution of Alternative Fuels to 2000 Fuel Mix (Based on Supply Committee Estimates)

	Wood (10^{12} BTU)	Solar (10^{12} BTU)
Case A	170	50
Case B	130	20
Case C	90	10

Source: Massachusetts Audubon Society, February, 1979.

percent if a Case C future is followed. The major point to be recognized, however, is this: a fairly modest program of increasing the overall thermal performance of the New England housing stock, both by increasing weatherization levels and heating systems efficiencies, can lead to a reduction in space heating demand in 2000.

Energy Programs Affecting The Low Income Sector

Following the release of the *Preliminary Report* in December, a subcommittee was organized within the Demand Committee to examine the impact of energy policy on low and moderate income groups. This subcommittee developed a number of recommendations specifically aimed at mitigating the impact of energy prices on low and middle income consumers. These recommendations were presented to the full Demand Committee and were voted on. Those that passed appear at the beginning of the committee's report.

In addition, the subcommittee compiled information on energy consumption patterns in the region and energy programs presently being implemented within the low income community. A review of this information appears in this section.

This section is divided into three parts. The first contains a summary of a report prepared by the Grier Partnership entitled *The New England Energy Consumer*. The Grier Partnership paper reviews statistical data on energy consumption patterns in the region.

The second contains a "descriptive essay" on the Low Income Weatherization Program in New England. Much of the information and all the tables which appear in the weatherization report come directly from a report published by NERCOM entitled *The Impact of the New England Regional Commission's Low Income Winterization Program*. A more comprehensive analysis of the Low Income Weatherization Program and the ensuing administrative problems has been prepared by Alan Davis for the Conservation Committee and appears in that committee's report. We strongly urge the reader to look at it.

The third part of this section reprints portions of a letter from the National Association of Regulatory Utility Commissioners (NARUC) to Congress on the issue of "phantom taxes" as back-up to the Demand Committee's recommendation number 24.

Table 13
Projected 2000 New England Housing Inventory
(1000 Units)

Category		SFD	SFA	MFLR	MFHR	MOBILE	
1985-2000		896	531	203	67	264	
1978-1985	E	113	72	31	7	0	
1978-1985	D	205	133	55	15	0	
1978-1985	M	62	40	17	18	0	
1965-1978	E	180	40	43	13	0	
1965-1978	D	247	73	52	58	0	
1965-1978	M	72	23	16	15	0	
1940-1965	D	514	43	52	0	0	
1940-1965	M	158	12	19	0	0	
Pre 1940 Unins	D	506	92	68	0	0	
Pre 1940 Unins	M	143	26	25	0	0	
Pre 1940 Ins	D	142	35	30	0	0	
Pre 1940 Ins	M	52	10	10	0	0	
Total		3290	1090	621	193	264	5458

Source: Residential Forecasting Model (REFORM), New England Energy Management Information System (NEEMIS)

In conjunction with the effort to develop recommendations to lessen the burden of energy costs on low and moderate income consumers, this subcommittee also established a set of funding priorities based on the need to cushion the impact of rising energy prices on New England consumers. The list is as follows:

1) Funding for short-run conservation activities should be favored over supply development because:
   A) Conservation offers the greatest potential for protecting low income and moderate income families.
   B) Several studies done for the New England Energy Congress show that the return is greater for conservation than supply development programs.
   C) Many of the alternative sources which hold the greatest hope for the long-run depend upon substantial conservation efforts to upgrade housing stock to be cost competitive.
2) All subsidies to supply should be "pump priming" rather than permanent because:
   A) Permanent subsidies do not lower the price of energy, they merely shift the incidence of payment.

A. FROM: THE NEW ENGLAND ENERGY CONSUMER BY EUNICE S. AND GEORGE GRIER

I. Population and Household Trends

Contrary to much popular belief, the New England Region is not losing population; and it is gaining households rapidly. The most recent (1977) Census Bureau estimates show a percent increase in households almost as great as that for the nation as a whole. The region's population growth is projected to continue until at least the year 2000. Moreover, the greatest household

increase has recently occurred in the colder and less populous states of Maine, New Hampshire and Vermont.

While popular opinion tends to stereotype New Englanders, the statistics reveal them to be just as varied and dynamic as other Americans. One thing they have in common, however, is that they spend much more for energy, and are far more vulnerable to fuel oil shortages and price increases.

II. Incomes and Poverty

In overall dollar terms, the average New Englander has a somewhat higher income than the average American. But averages often mask wide variations. For the year 1975 the median income of New England families was estimated by the U.S. Bureau of the Census at $15,096 — more than $1,000 higher than the median for all families in the United States. The median for "unrelated individuals" (defined by the Census Bureau as persons living either alone or with others not related to them by blood or marriage) was $5,452, or almost $300 higher than the U.S. median for this group. (Table 14.)

Not only are two of the six New England states considerably below the national median income, but all states have significant low-income populations — totalling 572,000 households in 1975 for the region as a whole. Of these low-income households, 233,000 were single individuals, among whom 142,000 were elderly persons living alone. Another 255,000 were families with children under age 18. Older people are especially vulnerable to energy shortages and costs.

Table 14
Median Incomes of Families and Unrelated Individuals
New England and States
1975

	Median Income	
	Families	Unrelated Individuals
Maine	$11,839	$4,436
New Hampshire	14,258	5,161
Vermont	12,415	4,236
Massachusetts	15,531	5,731
Rhode Island	14,530	4,525
Connecticut	16,244	5,939
New England	$15,096	$5,452
United States	$14,094	$5,168

Source: U.S. Bureau of the Census. *Current Population Reports, Consumer Income. Money Income and Poverty Status in 1975 of Families and Persons in the United States and the Northeast Region, by Divisions and States.* Series P-60, No. 110, March 1978.

But averages often mask large variations, and this is certainly true for New England. In the state of Maine, the median income for families in 1975 was more than $3,200 lower than the regionwide median — and hence considerably lower than the national median as well. In Connecticut, it was more than $1,100 higher than for the region. Among unrelated individuals in

Table 15
Number and Percent of Households With Incomes Below 125% of Poverty
New England and States
1975

	Number of Households	Percent of all Households
Maine	67,000	18.8%
New Hampshire	37,000	13.4
Vermont	33,000	20.8
Masschusetts	265,000	13.5
Rhode Island	52,000	16.5
Connecticut	118,000	11.4
New England	572,000	13.9%
United States	12,564,000	17.3%

Source: U.S. Bureau of the Census. *Current Population Reports, Consumer Income. Money Income and Poverty Status in 1975 of Families and Persons in the United States and the Northeast Region by Division and States.* Series P-60, No. 110, March 1978.

Vermont median income was more than $1,200 lower than for New England as a whole, and in Connecticut it was almost $500 higher. In general, incomes were lower in the three northernmost states.

Within the New England region as well as the individual states, there is also a wide range from the lower end of the income scale to the upper end. In the region as a whole the Census Bureau estimated that there were about 572,000 households[1] with annual incomes which fell below 125 percent of the federal poverty line. These households constituted 14 percent of all New England households. (Table 15). The poverty line, which is readjusted at fairly frequent intervals in accord with changes in the Consumer Price Index, takes into account not only total household income but also household size. It allows for a base-subsistence level of living — so low that many federal programs base their eligibility requirements instead on 125 percent of the poverty level. In 1975 the weighted average maximum for 125 percent of poverty was less than $3,400 for a household consisting of only one person. Many one-person households, of course, received much lower incomes than this. For a household consisting of four members the upper limit was about $6,800; some four-person households had incomes well below this level.

By far the largest number of New England's low-income households live in Massachusetts — which also has the largest share of the region's total population. However, the states with the largest proportions of low-income households include two of the three northernmost, Vermont and Maine. In both states roughly one-fifth of all households had 1975 incomes which put them below 125 percent of the federal poverty standard. There were 100,000 households in this situation in the two states combined — 33,000 households in Vermont and 67,000 in Maine. Both states, of course, suffer some of the coldest winters in the nation and pay among the highest prices for fuel. And price levels are no respector of income.

[1]A household consists of all occupants of a housing unit. Most commonly these occupants comprise a "family" (i.e. a group of persons related to each other), but a household may also consist of a single person living alone, two or more unrelated individuals sharing a home, two families living in the same housing unit (e.g. a family-homeowner plus a married couple who are servants), or a family plus one or more unrelated persons (e.g. a servant or lodger). In calculating "household income" the Census Bureau adds together the incomes of all members of the household, related and unrelated.

Table 16

Number of Unrelated Individuals with Incomes Below 125% of Poverty Living Alone and 65 Years or Older

New England and States
1975

	Number Living Alone All Ages	Number Living Alone 65 Years or Older
Maine	21,000	15,000
New Hampshire	17,000	11,000
Vermont	13,000	9,000
Massachusetts	108,000	58,000
Rhode Island	27,000	18,000
Connecticut	45,000	31,000
New England	233,000	142,000

Source: U.S. Bureau of the Census. *Current Population Reports, Consumer Income. Money Income and Poverty Status in 1975 of Families and Persons in the United States and the Northeast Region by Divisions and States.* Series P-60, No. 110, March 1978.

Table 17

Number of Families with Incomes Below 125% of Poverty with Children Under 18

New England and States
1975

	Number of Families With Children Under 18
Maine	31,000
New Hampshire	16,000
Vermont	16,000
Massachusetts	120,000
Rhode Island	17,000
Connecticut	55,000
New England	255,000

Source: U.S. Bureau of the Census. *Current Population Reports, Consumer Income. Money Income and Poverty Status in 1975 of Families and Persons in the United States and the Northeast Region by Divisions and States.* Series P-60, No. 110, March 1978.

Available published data on New England's low-income households are insufficient to tell us a great deal about their characteristics. We can tell, however, that an estimated 41 percent of them — 233,000 households regionwide in 1975 — consisted of single individuals who lived alone and thus were solely responsible for meeting all home fuel bills on an annual income which could not be higher than $3,400. More than half of these individuals — 142,000 in all — were elderly, and thus were unlikely to be able either to raise their incomes or to reduce the level of warmth in their houses without endangering not only their comfort but also their well-being. (Table 16.)

We can also infer that a great many of New England's low-income households are families with children. In 1975, the number of families with children under age 18 and incomes which fell below 125 percent of the poverty line totalled an estimated 255,000 in the six New England states. Almost half of these lived in Massachusetts, but the numbers were quite large in the other states as well. (Table 17.)

Table 18
Fuels Used for Home Heating
New England and States
1970

	Percent of Households			
	Fuel Oil, Etc.	Piped-in Gas	Elec-tricity	Other Fuels
Maine	91.8%	1.8%	1.9%	4.5%
New Hampshire	80.5	10.9	4.4	4.2
Vermont	80.4	5.0	5.9	8.6
Massachusetts	65.8	28.0	4.1	2.1
Rhode Island	67.9	27.4	2.7	1.9
Connecticut	71.9	20.6	5.2	2.2
New England	71.2%	22.0%	4.2%	2.6%
United States	26.0%	55.2%	7.7%	11.1%

Source: U.S. Bureau of the Census. *1970 Census of Housing. Detailed Housing Characteristics.* Final Report HC(1)-B 1972.

III. Factors Affecting Household Energy Costs

A) Fuel Used in Home Heating

One of the most important reasons for the large amount most New Englanders pay for energy is the type of home heating fuel they use. Alone among the regions of the nation, New England residents depend overwhelmingly on fuel oil. The proportion of all New England householdsusing oil at the 1970 Census was 71.2 percent.[1] However, this figure is heavily influenced by the three southernmost and most populous states. In Maine, New Hampshire and Vermont, over 80 percent use oil; and in Maine the proportion reaches almost 92 percent. (Table 18.)

A much smaller percentage of U.S. households as a whole heat with oil — 26 percent in 1970. Of the approximately 17 million households nationally which rely on fuel oil for heat, almost 16 percent reside in the New England states — although New England has less than six percent of the U.S. population.

This heavy dependence on oil by New England households is relatively recent. A couple of decades ago coal was much more common. Converting coal furnaces to oil — a relatively inexpensive procedure — made a great deal of sense for New Englanders until recently, because oil was cleaner, more efficient and cheaper. Today, of course, oil is no longer an inexpensive fuel, and the price continues to go up.

By any standard, oil is now a costly fuel. On a national average basis, it costs about 60 percent more per therm of heat delivered than gas in 1975. In New England, however, gas is about as costly as oil. Electricity is even more expensive, but only a tiny minority of New Englanders rely on it.

[1]The Census figure is actually for "oil, kerosene, gasoline, alcohol, and other combustible liquids." However, kerosene use is very small (less than two percent in the entire Northeast region), and the other types of fuel mentioned are used even less often.

Table 19
Average Retail Fuel Oil Prices
New England and States
October 1978
(Preliminary)

	Price per Gallon
Maine	50.7¢
New Hampshire	50.7
Vermont	52.4
Massachusetts	50.9
Rhode Island	52.2
Connecticut	51.7
New England	51.2¢
United States	50.1¢

Source: U.S. Department of Energy, Energy Information Administration

While we were unable to locate reliable and precise data on the extent to which New Englanders have shifted away from oil as their home heating fuel in recent years, the evidence suggests that any such trend is minor. Data from the 1976 Census Annual Housing survey for the entire Northeast region (which includes the states of New York, New Jersey, and Pennsylvania) do not indicate a substantial fuel shift for that region since 1970. However, there are other indications — sale of woodstoves, for example — that a growing number of households are supplementing their primary heat source with wood. This can save money if one has access to a woodlot, preferably on one's own property; but only a small minority of households own a woodlot, even in New England, and even fewer among low-income households.

We also found no published data on use of fuels by low-income households in New England. However, when we examined data from the 1975 National Survey of Household Energy Use, both for the U.S. as a whole and for the entire Northeast, we found no significant difference in type of fuel used between low-income households and all households.[1] Thus it seems safe to assume that low-income New Englanders are just as dependent on oil as are their higher-income neighbors.

B) High Energy Prices

New Englanders pay more than residents of any other region for oil — five cents more per gallon than residential consumers in the North Central Region which is also noted for its frigid winters. But natural gas, where available, is also expensive here — as is electricity. All New England states but one have electricity prices well above the midpoint of the national distribution by states. And three of the five states where electric rates are highest are in New England (the other two are New York and New Jersey). Gasoline is the only major energy source that is not significantly more expensive in New England than elsewhere in the U.S. Fuel oil, an expensive energy source anywhere in the U.S. today, is even more expensive in New England. Tables 19 and 20 show the average price per gallon of fuel oil at retail for the New England states, the nation and other regions in October of 1978, according to U.S. Department of Energy figures. All New England states paid more than the national average price at that time — in the case of Rhode Island and Vermont, over two cents per gallon more.

[1]Washington Center for Metropolitan Studies, National Survey of Household Energy Use, 1975. Unpublished tabulations.

Table 20
Average Retail Fuel Oil Prices
By Region
October 1978
(Preliminary)

Federal Region		Price per Gallon
1	(New England)	51.2¢
2	(New York-New Jersey)	51.0
3	(Mid-Atlantic)	50.0
4	(South Atlantic)	47.9
5	(Midwest)	47.6
6	(Southwest)	N.A.
7	(Central)	45.9
8	(North Central)	46.3
9	(West)	45.9
10	(Northwest)	48.3

Source: U.S. Department of Energy, Energy Information Administration.

Electricity — which, while used by few New Englanders for heating, is relied upon by virtually all for lighting and operation of appliances — is also more expensive here than in other parts of the nation. Data obtained from the National Association of Regulatory Utility Commissioners — covering residential electricity bills from major regulated utilities in 47 states plus the District of Columbia as of January 1, 1978 — were analyzed for this paper to obtain residential customer-weighted average prices for each state. These prices were calculated on a cents-per-kilowatt-hour basis for users of 1,000 kilowatt hours per month. For each state, the rate for each reported utility was then weighted by number of residential customers and a weighted average rate for the state was computed. All states were ranked in terms of these weighted average rates.

The analysis shows that electric utilities in only five states in the nation charge average rates above 5¢ per kilowatt-hour to 1,000-KWH users. Three of these are in New England — Massachusetts, New Hampshire and Vermont; the other two are New York and New Jersey.

The midpoint of the price distribution for all states in the nation is 4¢ per kilowatt-hour. Utilities in 22 states charge less than this amount, on average. In another 21 states, they charge between 4.0¢ and 4.9¢. Maine is the only New England state with an average price per kilowatt hour below the national midpoint (3.4¢). Connecticut's average is 4.5¢, New Hampshire's is 5.2¢, while Rhode Island's — obtained from another source — is 5.5¢. New York State tops the nation with 6.1¢; but not far below are Vermont (6.0¢) and Massachusetts (5.8¢). In other words, residents of these states average about 50 percent more for electricity than is typical for U.S. households. (Table 21.)

As a result of the industry practice known as "declining block rates," residential customers who use relatively small amounts of electricity pay a substantial premium for each kilowatt-hour used compared to larger consumers. This additional amount varies from state to state, as Table 22 shows. The household in Maine using 300 kilowatt hours per month pays 38 percent more than the household using 1,000 kilowatt hours. The difference narrows to 10 percent in Massachusetts. Overall, New England customers pay an average of 19 percent more per kilowatt hour if they consume only 300 kilowatt hours of electricity per month than if they use 1,000 kilowatt hours.

Table 21

Summary of Average Residential Electric Power Prices[1]

By State
January 1, 1978

	Cents per Kilowatt Hour
Maine	3.4¢
New Hampshire	5.2
Vermont	6.0
Massachusetts	5.8
Rhode Island	5.5
Connecticut	4.5
United States (mid-point of distribution by states)	4.0¢
Highest-priced state: New York	6.1¢
Lowest-priced state: Washington	1.7¢

[1] Cents paid per KWH by users of 1000 KWH per month; average of prices reported for major regulated utilities weighted by number of residential customers.

Source: Computed by The Grier Partnership from data provided in National Association of Regulatory Utility Commissioners, *Residential Electric Utility Bills: January 1, 1978.* Washington, D.C. March 30, 1978. Rate for Rhode Island obtained directly from Narragansett Electric Co. and applies to October, 1978. All rates are for residential customers who do not use electricity to heat water.

Table 22

Difference in Price Paid per Kilowatt-Hour Between Residential Users of 300 Kilowatt-Hours and 1000 Kilowatt Hours Per Month

Major Regulated Electric Utilities

By State
January 1, 1978

	Cents per KWH		
	300 KWH Users	1000-KWH Users	Percent Difference
Maine	4.7¢	3.4¢	38.2%
New Hampshire	6.3	5.1	25.5
Vermont	7.2	6.0	20.0
Massachusetts	6.4	5.5	10.3
Rhode Island	6.4	5.5	16.4
Connecticut	5.9	4.5	31.1
New England	6.2¢	5.2¢	19.2%

Source: Computed by The Grier Partnership from data provided in National Association of Regulatory Utility Commissioners, *Residential Electric Utility Bills: January 1, 1978.* Washington, D.C. March 30, 1978. Rates for Rhode Island obtained directly from Narragansett Electric Co. and apply to October, 1978. All rates are for residential customers who do not use electricity to heat water.

Table 23
Number of Housing Units in Structure
New England and States
1970

	One Unit	Two or More Units	Mobile Home
Maine	68.3%	27.4%	4.3%
New Hampshire	63.8	31.7	4.5
Vermont	66.4	28.1	5.5
Massachusetts	50.4	49.1	0.5
Rhode Island	51.7	47.6	0.6
Connecticut	59.1	40.0	0.9
New England	55.7%	42.9%	1.4%

Source: U.S. Bureau of the Census. *1970 Census of Housing. General Housing Characteristics.* Final Report HC(1)-A. 1971.

This practice, of course, penalizes conservation. It also penalizes smaller households, poor households, and elderly households — all of whom were found in the 1975 Washington Center for Metropolitan Studies (WCMS) survey of household energy use to consume substantially less electricity than the average, and most of whom are less able to pay for it.

C) Housing Characteristics and Energy Costs

About 57 percent of all energy used within the average U.S. home goes for heating. Home heating requirements are heavily influenced by the number of rooms in the dwelling and the structure type (i.e., single-family detached, multiple dwelling, etc.). Number of rooms determines the volume of space which must be heated; structure type determines the exposure of exterior walls to the elements, and hence the overall heat loss through those walls. Age plays a role in heat loss also, since older dwellings are less likely to be well-insulated and often have cracks in walls, foundations, and around windows and doors. Older houses often have inefficient heating plants also.

1) Structure Type — Like the rest of America, New England favors the single-family home. In 1970, well over half of all housing units in New England were in single-unit structures. In no individual state did the proportion fall below half. In Maine, New Hampshire, and Vermont, about two-thirds of all dwellings were single-family. (Table 23.)

The single-family home is inherently the most wasteful of heat energy of any housing type. Its walls are typically exposed to the elements on all sides; and little if any heed was paid in its design to such factors of significance in energy consumption as the compass direction of its long walls or the size of its glass areas. Thus, much of its requirement for heat energy has been built in from the beginning. Weatherization and other conservation measures can often reduce consumption somewhat; but an effective limit to the saving is set by the dwelling's basic characteristics. Many New Englanders have the disadvantage, in these energy-conscious times, of living in homes that are basically hard to beat.

Table 24
Number of Rooms in All Housing Units
New England and States
1970

	Rooms				
	1-3	4	5	6	7 or more
Maine	13.9%	18.6%	22.8%	20.3%	24.3%
New Hampshire	13.1	19.9	24.1	19.7	23.1
Vermont	12.2	16.6	21.3	19.5	30.4
Massachusetts	13.8	17.7	24.9	21.8	21.7
Rhode Island	11.8	21.4	28.9	20.9	17.0
Connecticut	12.4	18.8	25.7	21.1	22.0
New England	13.3	18.5	25.0	21.2	22.1

Source: U.S. Bureau of the Census. *1970 Census of Housing. Detailed Housing Characterisitics.* Final Report HC(1) 1972.

Table 25
Year of Construction For All Housing Units
New England and States
1970

	1965-Mar. 1970	1960-1964	1950-1959	1940-1949	1939 or earlier
Maine	8.8%	6.7%	11.6%	8.5%	64.4%
New Hampshire	14.0	9.2	12.9	6.7	57.1
Vermont	14.6	6.6	9.4	4.9	64.4
Massachusetts	8.9	7.5	14.8	7.9	61.0
Rhode Island	9.2	7.5	14.8	7.9	61.0
Connecticut	12.4	10.6	21.4	11.6	44.0
New England	10.3%	8.3%	15.9%	8.9%	56.6%

Source: U.S. Bureau of the Census. *1970 Census of Housing. Detailed Housing Characterisitics. Final Report HC (1)-B. 1972.*

2) Dwelling Size — More than 43 percent of all homes in New England had six rooms or more at the 1970 Census. (Table 24.) The largest proportion was in Vermont — about 50 percent. Except for Rhode Island, where 38 percent were this large, the other states had roughly 43 percent. Their size alone makes many New England homes consume a lot of heating fuel. One reason they are so large is that many were built decades ago when families were bigger; but recently-built houses are large also.

3) Age — New England's housing is among the oldest in the country. At the time of the 1970 Census, well over half its homes had been built before 1940 — and many were much older than that. Only about 10 percent had been built in 1965 and later. In Maine and Vermont the proportion of pre-World War II dwellings approached two-thirds, while only in Connecticut did they make up less than half the housing stock. (Table 25.)

4) Low-Income Households — Low-income households are typically less likely than those with higher incomes to occupy single family dwellings and more likely to reside in apartments. According to figures developed from the 1975 National Survey of Household Energy Use, only 38 percent of poor households in the Northeast region resided in structures with only one unit, compared to 62 percent of all households. The proportions were almost exactly reversed for structures with two or more units. Although figures for the Northeast also include the Middle Atlantic states, it is probable that the same difference exists for the New England states — with low-income households being more heavily concentrated in apartments. Still, a sizeable minority of low-income New Englanders must also live in single family homes, with large expenditures consequently required for energy.

Low-income households almost always occupy much higher proportions of small dwellings than those with more money. In the 1975 Annual Housing Survey households earning less than $5,000 a year in the Northeast region occupied about twice as high a proportion of one-to-three-room dwellings as did all income groups combined.[1] It seems reasonable to assume that the pattern is quite similar in New England.

As a rule, housing occupied by low-income households tends to be even older than that occupied by households of all income levels combined. In the 1975 Annual Housing Survey, low-income households in the Northeast region were about 30 percent more likely than households of all income levels to live in a pre-1940 home.[2] If the ratio is the same for the New England states, almost three-fourths of all low-income households in that region live in homes built before World War II. In Maine and Vermont the proportion may be as high as 84 percent.

D) The New England Climate: Severe Winters

New Englanders pay heavily for living in a cold climate. Data from the National Climatic Center indicate that the New England Region averages nearly 37 percent colder than the nation as a whole; Maine and Vermont are over 66 percent colder. Of all nine Census regions, only one — the West North Central Region, containing such very cold states as Minnesota, Montana and North Dakota — is colder than New England, and by less than two percentage points. (Tables 26 and 27.)

The three northernmost New England states are, of course, considerably colder than the rest. In these states, average annual heating degree days[1] range from 59 percent greater than the U.S. average (in New Hampshire) to 69 percent greater (in Maine). Only three states in the nation are colder than Maine — Minnesota, Montana, and North Dakota — and Montana is only slightly colder.

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[1]For a more detailed discussion, see Grier, Eunice S. and George Grier. *High Fuel Oil Prices: The Impact on Low-Income Households.* Report to the Community Services Administration, August 1978.

[2]U.S. Bureau of the Census. *Annual Housing Survey 1975: United States and Regions, Part C: Financial Characteristics of the Housing Inventory.* Series H-150-75C. March 1977.

Table 26

Long-Term Average Heating Degree Days
(Population-Weighted Annual Totals)
Nine Census Divisions and the Nation

Census Division	Heating Degree Days	Percent National Average
New England	6465	136.6%
Middle Atlantic	5752	121.5
East North Central	6218	131.3
West North Central	6551	138.4
South Atlantic	3049	64.4
East South Central	3341	70.6
West South Central	2231	47.1
Mountain	5629	118.9
Pacific	3322	70.2
United States	4734	—

Source: National Oceanographic and Atmospheric Administration, National Climatic Center. *State, Regional and Naitonal Monthly and Seasonal Heating Degree Days Weighted by Population.* (July 1931-June 1976). March 1977.

Table 27

Long Term Average Heating Degree Days
(Population-Weighted Annual Totals)
New England and States

	Heating Degree Days	Percent of National Average
Maine	8017	169.3%
New Hampshire	7533	159.1
Vermont	7882	166.5
Massachusetts	6242	131.9
Rhode Island	5891	124.4
Connecticut	6106	129.0
New England	6465	136.6%
United States	4734	—

Source: National Oceanographic and Atmospheric Administration, National Climatic Center. *State, Regional and National Monthly and Seasonal Heating Degree Days Weighted by Population* (July 1931-June 1976) March 1977.

New England households are thus hit with a "triple whammy" in terms of their energy costs. Most of them must rely on oil, an expensive fuel. Many of their homes are inherently energy-wasteful. And their climate is one of the coldest in the nation.

IV. What New Englanders Pay For Residential Energy

New England households pay much more for the energy they use than do others in the United States. There are several reasons for this. Most important among them are the cold climate and the higher prices paid for energy in the New England states. Only in part is this due to the region's heavy dependence on fuel oil. All types of energy except gasoline cost more in New England.

A) Fuel Oil

Since it is the predominant fuel used in New England for space heating, we have estimated the average amount spent by New Englanders for home heating oil for the average heating season at the most recent prices available from DOE (fall 1978). Since the last winter (1977-1978) was considerably colder than average we have also estimated the heating cost for such a season to indicate how much more expensive a cold winter can be at current prices.

Our basic data for estimating expenditures came from the 1975 National Survey of Household Energy Use, directed by one of the authors of this paper for the Washington Center for Metropolitan Studies. This survey obtained data on energy expenditures and a variety of other items from a representative sample of U.S. households. While results are not available specifically for the New England Region, we were able to update and adjust the national statistics (covering the 1974-1975 heating season) to obtain good current estimates for New England based on data from federal sources. The adjustment factors are shown in Table 28.

We estimate that the New England household whose home and living situation are comparable to the average U. S. household elsewhere pays $736 for fuel oil in an average heating season at current prices. That is about one-third more than spent by the average American household.

To arrive at this figure:

- We started with the average amount spent by American households in 1974-1975 — $427.70;
- We first added 36.6 percent for the difference in heating degree days between New England and the U.S.;

[1]The standard measure of relative coldness for calculating heat energy demands is "heating degree days." The "heating degree days" for a given date and locality are determined by subtracting the average of the maximum and minimum temperatures for that date from 65. If the average temperature is 65 or higher, the heating degree days total for that date is zero. The National Climatic Center aggregates the totals from all local weather stations on a population-weighted basis to determine state, regional and national totals. These totals are further aggregated on a monthly and annual basis. It is the long-term annual average (for the 45-year period 1931-1976) that we use here.

Table 28
Factors Used To Adjust National Fuel Oil Expenditure Data For 1974-1975 Heating Season To New England

For the Average Year*:	
Difference in heating degree days between New England and U.S. (from National Climatic Center)	+36.6%
Difference in retail fuel oil price between New England and U.S. (from U.S. Department of Energy)	+2.2%
Difference in retail fuel oil price between 1974-1975 average and current level (Oct. 1978)	+29.8%
Difference due to conservation and weatherization	-5.0%
For the 1977-1978 Heating Season:	
Difference in heating degree days for New England between 1974-1975* and 1977-1978	+6.5%

*1974-1975 was an average heating season in climatic terms.

- To the resulting total, we added 2.2 percent for the differential in oil prices between New England and the U.S. average;
- To that result we added 29.8 percent for the increase in fuel oil prices between 1974-1975 and October 1978 (latest available);
- Finally, we deducted 5 percent for assumed savings due to conservation and weatherization practices since the 1974-1975 season.[1] Table 29 shows the computations.

The resulting amount almost certainly will understate fuel oil expenses for the current heating season, even if the season is an average one, since fuel oil prices are expected to continue to increase. Furthermore, no allowance has been made in computing it for the fact discussed earlier than many New Englanders live in houses that require more energy to heat than the average American home. Hence, it is probably conservative.

The winter of 1977-1978 was a particularly cold one. We have also estimated how much New Englanders would pay for fuel oil in such a winter at current prices, an indication of the difference more severe weather than average can make. The estimated amount is $784. The difference is accounted for by a winter that was 6.5 percent colder than average.

B) Other Home Fuels

Based upon the expenditures reported for electricity and gas by households who

[1]We did not make any allowance for differences between 1974-1975 and the average season since 1974-1975 was an average season for New England — with less than one percent difference in heating degree days from the long-term mean.

Table 29

Computation of Estimated Fuel Oil Expenditure for Average New England Household at Current Price

Average expenditure by all U.S. households in 1974-1975		$427.70
Adjustment for colder New England climate (+36.6%)		+156.50
	Subtotal	$584.20
Adjustment for higher fuel oil prices in New England (+2.2%)		+ 12.85
	Subtotal	597.05
Adjustment for increase in fuel oil prices between 1974-1975 and October 1978 (+29.8%)		+177.92
	Subtotal	$774.97
Adjustment for savings due to conservation (-5%)		- 38.75
	FINAL ESTIMATE	$736.22

heated their homes with fuel oil and were contacted in the 1975 National Survey of Household Energy Use, updated using current price data, we estimate that New Englanders who heat with oil now spend an average of an additional $373 annually for these other home fuels combined.[1] Some households use both electricity and gas; others use electricity only. This estimate covers the average total expenditure for one or both fuels regardless. In calculating it, we have allowed for a 5 percent reduction in average amounts consumed through conservation.

C) Gasoline

The New England household whose car uses leaded regular gas and which patronizes the self-service island — hence getting the lowest price — will pay about $393 annually for gasoline at October 1978 prices. This assumes that its car uses about the same amount of gas as it did in 1974-1975. If the car demands unleaded regular, the cost rises to about $436. Premium will increase the total still further.

This is one respect in which the New Englander is somewhat better off than the average resident of the United States as a whole, who will pay about $442. The main reason is that the New Englander puts fewer miles on his car in the course of a year. And gas is the one major fuel for which the New England resident does not pay significantly more, on the whole.

D) Overall Energy Expenditures

The average New England household which (1) heats with oil, (2) uses electricity or a combination of electricity and gas for other home energy needs, and (3) fuels its car with leaded self-service gasoline now pays a combined estimated total of over $1500 for

[1]Source: Calculated by The Grier Partnership using unpublished tabulations from the 1975 WCMS National Survey of Household Energy Use and price data from the National Association of Regulatory Utility Commissioners.

Table 30
Estimated Household Energy Expenditures
In Average Heating Season at Current Prices
New England Households Heating with Oil

	All Households	All Low-Income Households	Low-Income Households With Cars
Fuel oil	$736	$685	$685
Other home fuels	373	280	280
Gasoline	393	137	327
All fuels combined	$1,502	$1,102	$1,292

Source: Calculated by the Grier Partnership using unpublished tabulations from the 1975 WCMS National Survey of Household Energy Use and price data from the National Association of Regulatory Utility Commissioners and the U.S. Department of Energy.

energy from all three sources. (Table 30.) This figure assumes that its home is not unusually wasteful of heat, and that it is taking some measures to conserve by weatherization and other means.

For low-income New England households the amount paid is less, but the burden is considerably greater relative to income. We estimate that the low-income New Englander will pay about $685 for fuel oil in an average heating season at October 1978 prices, and about $730 in a severe winter like 1977-1978. This is not much less than the average paid by households of all income levels.The reason is simply that most low-income households in New England are not in a position to use much less heating oil without suffering, or even danger to health or life.

For other home fuels, the same low-income household will pay substantially less than the household of average income, about $280. For gasoline, it may very well pay nothing — since over half (58 percent) of all low-income households in the Northeast did not have cars in 1975. But low-income households who do have cars now pay about $327 annually, assuming that they use about the same amount of gasoline they reported in 1974-1975, and buy leaded regular at the self-serve island. The average for all low-income households, whether or not they own cars, is estimated at about $137 annually.

Thus the total paid for energy by the low-income household with a car in an average year is now estimated at $1,292 annually. (Table 30.) This amount rises to about $1,376 in a cold year like 1977-1978. Including those without cars, the total spent by all low-income New England households now averages an estimated $1,102 in a typical heating year and $1,174 in a year like 1977-1978. These are average amounts, and while some pay less many pay more.

These are also annual averages, and do not indicate how high the monthly energy bills can go during the cold winter months. In New England, 77 percent of the total heating degree days for the whole year are accumulated during only five months, November through March. Those households who are on "budget" plans can spread their heating costs evenly over the whole year. But many low-income households cannot qualify for these plans, which demand established credit and regular payments. As a consequence, many find themselves facing monthly outlays of well over $100 per month for fuel oil alone in the coldest season.

The recently-announced OPEC price increase will raise these amounts significantly, of course. While the OPEC rise will be about 15 percent for the whole of 1979, the immediate increase effective January 1 will be about 5 percent. This increment applies to the price of imported crude oil, which at the end of 1979 was about 30¢ per gallon. Such increases are normally passed on directly to the consumer, along with any other increases in the cost of production or distribution. Hence retail fuel oil prices can be expected to rise immediately by at least 5 percent of 30¢, or 1.5 cents per gallon. Over the whole of 1979 they will increase in several steps by a total of at least 4.5¢ per gallon.

For most of the rest of the 1978-1979 heating season, New Englanders will thus pay for fuel oil at a rate of at least $757 annually; low-income households will pay at least $705. By the time the entire 14.9 percent price increase has been absorbed, during the 1979-1980 heating season, the average New England household of all income levels will be paying over $800 annually for fuel oil; low-income households will be paying at least $745.

The budgetary impact of current fuel oil prices on low-income New Englanders is already severe. In 1977-1978, the average before-tax money income of U.S. low-income households (below 125 percent of poverty level) was estimated at $3,850. At $1,102 per year, the average for all households with and without autos, the low-income New Englander is paying 29 percent of this average income for energy. Those with cars pay even more, nearly 34 percent.

As we have noted, an average means that some pay less but many pay more. This is particularly the case with the budgetary impact of energy expenditures. The average income of $3,850 just cited is the average of a "skewed" income distribution in which the individual incomes can be considerably lower than the average, but are seldom very far above it. This is because the maximum level at which a household is considered low-income (and hence eligible for special assistance) is set by federal standards. While these standards allow higher maxima for larger households, the number of large low-income households is so small in relation to the total that in 1974-1975 almost four-fifths of low-income households in the Northeast who were contacted by the WCMS National Survey of Household Energy Use received incomes below $4,000.

The distribution of fuel oil expenditures by low-income households in the Northeast, on the other hand, is "skewed" in the opposite direction. In 1975 only about 25 percent paid less than $360 for oil (equivalent to about $467 at October 1978 prices). Nearly half, 45 percent, paid between $360 and $599 (equivalent to $467 to $778), while about one-fourth paid still more. These figures are for all households in the Northeast, parts of which are considerably warmer than New England. Hence, there are undoubtedly many low-income New Englanders who are paying well over the average of 29 to 34 percent of their incomes for energy. In combination, energy costs and housing costs now absorb most of the budgets of many low-income households, leaving very little for other necessities of life. This situation can only become worse.

V. The Need For Emergency Energy Payments

During the two winters just past, a considerable number of low-income households in New England, as well as in the rest of the nation, received help from the federal government with their fuel bills. While federal monies covered only a small percentage of the total spent by these households for energy, and only a fraction of the poor received help, the special financial aid unquestionably prevented disastrous circumstances for a goodly number of households. Had not special aid been available, there would certainly have been many more homes in which the heat was cut off, and many more homes in which other necessities were eliminated or cut back in order to keep the furnace running.

With most fuel prices higher still this winter season and incomes not improving in tandem, it is again likely that many poor families in the New England region will need this kind of special financial assistance.

Barring an unusually warm winter season or a large drop in energy prices — neither of which is likely to occur — it is a certainty that low-income households in New England will require special financial aid again this winter. In fact, the need will probably be even greater this year than last, even should the winter be just average rather than unusually severe. Recent and pending fuel oil price increases alone will have this result.

A number of states now bar regulated utilities from cutting off service for non-payment during the coldest months (though some set a maximum on the amount which can be in default, such as $250). But fuel oil companies are not regulated utilities, and oil customers can and do have deliveries cut off if they do not keep up payments reasonably well.

Many low-income oil users are in an even more vulnerable situation, being on a "cash-on-delivery" basis. They cannot defer payment for even a few days or weeks until the paycheck, welfare payment or social security check comes in. For such households, emergency financial assistance such as that provided for Emergency Energy Assistance Program (EEAP) can literally be a life-saver.

The need is particularly urgent in the case of elderly people. An estimated 142,000 low-income elderly people live alone in New England.There are also 34,000 low-income families headed by people 65 years of age or older. For old people, adequate heat is a necessity. The U.S. Public Health Service has warned that elderly persons — particularly those with circulatory diseases and on certain medications — are vulnerable to a condition called "accidental hypothermia," which can be fatal and can occur when temperatures fall below 65 degrees. For this reason it advises older people not to turn their thermostats below 65.

By conservative estimate, well over 100,000 elderly fuel oil users in New England are eligible for aid under the income standards used in last year's EEAP program. Many of these could be potential casualties of fuel oil cutoffs this heating season.

Utilities also stand to lose if emergency financial aid is not provided. Many could find themselves unable to collect from low-income customers whose bills have run up past the point where they can make up the difference. The defaults could well run into the millions.

If next winter is typically severe, the average New England household will probably pay in excess of $1600 for energy, and the average low-income household will spend over $1200. This will be the result of currently foreseeable price increases, and more could well be in the offing. Under these circumstances, continuing a program of aid to enable low-income households to meet energy costs is essential.

The average amount reportedly paid out per household varied from about $150 in Maine to $245 in New Hampshire with a regionwide average of about $220. For the average low-income household in New England without a car, this would have covered about 22 percent of its total energy bill of roughly $985. For the average low-income household with or without a car, it would have covered about 20 percent. The EEAP payment amounted to about six percent of the average low-income household's total before-tax income.

From the available information on households receiving EEAP aid, we do not know how much either their incomes or their energy expenditures deviated from the "average" for all low-

Table 31
Estimated Total Energy Expenditure By Low-Income Households in 1978 Compared To Amount Obligated Under EEAP
New England

Estimated aggregate energy expenditure by low-income households (@ $1,121 per household)	$641,212,000
Total amount obligated under EEAP in 1977-1978	$17,833,347
Percent EEAP aid of total energy expenditures	2.8%

Source: Total energy expenditure estimated by The Grier Partnership on basis of other data in this report. EEAP obligations from Region I EEAP Final Report.

income households in New England. If, as seems likely, EEAP recipients included those in greatest need of help, then their incomes were probably below average, and the ratio of energy costs to income probably higher than average.

The overall amount expended under EEAP was relatively small, in any event, compared to the estimated total paid out by all low-income households in New England for energy. The $17.8 million obligated under EEAP last year was only about three percent of the overall estimated amount of $641 million spent for energy by all low-income New England households. (Table 31.)

B. THE LOW INCOME WINTERIZATION PROGRAM

One of the greatest areas of energy waste is in the heating of residential buildings, which accounts for 20% of all the energy used in New England. This is one area in which the poor — often through no fault of their own — are wasting as much as anybody. Low income housing, as a rule, tends to be older than that occupied by all income levels combined, and, according to the 1975 Annual Housing Survey, low income families in the Northeast are 30 percent more likely to live in pre-1940 homes than middle and upper income households.[1]

Not surprisingly, then, the Low Income Winterization/Weatherization Program has had the greatest impact on energy conservation and demand reduction of all Low Income Energy Programs. Since 1975, the Community Services Administration (CSA), the Department of Energy (DOE), the New England Regional Commission (NERCOM), and several manpower training programs, including CETA, have provided $21.2 million to winterize the homes of low income families in New England. These funds are distributed by the six New England states to local Community Action Agencies, which perform the actual winterization. The Community Action Agencies use the funds from CSA, DOE, and NERCOM to caulk and weatherstrip; install windows and doors; install storm windows; insulate ceilings, floors, and walls; and adjust furnaces.

In a three-year period, approximately 27,700 low income homes have been winterized in New England and an additional 1,000 oil burners adjusted.

[1]"The New England Energy Consumer," The Grier Partnership, January 1979.

Table 32
Sources of Winterization Funds

FY 1976-1977 ($ in Thousands)

	CT		ME		MA		NH		RI		VT		N.E.	
	$	%	$	%	$	%	$	%	$	%	$	%	$	%
NERCOM	325	34	340	13	412	22	317	24	308	21	317	25	2,019	21
CSA	145	15	1,516	57	500	26	645		614	43	542	43	3,962	42
State									350	25			350	4
CETA	200	21	500	19	980	52	361	27	151	11	406	32	2,104	27
Title II[1]	285	30											285	3
New Title XX			300	11									300	3
Total	955		2,656		1,892		1,325		1,425		1,267		9,520	

FY 1978 ($ in Thousands)

	CT		ME		MA		NH		RI		VT		N.E.	
	$	%	$	%	$	%	$	%	$	%	$	%	$	%
NERCOM	81	5	85	4	103	2	74	12	77	9	79	4	500	4
CSA	196	11	730	39	1,500	32	76	13	406	47	1,120[2]	60	4,028	34
DOE	394	77	433	23	726	16	252	42	227	26	261	14	2,293	20
State			92	5									91	1
CETA			400	21	2,300	50	197	33	154	18	408	22	3,459	30
Title II[1]	1,123	62											1,123	10
New Title XX			150	8									150	1
Total	1,794		1,890		4,629		599		864		1,868		11,644	

[1] Title II "Anti-Recessionary" grant funds run from April 1977 through April 1979. They have been allocated to fiscal years as if spent uniformly during the period.
[2] Includes more than $700,000 in reprogrammed Special Crisis Intervention Program (SCIP) funds.

Source: SEOO Winterization staff; SEOO files.

Table 33
Total Low-Income Housing Units Winterized
New England States
Through June, 1978

State	Total $ Spent (in Thousands)	Units Weatherized	Expenditure Per House
Connecticut	2,700	3,300 (to 5/31/78)	$830
Maine	4,500	5,900	$760
Massachusetts	6,500	7,000 (est.)	$930
New Hampshire	1,900	2,600[1]	$730
Rhode Island	2,300	3,500	$650
Vermont	3,100	4,900 (to 3/31/78)	$640
New England	21,100	27,300	$780

[1] Does not include approximately 1,000 oil burners adjusted.

Table 34

State	Degree Days	No. of Houses	BTUs Saved per house 10^6 BTU	Total BTUs Saved 10^{12} BTU	Oil 10^6 Gal.	Gas 10^6 cu. ft.	Electricity 10^6 KWH
Connecticut	6,100	4,900	16	.12	.54	31.8	3.9
Maine	8,000	2,600	48	.28	1.78	5.5	9.1
Massachusetts	6,200	5,900	37	.26	1.23	68.3	5.3
New Hampshire	7,500	3,300	45	.12	.61	12.6	5.8
Rhode Island	5,900	3,500	35	.12	.56	38.9	2.2
Vermont	7,900	7,000	47	.23	1.34	15.7	8.1
NEW ENGLAND	7,000	27,300	42	1.13	6.06	173.0	34.5

Table 35
Rate of Return of Winterization

State	Cost $\$10^6$	Present Value $\$10^6$	Internal Rate of Return %
Connecticut	2.7	5.1	13
Maine	4.5	10.8	19
Massachusetts	6.5	10.0	9
New Hampshire	1.9	5.5	24
Rhode Island	2.3	4.8	15
Vermont	3.1	9.2	25
New England	$21.1	$45.5	16%

In the first year after winterization, the fuel savings was calculated at 6.1 million gallons of oil, 173 million cubic feet of gas and 35 million kilowatt hours of electricity. Translated into oil, this represents a savings of 8.2 million gallons. On the average, winterized homes realized a 25 percent fuel savings in the first heating season, the equivalent of 300 gallons of oil per home.

The total fuel savings since the Weatherization Program formally began in January 1975 (excluding 1978-79 winter) has been valued at $45 million.[1] The cost of the program has totaled $21 million, yielding an internal rate of return of 16 percent.

Table 35 indicates that the winterization activities have resulted in benefits substantially greater than the cost of investment. Some of the direct benefits that weatherization has provided to low income households include cost and fuel savings, increased comfort, and improved health conditions. In addition, the training required for CETA workers who participate in the Weatherization Program has increased the efficiency of winterization and increased the chance that these workers will remain gainfully employed after they leave the program.

[1]At 1978 oil prices.

Table 36
Eligible Low-Income Dwellings Remaining to be Winterized, Estimates for New England States
July 1978

State	No. of Units
Connecticut	60,400
Maine	(greater than) 100,000
Massachusetts	(greater than) 100,000
New Hamphshire	19,400
Rhode Island	25,500
Vermont	(greater than) 12,000
New England	(greater than) 317,300

Table 37

Grantee	Manpower Status as of June 30	Manpower Status as of October 31	Total Slots Needed to Achieve Goals
ME	55	25	89
NH	20	10	39
MA	218	87	320
VT	56	40	59
RI	44	0	72
CT	61	17	107
Region Total	454	179	686

Cost savings by low income households and improved job training as a result of the Weatherization Program have also provided indirect benefits to the taxpayers of New England. These include reduced welfare and compensation costs, decreased dependence on imported oil in the New England region, and a shift of consumption from fuel to other goods and services.

State Offices of Economic Opportunity (SOEO) in New England estimate there are 317,000 eligible low income houses remaining to be winterized. This is twelve times as many buildings as have already been completed — more than twenty-five years of work at current program levels.

Community Action Agencies have been required to rely mainly upon CETA labor to carry out weatherization activities. Experience has shown, however, that CETA labor "provides too few slots for weatherization personnel, too little training for the majority of workers — who are unskilled — too little pay for those workers who are skilled, too brief a work assignment to enable workers to either gain experience or establish an identification with the Community Action Agency, the program or weatherization as a trade, and far too much uncertainty as to future funding levels."[1]

This labor problem is highlighted in Table 37, which shows the manpower status of Title VI (CETA) slots as it existed on October 31, 1978.

[1] "Study of New England Weatherization Program" by N.E. Community Action Program Directors Association, February 1979.

It is evident from the above figures that replacement for the 322 CETA slots which expired on October 31, 1978, is imperative. In addition Community Action Agencies in New England estimated at that time that an additional 354 slots would be needed over and above the 322 replacements in order to keep the Weatherization Program operating at a level allowing it to reach its projected goal of weatherizing 20,815 dwelling units during the first quarter of 1979.

C. PHANTOM TAXES

The following is recommendation 24 of the Demand Committee Report. This recommendation is consistent and supportive of the position taken by the National Association of Regulatory Utility Commissioners in a letter to Congress on October 11, 1978. NARUC's reasons appear below.

Consumer and Low Income Impact Subcommittee urges Congress to repeal Sections 46 (f) and 167 (1) of the IRS Code of 1954 so that the choice between the use of "flow-through" or "normalization" methods of accounting by utilities subject to state regulation is restored to the state regulatory commissions.

Reasons for the Repeal of Sections 46 (f) and 167 (1)[1]

Sections 46 (f) and 167 (1) of the Internal Revenue Code, which were enacted in 1969 and 1971, place restrictions on utility companies' use of accelerated depreciation and the investment credit. These provisions were added to the law on the basis of incomplete information, with the aim of reaching an unreachable goal. They have led to what state regulatory officials of both parties have called a "never-ending rate-making hassle," and have produced great consumer discontent, without fulfilling any of the goals that Congress set in enacting them.

These sections provide that in order to be eligible for accelerated depreciation and the investment credit, utilities must use a method of accounting which reserves use of the tax savings to the companies. Thus, while a utility might include a certain amount in rates to cover taxes, a much smaller amount is actually paid. In recent years, the difference nationally has been greater than $6 billion annually for gas, electric, and telephone utilities. If regulators insist upon a method of accounting that allows collection only of taxes actually paid in a given year, utilities become ineligible for the benefits. An examination of the reasons for enactment of these provisions makes clear the need for their repeal.

First, both AT&T and the Treasury claimed that if benefits were passed directly to customers, rather than retained by utilities, federal tax revenues would be substantially lower in the long run. But this analysis failed to take into account the fact that utilities which retain the benefits are substantially less risky than those that pass them through. This lowers the rate of return on capital required for those companies, thus producing *lower* tax revenues. It is now generally acknowledged by Treasury, the IRS, and in the academic literature that the 1969 and 1971 laws not only fail to protect revenues but may in fact lead to a long-run revenue loss.

Second, it was claimed that rates to consumers are actually lower if companies have use of the funds, since borrowing needs are reduced. In the case of the investment credit, this is clearly untrue, since the law allows the companies to earn a profit on the value of the credit, just as if it were borrowed capital; in other words, taxpayers and rate-payers not only provide the credit funds initially, but pay interest on them to shareholders in subsequent years. A senior partner of Arthur Anderson, which keeps the books for a third of the nation's electric utilities, calls this a "serious overreaching" by Congress. The case of accelerated depreciation is more complex, and whether it is cheaper to consumers for the company to use tax benefit funds instead of borrowed capital

[1]Prepared by Staff, California Public Utilities Commission.

depends on both the market interest rate and the company's growth rate. This is best illustrated by an Arthur Anderson report done for the FEA in 1977,[1] which shows that over the next eight years, at projected growth rates, electricity rates will be three-quarters of a billion dollars higher than if utilities only collected from customers the tax they actually pay. In other times, or in certain places, it may be cheaper for companies to have use of the funds. These federal provisions therefore do not necessarily provide lower rates, as was claimed in 1969, and the federal policy is counter-productive, given the existence of state regulatory bodies which are charged with taking account of different companies' different circumstances.

Third, it was claimed in 1969 and 1971 that to flow the tax benefits through to utility customers violates the Congressional goal of stimulating capital formation by reducing the cost of investment and allowing speedier recovery of capital. Yet such a goal is bound to be counter-productive, if not impossible to achieve, in the case of regulated monopoly businesses. In these businesses, growth must be limited by the regulatory process to what is required to meet the public's needs. In an age of energy scarcity, additional tax incentives to encourage new construction make it worthwhile for utility companies to oppose conservation measures. Incentives are warped. At the least, federal policy should be neutral in this regard. The Senate has taken this position in rejecting the Administration's attempt to force states to adopt conservation-oriented rate structures. It makes little sense to continue to have tax provisions which point in the opposite direction. In any case, state utility regulators have enough power to overcome these federal provisions by making a variety of regulatory adjustments. Thus, it is difficult to know whether the tax provisions actually do lead to overconstruction.

Utilities and regulators alike agree that construction programs must be based on service needs, not on tax incentives, and that regulators in the end determine the total funds that go to utilities, regardless of the tax code. Often those companies with the greatest needs for capital and the greatest financial problems get hardly any tax benefits, because of a lack of taxable income. The largest, most successful companies, with the best credit, get the lion's share of the benefits.

Because of the confusion over the effect of these tax benefits on growth and on rates, consumers have become convinced that a massive rip-off is occurring, with the federal government in league with the utilities and the regulators. The extent of the problems caused by these provisions is illustrated by letters received from regulators — both Democrats and Republicans — from over twenty states. The National Association of Regulatory Utility Commissioners went on record against these provisions at the time they were enacted, and a study committee of four Republicans and three Democrats recommended in February 1978 that NARUC maintain that position.

Thus, the original Congressional goals are not met by the existing provisions — a federal revenue loss is not stopped, rates are not necessarily lowered, growth may or may not be increased, and this last "goal" is of questionable desirability. Regulation is definitely made more complex, and consumer confidence definitely diminished. These sections should be repealed.

Further Studies

The committee felt that a number of additional areas needed to be studied.

1) Heat Loss Characteristic of Housing Stock

In attempting to determine the energy conservation potential of New England, it was discovered that very little good data exists on what the actual characteristics of the housing stock are. The reasons for this have already been listed in the section on

[1] "A Study of the Treatment of Construction Work in Progress and Tax-Timing Differences for Rate-Making Purposes in the Electric-Utility Industry," March 25, 1977, prepared by Arthur Anderson & Co., for the Federal Energy Administration.

conservation potential. It is important to know these characteristics, particularly as they relate to the socioeconomic level of the inhabitants of the houses, to develop legislation to encourage conservation. If the greatest heat loss occurs in middle or upper income housing, a program of tax incentives and low interest loans could be developed to encourage conservation. However, if the greatest heat loss occurs in lower-income housing the program must consist more of subsidies to accomplish the same end. The Residential Demand Subcommittee therefore recommends that an in-depth program of determining the housing stock characteristics in New England be undertaken, broken out by the income level of the occupants of the residences. The information should be gathered by certified energy auditors who know how to determine accurately the heat loss characteristics of a building.

2) Conservation Potential in Electricity Demand

Extensive studies have been undertaken to estimate the effect of weatherization and improved heating system efficiencies on the growth in residential heating demand. Yet, similar studies with regard to the effect that lighting codes, improved appliance efficiency standards, and rate reform (e.g., time of use rates) have of the growth in residential electricity demand are lacking. Such studies are necessary.

3) EPCA/ECPA Conservation Goals

One of the provisions established in the EPCA/ECPA legislative actions was to mandate a goal for each state to reduce consumption in 1980 by five percent of what initial energy consumption figures had forecast. Many believe, however, that this goal is not strong enough; they claim that states aim for five percent reduction and no more.

4) Energy Education

One of the major problems in promoting demand modification is educating people on what conservation and alternative fuels are and what programs or incentives are available to them. Energy education is vitally important. One part of society where this education is noticeably lacking is among low income groups. The types of programs aimed at college-educated people (e.g., pamphlets on energy) are useless among the poor, many of whom lack a high school education. "Energy mobiles" may be useful education devices among these groups. Also, a developed energy education program has already been employed in the Energy Outreach Program administered by the Department of Agriculture. It may be useful to target one branch of this program to low income groups.

5) Low Income Energy Costs

The General Accounting Office should study the energy cost problems of persons with incomes below the median for the United States; these persons are most hard hit by the escalating energy prices.

COMMERCIAL SECTOR

I. Attributes of the Commercial Sector

The commercial energy-using sector in New England has a number of distinct characteristics. These must be understood and taken into account if we are to determine with any assurance what commercial demand for energy is likely to be and how that future demand can best be fulfilled or reduced. We review these factors.

A) The commercial sector is the least understood and the poorest defined of the four major sectors. It is, in fact, a dumping ground; the major common characteristic of its members is that they do not fit neatly into any of the other three sectors. There does not exist a generally accepted definition of the commercial sector.

B) Energy use data for the commercial sector are of greater uncertainty than those for the other sectors. The dividing lines between the commercial sector and each of the other three sectors are unclear. As a result historical data are probably of lesser quality because the data base has varied among fuel types, among states and utility service areas, and over time. Despite this, however, the existing data seem to show considerable consistency in the figures for the portion of the total energy picture that is attributable to the commercial sector.

C) It is more difficult to define how energy is used in the commercial sector. How much energy is used for what purposes is well understood for the residential and transportation sectors. It is more difficult to find disaggregated data for, or to generalize about, the commercial sector.

D) Energy use by the commercial sector in New England has been growing faster than energy use by the residential and industrial sectors. Data are contained in Table 38, which show that because of declining fractions of the total energy by the residential and the industrial sectors in percentages, and with the commercial sector fraction remaining constant, the net effect is a relative growth of the commercial sector. These results are consistent with the fact that service industries and government have been growing faster than the components of the other sectors. Replacement in the commercial sector as well as net growth has led to greater energy use; new commercial structures and practices have generally been more energy intensive than those which they replace.

Table 38
Energy Consumption by Sector, 1960-1975

	Percentage of total energy	
Sector	1960	1975
Residential	27%	23%
Commercial	20%	20%
Industrial	18%	11%
Transportation	24%	28%
Utilities	12%	18%

E) Energy use by the commercial sector is more visible than that by the other sectors. To the extent that over wasting of energy, conservation of energy, or use of novel technologies influences public attitudes and behavior, the energy use practices of the commercial sector will have greater influence than those of other sectors.

F) The commercial sector impacts directly energy use in the other sectors. The location of a commercial entity can significantly affect energy use for transportation.

G) Economic incentives in the commercial sector are often not sufficient to produce desirable changes in energy use. Rapid turnover, high rate of return requirements, and a bias in favor of first costs, all reduce the likelihood that the invisible hand will maximize the national well being. Competitive forces can lead to increased energy consumption. Retail businesses may stay open longer hours and may heat or cool their buildings

beyond essential levels for comfort in pursuit of competitive advantages or in fear of competitive disadvantage. There are strong incentives to be as up-to-date as one's competitors; being up-to-date has more often than not meant using more energy.

H) There has been excessive emphasis upon first cost in commercial investment decisions. Very often the person making a design or purchase decision will not be responsible for paying the resulting energy bills. Often, commercial enterprises require a higher rate of return for energy saving (and other) investments than do industries or home owners. Established governmental procurement and construction practices have often ignored lifetime costs.

I) We believe the commercial sector's energy use in New England is dominated by heating and, to a lesser extent, cooling. In spite of the difficulty of generalizations, some conclusions can be drawn. In addition to heating and cooling, lighting and ventilation are important both in using energy directly and in requiring the use of additional energy for cooling or heating.

J) The commercial sector's use of electricity and natural gas in New England is highly temperature sensitive. Unlike the industrial sector and probably even more so than the residential sector, the commercial sector contributes disproportionately to winter and summer peak demands for electricity and to winter peak demand for natural gas. Peak demand charges are essential to avoid having those not requiring high peak demand from subsidizing those with high peak demands.

K) The commercial sector in New England may grow more quickly, or perhaps decline more slowly, than other sectors. Such a trend results directly from the expectation that New England's emphasis upon services will continue.

L) The commercial sector is vulnerable to supply interruptions. A chronic or acute shortage of electricity, natural gas, or oil would probably impose political and economic forces that would be disproportionately burdensome to the commercial sector. Many commercial functions are felt to be less essential than heating homes, fueling factories, or maintaining transportation. The reputation of the commercial sector as a major energy waster may set it up as a scapegoat. On the other hand, the commercial sector may well provide opportunities for retrenchment of energy use that could offer real incentives for action.

M) New energy use programs aimed largely or solely at the commercial sector will in many cases be more cost effective than those aimed at other sources. For a combination of reasons discussed above, the commercial sector appears to be the best target for new governmental programs. This conclusion relates to the relative merits of programs focused upon all four sectors, regardless of whether a particular program is cost effective in any or every circumstance and regardless of whether a program is desirable or undesirable for reasons unrelated to cost. Cost could be defined in terms of private dollars expended, public subsidies required, or political capital expended.

II. Demand Projections in the Commercial Sector

To establish demand projections within a sector which is not too clearly defined, which is amenable and sensitive to changes in style and regulation, and which is responsive to varied demands, requires a review of the many factors which impact on the sector. These factors are often conflicting in their impacts, and judgement rather than quantification provides the basis for assessing each factor.

Among the factors that must be considered are the following, but without any order of priority:

A) The best projection at present is that the population of New England during the balance of this century will not change dramatically.[1] Population growth estimates range from essentially zero growth to about 0.7% per year, with actual figures in the mid-1970's showing a 0.47% annual growth. Moreover, the age distribution will move toward a higher proportion of older people, and with the rising cost of living, this will probably result in an increasing number of low and fixed income families. As a result, that part of the commercial sector that caters to general services will probably grow at a smaller rate than government and non-consumer related activities.

B) The commercial sector is very sensitive to regulatory and cost saving incentives. For example, changing standards in lighting and in building code construction practices could substantially reduce space heating and cooling demands and reduce lighting practices. Demand control equipment can be an attractive investment.

C) The projected increase in employment of the existing population which reflects itself in an increasing employment per family could result in a reduction in residential energy demand but in an increased commercial energy demand.

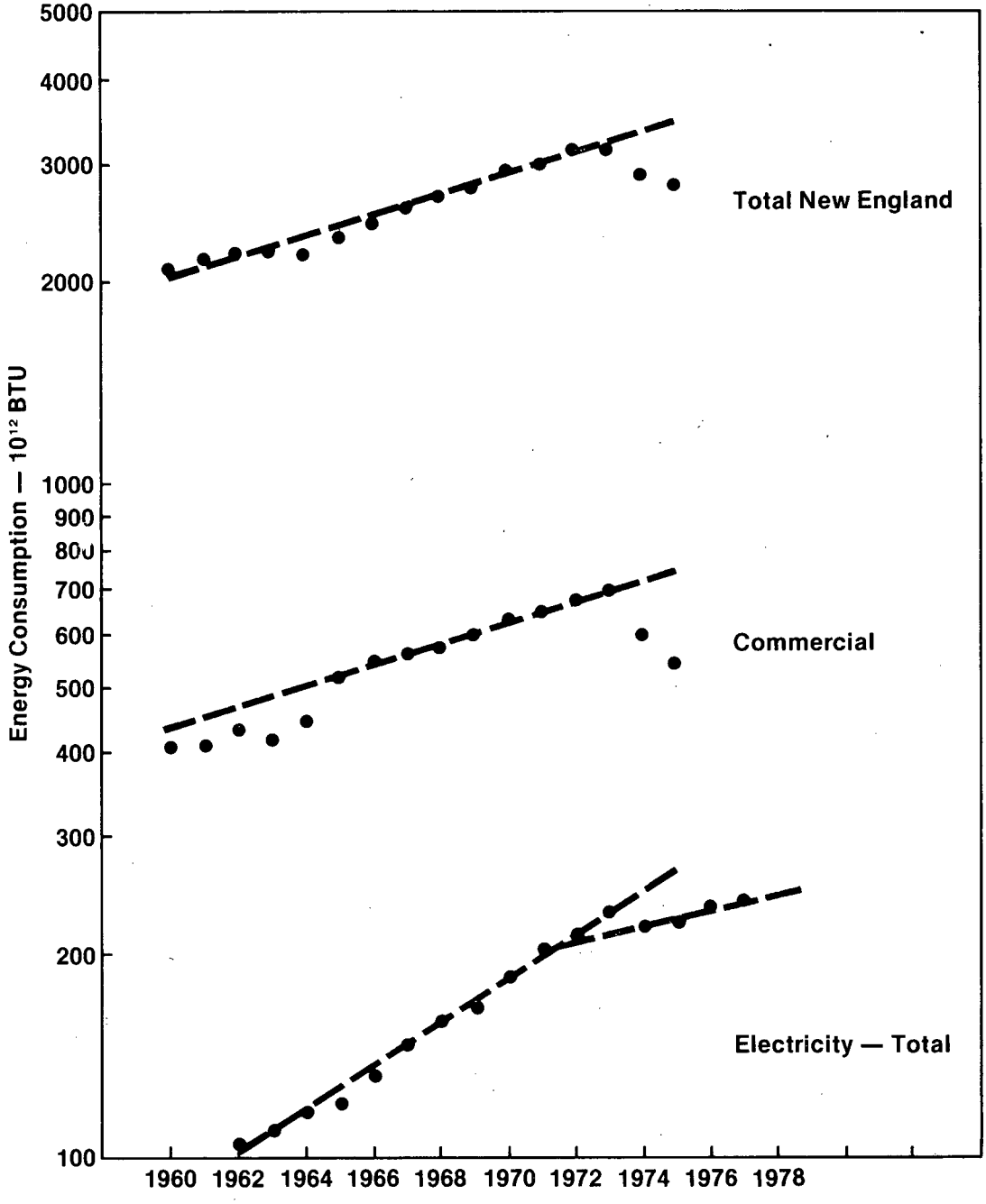
D) Available data show the following trends in total energy consumption in New England during the period 1960 through 1975 (Table 38). These data show that the commercial sector has consumed a fairly constant 20% of the total energy consumed in New England over this 15 year period. If this trend were to continue, this would indicate that all actions at energy conservation or any other actions that reduce total energy demand in any or all sectors might be matched by a corresponding effect in the commercial sector. Note that this constant fractional demand of the commercial sector was maintained even in the 1973-75 period when the total energy consumption fell significantly (see Fig. 4), that is, the commercial sector fell in step with the total decline to maintain the constant energy consumption fraction.

E) As indicated in Table 38, electrical energy (utilities) growth has required an increasing portion of the total energy consumption. But electrical energy growth has suffered marked changes since 1971-72 for a variety of reasons. An indication of the situation is to be found in the sales figures reported by the Electric Utility Industry in New England Statistical Bulletin. The electric energy sales by New England utilities during the 6 year period 1971 through 1977 has increased about 3.4% per annum. This shows there has been a growth rate of electricity sales to 3.4% from the much higher "historic" rate in New England, such as the 6.1% per annum during the period 1965-75 and shows the extent to which electrical energy use has changed during the 1970's.

F) Because energy use is price driven, it is anticipated that electrical energy growth will continue to be impacted by continued rising costs of electricity, as has already occurred, just as other energy use demands will respond to price changes. Rising costs of energy will be countered by many conservation strategies, by the use of alternate sources of energy, by the employment of more efficient electrical equipment and devices, and where feasible, by the employment of special energy control equipment. The increased use of solar hot water heaters and solar space heating will have a considerable impact on oil and electricity use in New England. Replacement of conventional electric resistance heating by heat pumps will reduce the demand for electricity. However, if heat pumps are installed to replace oil heating systems, this would result in an increased electricity use. The impact of improved insulation, weatherization, and more tempered use of energy in home heating is increasingly well understood. These same strategies can have

[1] For purposes of demand projections for the commercial sector the committee utilized population growth rates put forth by the Residential Subcommittee.

FIGURE 4
Energy Consumption
1960-1975



similar impacts in the commercial sector, probably a significant impact in the late 1980's to 1990's.

G) In the residential sector, a zero or negative growth in the use of oil and electricity is entirely possible. There is a marked increase, for example, in the use of wood-burning stoves. Also, there is a widespread reduction in the temperature levels in the home. Efforts at restraint are being impacted by non-economic factors in addition; there is more concern of a socio-political nature that is coming into play in energy use.

H) As indicated in Table 38, the industrial sector in New England has been reducing its total energy demands with time. Some of this has been attributed to energy cost levels and to labor costs, and the consequent loss of energy intensive factories, but with a trend toward the substitution of labor intensive industries. Few users of substantial amounts of energy have been adopting co-generation to provide their electricity and other energy needs directly. Energy control and demand control strategies have been adopted by some larger users of electric energy, and it is expected that such procedures will become of increasing interest as energy costs continue to rise at the faster than normal levels of price escalation. Such control strategies have resulted in reduced electrical energy consumption by upwards of 30% in selected industries without any adverse effect on the operations of the industry.

I) Demand management is likely to increase in importance in the commercial sector. Already there are computer systems available to manage loads in large commercial buildings. These can limit demand by using scheduling techniques; they provide space conditioning only where required in the building; they can provide lighting control. These could result in the reduction of the percentage demand of total energy in the commercial sector, as well as an absolute reduction resulting from all other energy use factors.

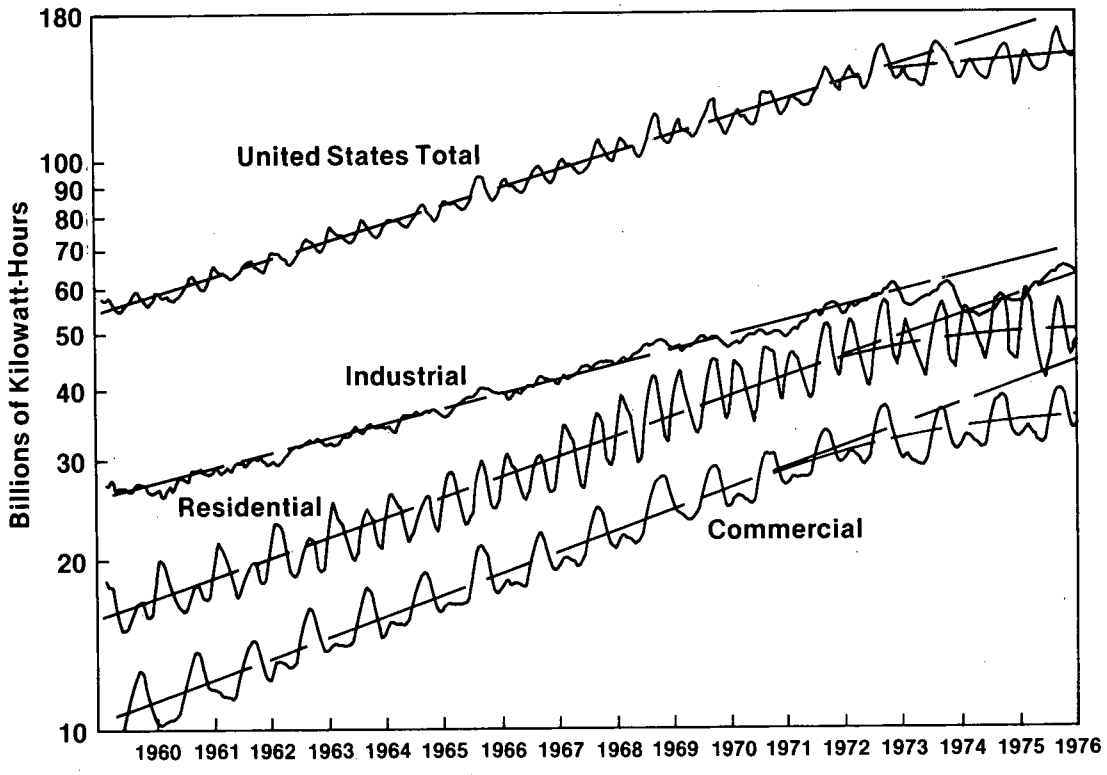
J) A large number of federal and state programs exist which are designed to encourage energy conservation (See Part IV of this Commercial Sector Report).

The foregoing discussion must be assessed in the light of the realities of energy consumption that have existed in the past. The situation is made evident by referring to Fig. 4 which shows the total New England consumption, that by the commercial sector, and the total electrical energy consumption. These curves show that very substantial reductions have occurred in total energy and commercial sector total energy in New England in the 1973-1975 period. Not shown are results which show that the fraction of the electrical energy in the commercial sector has been rising rapidly from about 5% in 1960 to about 13% in 1975. The curves of Fig. 5 show the national monthly total electrical energy consumption.

Fig. 4 for electrical energy consumption shows that deviations in electrical energy consumption growth rate appear to have begun in the 1971-1972 period, and this was prior to the OPEC actions in 1973. The same break from the historic levels is manifest in Fig. 5 which shows that near saturation has occurred in the commercial and residential sectors with considerable reduction in the industrial sector on the national scene. However, a 1% or 2% growth would not be discernable on this logarithmic plot. In light of the fact that the percentage of electrical energy to total energy continued to increase during the 1973-1975 period, the greater part of the reduction in energy use occurred in energy other than electrical.

The curve in Fig. 4 for the electrical energy component includes data beyond 1975. These data were obtained from New England Power Co. sources. However, the available data have been modified to establish the same relative levels as those for the period 1971 through 1977 as contained in the FEDS Statistical Summary, February 1978. These data can be interpreted to show that growth

FIGURE 5
Monthly Residential, Commercial, and Industrial Sales for the United States



in electrical energy sales fell from the 1965-75 rate of 6.1% per year to a 3.4% rate after 1971/72, as shown by the break point in the curve.

An assessment of the many contributing factors suggest that the total energy growth rate in the commercial sector of New England will fall to values considerably below the historic growth rate of 3.6% shown in Fig. 4 for both the total New England energy consumption and consumption of the commercial sector. A bottoming of the growth rate in total energy and commercial-sector energy, which began before the OPEC actions of 1973, is anticipated. With it, it is expected that new trend lines will occur, and these may show a much slower rise in energy than in the past decade. Any estimate of the bottomed level reflects a judgement of the contributing factors discussed above, but 1976 and 1977 data, when available, will more clearly establish these levels. It is our judgement, based on the population trends, the rising costs, the general inflation trends, that future growth of commercial-sector energy use in 1975-85 decade will be about 2.5% per annum. Despite the fact that electrical energy consumes a progressively increasing fraction of the total energy requirements in the commercial sector, our best judgement is that growth of electric sales to this sector will not exceed twice the rates of growth of total energy demand in the commercial sector. This relatively high commercial growth component, when combined with the expected lower growth rate in the residential sector, will probably result in a total electrical energy sales growth for New England that could fall from the indicated 6.1% of 1965-75 to 3.9% or less during the 1975-85 period. These figures appear to be consistent with estimates from a number of different sources.

III. Reasons for Emphasis Upon the Commercial Sector

The commercial sector is particularly suitable for governmental programs intended to influence energy use, for the following reasons.

A) A large share of growth in the near future is expected to occur in the commercial sector.

Recent electric utility forecasts indicate that the commercial sector accounts for 30% of current sales, and is expected to be responsible for 40% of anticipated growth. Conservation measures, new technologies, and fuel shifts can be implemented most easily in new construction; the commercial sector appears to be where a large share of new construction will occur, at least in New England.

B) Much commercial property is subject to fairly frequent renovation.

A major renovation is the best opportunity for retrofit measures.

C) The commercial sector appears to be generally inefficient.

This is not to say that it is the least efficient sector or that there are no exemplary commercial enterprises. It is to say that there exist major opportunities for improvement.

D) The commercial sector is a major contributor to peaks for both the electric and gas utilities.

At least for electric utilities, the commercial sector appears to have a relatively uneconomical load factor. Growth of the commercial sector could consequently mean poorer load factors overall.

E) The commercial sector is a highly visible energy consumer.

Waste in the commercial sector has a major detrimental effect upon public attitudes. Positive steps can have the opposite effect.

F) Economic incentives in the commercial sector are often not sufficient to produce desirable changes in energy use.

Rapid turnover, high rate of return requirements, and a bias in favor of first costs reduce the likelihood that the invisible hand will maximize the national well being. Competitive forces may even lead to wasteful practices as businesses strive to maintain longer hours or more unseasonable interior temperatures than their competitors.

G) New energy use programs aimed largely or entirely at the commercial sector will, in many cases, be more cost effective than those aimed at other sectors.

For a combination of the foregoing reasons, the commercial sector appears to be the best target for new governmental programs. This conclusion relates to the relative merits of programs focused upon the four sectors, regardless of whether a particular program is cost effective in any or every circumstance and regardless of whether a program is desirable or undesirable for reasons unrelated to cost. Cost could be defined in terms of private dollars expended, public subsidies required, or political capital expended. Because of these factors, the existing federal programs listed in Part IV should be supplemented by state actions to foster energy actions designed to reduce energy demand without effecting economic growth.

IV. Existing Federal Programs in the Commercial Sector

A) Prior To The National Energy Act

1) *State Energy Conservation Program (SECP)*

Under the Provisions of the Energy Policy and Conservation Act of 1975 (P.L. 94-163), the Department of Energy has given grants to states to implement State Energy Conservation Plans aimed at saving 5 percent of their energy consumption in 1980. The plans contain different program measures to reach this goal, but all must include the following:

a) Mandatory lighting efficiency standards for public buildings,

b) Mandatory standards and policies for improving energy efficiency through procurements practices for states and communities,

c) Mandatory thermal efficiency standards for new and renovated buildings,

d) Program to promote carpools, vanpools, and public transportation,

e) Traffic law or regulation allowing right turn on red light after stopping.

All New England states have had their plans funded, and will be eligible to apply for further funding in FY 78. The state shares of appropriated funds are:

Table 39

	FY '77	FY '78	FY '79 (Tentative)
Connecticut	$ 345,000	$ 632,900	$ 711,400
Maine	184,000	365,600	383,000
Massachusetts	153,000	1,156,700	146,200
New Hampshire	165,000	339,000	343,500
Rhode Island	179,000	341,000	361,200
Vermont	139,000	283,500	287,000
Region 1 Totals:	$1,576,000	$3,118,700	$3,232,300

2) *Energy Conservation and Production Act*

The Energy Conservation and Production Act of 1976 (P.L. 94-385) provides for Supplemental State Energy Conservation Plans which must contain the following measures:

a) Procedures for carrying out a continuing public education effort regarding:

i) Energy costs/savings from energy conservation and renewable resource measures

ii) Information and other assistance on planning, financing, installing and monitoring energy efficiency and related measures.

b) Procedures for insuring effective intergovernmental coordination.

c) Procedures for encouraging and carrying out energy audits for buildings and industrial plants.

Supplemental State Plans were funded with FY'77 funds and states are eligible to apply for FY '78 funds as follows:

Table 40

	FY '77	FY '78	FY '79 (Tentative)
Connecticut	$ 183,000	$ 359,000	$ 151,400
Maine	99,000	193,400	81,500
Massachusetts	294,000	576,900	243,900
New Hampshire	88,000	173,300	73,100
Rhode Island	93,000	181,800	76,800
Vermont	74,000	145,300	61,100
Region 1 Totals:	$ 831,000	$1,629,700	$ 687,800

In addition to program measures required to be implemented, the following are examples of activities underway in New England oriented toward the commercial sector: Technical Information Sharing Workshops (Connecticut); Computerized Energy Audits for Municipal Buildings (Maine); Energy Conservation Extension Service (Massachusetts); Institutional Conservation Program Utilizing Engineering Students (New Hampshire); Guidelines for Schools and Municipal Buildings (Rhode Island); Promotion of Wood-Burning (Vermont).

A complete descriptive inventory of SECP program measures affecting the commercial (and other) end-use sector(s) is being prepared for the Energy Congress by DOE, Region One.

3) *Voluntary Small Business Energy Conservation Program*

This technical assistance program originated with the Federal Energy Administration as one which could be administered via trade associations and utilizing the Service Corps of Retired Executives (SCORE—a joint SBA-VISTA program). Guidebooks for energy intensive small businesses (e.g., laundry and dry cleaning, printing, real estate management) have been developed, and training sessions conducted, but results to date (as determined by energy conservation actions taken) have been described as sporadic. One-to-one follow-up is said to be required, inasmuch as only generalized information can be presented in publications, workshops and the like. Trade associations or SCORE volunteers cannot be relied upon nor expected to provide the guidance necessary to produce the potential energy savings.

Working through state energy offices, tying in with their respective conservation plans, is believed to be a more coordinated, effective approach to this kind of program.

4) *Energy Extension Service*

Connecticut is one of ten states nationally participating in a pilot Energy Extension Service program. The Connecticut Department of Commerce has the largest role in the commercial sector with a program to train energy technicians who will assist small businesses with energy conservation information. Assistance is in the form of analysis of energy use, recommendations for operational

modifications (such as thermostat control or other actions that can be taken at little or no cost) and suggestions for physical changes in the structure. About one half of the program recipients are said to have gone beyond the analysis and operational phase, although this proportion is expected to increase when tax credits are effective.

5) *Small Business Energy Conservation Loan Program*

Enacted in July and administered by the Small Business Administration, this program provides for direct funds and loan guarantees to firms engaged in the energy conservation business (products or services). (More specific information is forthcoming.)

B) National Energy Act

1) *Energy Conservation*

a) Federal Solar Energy Demonstration Program

The federal government is authorized to spend up to $100 million to demonstrate solar technology by undertaking a 3-year program for installation of solar equipment in federal buildings. The program is designed to stimulate the manufacture of solar equipment, help lower its costs, and thereby make solar energy systems more attractive for widespread commercial use. In addition to this program, the federal government is authorized to spend $98 million over three years to purchase photovoltaic energy devices for use in federal buildings. The purpose is to stimulate the development of a permanent low-cost private photovoltaic production capacity.

b) Energy Conservation in Federal Buildings

Energy audits are required of all existing federal buildings. Each federal agency must retrofit a certain percentage of its total square footage with energy conservation measures or solar energy systems so that by 1990 all federal buildings will be retrofitted to assure maximum efficiency. All new buildings must be designed to minimize their life cycle energy costs. These provisions will strengthen existing requirements for energy conservation in federal buildings.

c) Schools, Hospitals, and Public Buildings Grant Program

Grants to states of $900 million over the next 3 years are authorized to assist schools and hospitals to pay for energy audits and installation of energy conservation and solar energy measures. These grants will generally cover up to 50 percent of the costs. Institutions eligible for grants to schools and hospitals include public and private non-profit elementary and secondary schools, colleges and universities, and hospitals.

In addition, $65 million in grants are authorized over 2 years to conduct energy audits of public buildings. Institutions eligible for public buildings grants include buildings owned by units of local governments and non-profit nursing homes, community health centers, neighborhood health centers and orphanages.

Applications of schools, hospitals, local governments and public care institutions for grants must be made through the state energy agency.

2) *Energy Tax Act: Business Energy Tax Credits*

A variety of tax credits for investment by business is provided. An additional 10 percent of investment tax credit (non-refundable except for solar equipment) is provided for investment in:

a) Alternative Energy Property

This applies to boilers and other combustors which use coal or an alternative fuel, equipment to produce alternative fuels,pollution control equipment, equipment for handling and storage of alternate fuels, and geothermal equipment. This credit compliments and provides a major economic underpinning for the coal conversion regulatory program. The credit is not available to utilities.

b) Solar or Wind Energy Property

A refundable credit for investments in equipment to use renewable energy to generate electricity to heat or cool, or provide hot water. This credit is not available to utilities.

c) Specially Defined Energy Property

This applies to equipment to improve the heat efficiency of existing industrial processes, including heat exchangers and recuperators.

d) Shale Oil and Geopressurized Methane Equipment

This applies to equipment for the extraction and production of geopressurized methane and shale oil (but not for refining).

e) Recycling Equipment

This applies to equipment for the recycling of waste materials.

Industrial Sector

I. Projections

Figure 6 shows electrical energy and nonelectric energy used in the industrial sector, based on FEDS data.[1] The FEDS data extends only to 1975, but electrical data for 1976 and 1977 have been added, and is taken from *Electric Power Statistics* DOE/EIA-00U34.

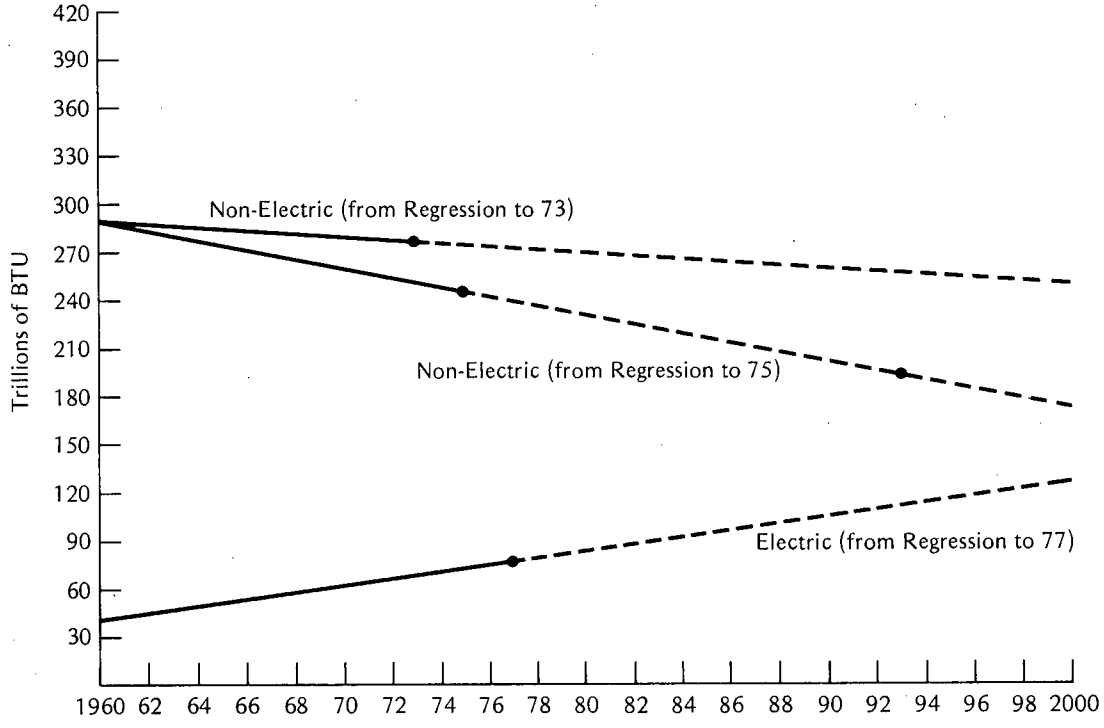
Regression analysis was applied to electrical energy, using data from 1960 to 1976 and the plotted line extended to the year 2000 to represent future energy usage consistent with experienced relationships between electrical usage and industrial product. It is noted that the ratio of electrical energy to total energy has increased over time, and probably will continue to do so, since this form of energy seems closely related to industrial productivity.

The extended plot represents the extreme upper limit of future demand estimate; the effects of conservation and process efficiency would reduce the estimate.

Regression analysis was applied to nonelectrical energy, using data from 1960 to 1973, and again using data from 1960 to 1975, and these two plotted lines extended to the year 2000.

[1]Petrochemicals used for feedstock, averaging 35×10^{12} BTU per year, are not included.

FIGURE 6
Industrial Sector Energy Projections
Based on Straight Line Projection from Regression Analyses
(Chemical Feedstocks Not Included)



The upper line represents energy usage consistent with experience to 1973, whereas the lower line includes the effect of the significant energy reduction in 1974 and 1975. The upper line represents an extreme upper limit to future nonelectric demand estimates; the effects of conservation and process efficiency would reduce this estimate.

These *upper limit* estimates assume no cogeneration nor special attention to conservation and efficiency. Although cogeneration does not in itself alter the demand for electrical energy nor the demand for process or space heat, it does result in a total energy demand less than the sum of electrical and nonelectrical demand, (depending upon the degree of the cogeneration applied because it is more efficient).

As an independent check, the subcommittee examined relationships between electrical energy usage and economic activity for the period 1974 - 1976. Electrical and nonelectrical usage by Standard Industrial Classification (SIC code) is given in Table 41. Value added is the measure of industrial activity; it is derived by subtracting the total cost of materials including supplies, fuel, electricity, cost of resales from the value of industrial shipments. These data are shown in Table 42.

The ratio of energy to value added is given by SIC in Table 43 for total industry in New England. For the period analyzed, virtually every industrial sector shows a declining ratio of energy used to value of production. This is even evident for electrical energy where the decline is not as striking as for nonelectrical, but, nevertheless, distinct.

In order to project future demand, an independent projection of industrial earnings from the Bureau of Economic Analysis was used. Although industry earnings are not identical with value added statistics, for purposes of this study the two factors were assumed to vary together over time. These figures for all SIC groups by state are presented in Table 44.

Table 41
Usage and Growth Rate by Standard Industrial Classification Code (SIC) - 1974-1975

Usage

Standard Industrial Classification Code by Industrial Group	1974 Electric 10^6 KWH	1974 Non-electric 10^{12} BTUs	1975 Electric 10^6 KWH	1975 Non-electric 10^{12} BTUs	1976 Electric 10^6 KWH	1976 Non-electric 10^{12} BTUs
20 Food and Kindred Products	1068.	20.1308	1245.7	18.766	1007.2	18.1
22 Textile Mill Products	1197.1	25.59	1287.5	22.5192	1040.5	25.6
23 Apparel, Cloth, Textile Products	247.6	2.3884	325.	1.0236	289.5	1.6
24 Lumber and Wood Products	317.1	9.2124	368.3	5.118	344.2	5.
25 Furniture and Fixtures	140.1	2.0472	165.6	2.0472	129.4	1.9
26 Paper and Allied Products	3218.9	106.1132	2931.3	95.8772	2970.	99.6
27 Printing and Publishing	551.1	4.0944	637.4	3.412	581.9	3.5
28 Chemicals, Allied Products	1130.8	25.59	1035	21.1544	947.6	21.7
29 Petroleum and Coal Products	81.8	4.0944	92.6	3.412	62.9	3.
30 Rubber, Misc. Plastic Products	1645.8	13.048	1409.7	9.2124	1371.3	9.5
31 Leather, Leather Products	227.2	3.412	254.3	3.0708	192.9	3.2
32 Stone, Clay, Glass Products	702.4	19.1072	729.7	19.4484	712.7	19.2
33 Primary Metal Industries	1620.3	20.8132	1438.9	15.354	1363.4	14.5
34 Fabricated Metal Products	1474.8	19.4484	1502.	17.06	1363.	17.4
35 Machinery Except Electric	1716.3	15.0128	1911.1	12.6244	1591.	12.7
36 Electric, Electronic Equipment	1605.3	10.236	1594.7	8.53	1484.4	9.
37 Transportation Equipment	1194.4	11.6008	1260.5	10.5772	1280.3	11.6
38 Instruments, Related Products	625.1	6.1416	754.6	5.4592	753.6	6.2
39 Misc. Manufacturing Industries	703.8	5.8004	507.8	5.118	378.8	5.5
Total	20015.4	329.258	20147.5	284.902	18609.8	294.1

Growth Rate

	1974 Non-electric	1974 Electric	1975 Non-electric	1975 Electric	1976 Non-electric	1976 Electric
20 Food and Kindred Products	-6.8	18	-3.5	-19.1	5.2	-2.9
22 Textile Mill Products	-13.0	7.6	13.7	-19.2	0.0	-6.8
23 Apparel, Cloth, Textile Products	-57.3	31.1	75.8	-10.9	-13.2	8.0
24 Lumber and Wood Products	-44.4	15.5	-2.3	-6.0	-25.3	4.2
25 Furniture and Fixtures	0.0	17.7	-7.2	-21.9	-3.7	-4.1
26 Paper and Allied Products	69.6	07.4	3.9	-0.4	-63.1	-93.9
27 Printing and Publishing	-16.7	19.3	2.6	-63.4	-7.9	-8.5
28 Chemicals, Allied Products	-17.3	-8.5	2.6	-3.4	-7.9	-8.5
29 Petroleum and Coal Products	-16.7	18.2	-12.1	-32.1	-14.4	-12.9
30 Rubber, Misc. Plastic Products	-32.5	-10.7	3.1	-6.7	-16.6	88.7
31 Leather, Leather Products	-10.0	11.8	4.2	-24.1	-3.2	-7.9
32 Stone, Clay, Glass Products	1.8	3.9	-1.3	-2.3	0.2	0.7
33 Primary Metal Industries	-26.2	-11.2	-5.5	-5.1	-16.5	-9.3
34 Fabricated Metal Products	-12.3	1.8	2.0	-.3	-5.4	-3.9
35 Machinery Except Electric	-15.9	11.8	0.6	-16.7	-8.0	-3.7
36 Electric, Electronic Equipment	-16.7	-0.7	5.5	-6.9	-6.2	-3.8
37 Transportation Equipment	-2.8	5.5	9.7	1.6	0.0	3.5
38 Instruments, Related Products	-11.3	28.7	13.6	-0.2	0.5	9.8
39 Misc. Manufacturing Industries	-11.8	-27.8	7.9	-25.4	-2.6	-26.6
Total	-13.5	0.7	3.2	-7.5	-5.5	-3.6

Compiled by: The New England Regional Energy Project, Burlington VT from the Census of Manufacturer's Data, U.S. Bureau of Census

Table 42
Value Added by SIC: 1974-1976

Standard Industrial Classification Code by Industrial Group	Usage 1974	1975	1976
20 Food and Kindred Products	1378.8	1419.4	1573.
22 Textile Mill Products	2762.9	992.7	1143.8
23 Apparel, Cloth, Textile Products	747.1	752.8	846.9
24 Lumber and Wood Products	432.8	383.5	453.6
25 Furniture and Fixtures	396.4	311.1	359.6
26 Paper and Allied Products	1638.8	1566.7	1818.5
27 Printing and Publishing	1593.3	1018.5	1828.
28 Chemicals, Allied Products	1350.5	1402.7	1523.1
29 Petroleum and Coal Products	2.	2.	2.6
30 Rubber, Misc. Plastic Products	1271.9	1181.1	1281.9
31 Leather, Leather Products	646.4	662.9	798.7
32 Stone, Clay, Glass Products	645.7	651.5	744.
33 Primary Metal Industries	1335.2	970.3	1102.2
34 Fabricated Metal Products	2536.2	2496.1	2927.2
35 Machinery Except Electric	4273.9	3974.2	4716.2
36 Electric, Electronic Equipment	2975.1	2865.5	3329.3
37 Transportation Equipment	2306.	2519.	2852.7
38 Instruments, Related Products	1810.7	1958.3	2213.2
39 Misc. Manufacturing Industries	1310.7	1303.1	1579.1
*Total	28092.1	27481.1	31637.3

*Of value added of all SIC Classifications as reported by six New England States

Table 43
Value Added by SIC: 1974-1976

Standard Industrial Classification Code by Industrial Group	Growth Rate 1974		1975		1976	
	Non-electric	Electric	Non-electric	Electric	Non-electric	Electric
20 Food and Kindred Products	1.450023209	0.774586597	1.322107933	0.877243483	1.146295123	0.6378720709
22 Textile Mill Products	0.9262007311	0.7332766296	2.268479903	1.297270072	2.2385449466	0.9098461
23 Apparel, Cloth, Textile Products	0.3196894659	0.3314148039	0.1399723893	0.4317215728	0.2125398512	0.3418349274
24 Lumber and Wood Products	2.128558226	0.7326709797	1.317374517	0.9428571429	1.102292769	0.7588183422
25 Furniture and Fixtures	0.5164480323	0.3549445008	0.6588052073	0.5323047252	0.5283648498	0.3598442714
26 Paper and Allied Products	6.475054918	1.964181108	6.11959107	1.902916959	5.477041518	1.633214188
27 Printing and Publishing	0.2569760874	0.3458858972	0.2108124807	0.4061785604	0.1914660832	0.3073851204
28 Chemicals, Allied Products	1.894853758	0.8373195113	1.508120054	0.7378626534	1.424725883	0.6221521896
29 Petroleum and Coal Products	204.72	40.9	170.6	46.3	15.3846154	24.19230769
30 Rubber, Misc. Plastic Products	1.073040333	1.293969652	0.77998473	1.244348489	0.7410874483	1.069740229
31 Leather, Leather Products	0.5278465347	0.3514851485	0.4632372907	0.383617439	0.400651053	0.2415174889
32 Stone, Clay, Glass Products	2.959145114	1.087811677	2.985172673	1.12030693	2.580645161	0.957930179
33 Primary Metal Industries	1.558807669	1.213526064	1.502397197	1.480862201	1.31550717	1.236980581
34 Fabricated Metal Products	0.7668322687	0.5814998817	0.6834662073	0.6017367124	0.5944247062	0.4656326815
35 Machinery Except Electric	0.2512669927	0.401577014	0.2176588999	0.4808766544	0.2692845939	0.3373478648
36 Electric, Electronic Equipment	0.344055662	0.5395785016	0.2976792881	0.5565171872	0.2703270958	0.4458949
37 Transportation Equipment	0.5030702515	0.5179531657	0.4198967844	0.5003969829	0.4066323132	0.4488028885
38 Instruments, Related Products	0.3391837411	0.3452256034	0.2787724046	0.3854363479	0.2801373577	0.3405024399
39 Misc. Manufacturing Industries	0.442542153	0.5367360952	0.3927557363	0.2896961331	0.3482996644	0.2398834779
Total	3.372066168	0.712492141	1.036719792	0.7331402309	0.9295989229	0.5882233945

Compiled by: The New England Regional Energy Project, Burlington, VT from the Census of Manufacturer's Data, U.S. Bureau of Census

Table 44
Projected Growth in Industrial Earnings

	1976	1985	2000
Maine	735.435	914,230	1,255,087
N. H.	723,137	965,261	1,371,636
Vermont	347,917	447,538	616,216
Mass.	5,417,171	6,193,164	6,900,687
R.I.	930,855	1,164,160	1,601,500
Conn.	4,112,960	4,994,197	6,161,343
TOTAL	12,267,205	14,678,550	17,906,469
Compound Growth Rates:		1976-85 .... 2.01%	
		1985-00 .... 1.33%	

Source: Bureau of Economic Analysis projections.

For the period 1976 - 1985, industry earnings in New England grew at 1.01%; for 1985 - 2000 earnings grew at 1.33%. For the projection given in Table 45, it is assumed that energy use per unit of output remains constant. This assumption is obviously conservative in light of the rather steep decline indicated by data in Table 43. These data from the three years were too limited to allow an interpretation in depth. Moreover the period contains effects from both the rapid price rise in energy and a business recession. For these reasons, (shortness of the period covered and the unusual one-time occurrences) these data were not considered complete for determination of reliable projections.

Table 45
New England Industries By Size and Energy Use Compared With Leading U.S. Energy Users - 1976

(a) Rank	Sic Code	Employees (10^3)	% National Employee	Employee Rank	Energy 10^{12} BTU	Energy Rank
1	Chemical	856.5	3.7	10	25.1	3
2	Primary Metals	1102.0	4.8	7	19.1	6
3	Petroleum	143.8	1.6	19	3.3	16
4	Stone-Clay-Glass	580.5	4.3	14	21.5	5
5	Paper	615.2	10.3	13	109.8	1
6	Food	1480.5	3.7	4	21.5	5
7	Fabricated Metals	1442.1	7.9	5	22.0	4
8	Transp. Equip.	1679.2	6.3	2	16.0	8
9	Machinery	1990.7	8.1	1	18.4	7
10	Textile	884.5	7.1	9	29.2	2
	Tobacco	63.0	0.5	20	-	19
	Apparel	1323.5	4.8	6	3.0	17
	Lumber	632.5	4.2	12	6.1	13
	Furniture	435.3	4.3	16	2.2	18
	Printing	1082.1	7.1	8	5.5	14
	Rubber-Plastics	648.6	9.7	11	14.1	9
	Leather	253.5	23.5	18	5.0	15
	Electric Electronic	1610.2	8.5	3	14.0	10
	Instruments	522.5	14.5	15	8.7	11
	Miscellaneous	433.9	16.5	17	6.7	12

(a) First ten industries rankes as most energy intensive from among 50 most energy consumative corporations in the industry.

II. Conservation

Increased energy prices provided incentive for conservation that has been lacking during the past several decades of cheap energy. Cost reduction efforts in industry generally has been directed to areas other than energy usage. It cannot be assumed that energy consumption is inelastic and will be reduced as price increases. To remain competitive, industry must consider other factors, chiefly productivity per man-hour, which is usually energy dependent. It is this need to increase productivity per man-hour in order to remain competitive that has been the prime reason for the increase in energy usage (especially electrical).

Although some reduction in the electrical energy usage relative to value added can be expected through non-technological conservation practices (shutting off unneeded machinery, etc.), it is expected that conservation will have its major impact on nonelectric energy demand—especially for space heating. This has been the most neglected area and the one most amenable to improvement both by capital expenditures and, in particular, operating procedures (reduced thermostat settings, better ventilation control, etc.).

Conservation, other than that voluntarily undertaken because of cost factors, may be encouraged by legislation and tax incentives. Legislation without tax incentives may have small impact, because it must not be allowed to create a regional cost disadvantage to industry. On the other hand, there is a possibility that new, more-efficient energy-using technologies could lower the cost of production and make regional industry more competitive.

III. Cogeneration

As noted under Section I, *Projections*, the baseline projection assumes no decrease in the electricity use per dollar of value added, despite indications in recent years that this ratio may continue to decline. Figure 6 shows purchased electricity, and does not include that self-generated by industry (mainly the paper industry), and assumes no increase in self-generated electricity. It is generally accepted that efficiency improvements to existing processes, introduction of new, more efficient processes, and a shift to electric cogeneration and process heat could substantially reduce industrial purchased electricity below existing baseline levels.

To show what the impact of cogeneration or self-generation could be on purchased electricity demand, results of the Thermal Electron Corporation *Reference Study of Cogeneration in New England* were used to calculate the reduction of purchased electric demand and the use of non-electric energy. In making these calculations, plant boilers were assumed to normally operate at an 84% efficiency. This is consistent with the use of steam turbines which produce a relatively large amount of process steam per unit of input compared to gas turbines. If industries can sell energy to electric utility grids at higher prices than are currently attractive to utilities (designated rate reform in Table 46), then it is more likely that gas turbines would be used, since they have a relatively high ratio of electricity generated to steam produced.

Table 46 summarizes the data from the Thermo-Electric report and shows the impacts on the amount of electricity purchased and the additional fuel required for the cogeneration equipment. At this time, the subcommittee offers no recommendations for legislation intended directly to reduce industrial demand. Industrial demand will, however, be indirectly influenced by the goods, services, and jobs required to support the other sectors and will be moderated indirectly by current and new legislation intended to reduce energy consumption in all sectors.

Table 46
Base-Line Low Electricity Projection

	1976[1]		1985[2]		2000[2]	
	10^6 KWH	10^9BTU	10^6 KWH	10^9 BTU	10^6 KWH	10^9 BTU
Purchased	18610	63.5	22268	76	27165	(92.7)
Self-Gener.	3769	12.9	4510	15.4	5502	(18.8)
TOTAL	22379	76.4	26778	91.4	32667	(111.54)

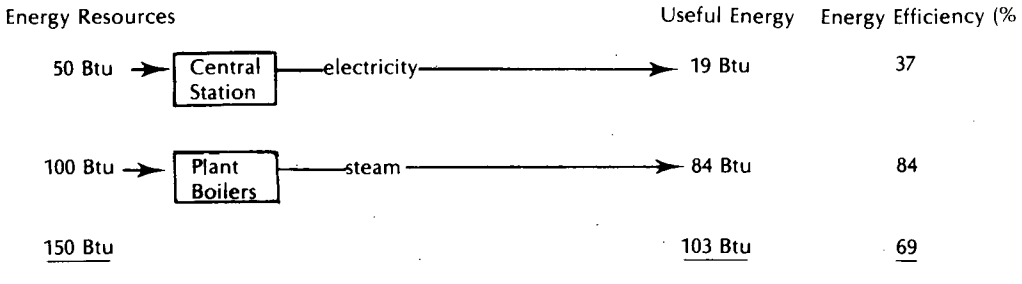
Economically Feasible Cogeneration of Electricity by 1985[1]

	No Rate Reform	Rate Reform
Cogeneration	5710	16,320
Additional Fuel (10^{12} BTU)	5	63
Adjusted Purchased Electricity (10^6 KWH)	21068	10458
Percent Decrease in Purchased Electricity	5.4%	53%

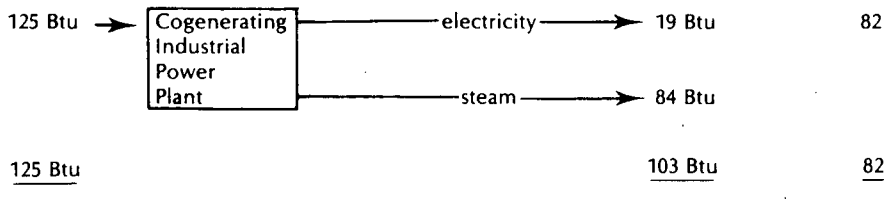
[1] Annual Survey of Manufacturers
[2] Based on growth at BEA earnings rate. See Table 44.
[3] Bases on Thermo-Electron Report. *A Study: Inplant Electric Power Generation in the Chemical, Petroleum Refining, and Pulp and Paper Industries.* TE-5429-97-76

Table 47
Cogeneration Versus Separate Generation Of Electricity and Steam For A Large Industrial Plant

Separate Generation Mode



Cogeneration Mode



Source: Bernow, S.S., *Industrial Cogeneration in NY State*, Energy Systems Research Group, Inc., Proposed for New York State Energy Office.

IV. Nature of New England Industry

Over the past eight decades there has been a steady trend toward centralization of manufacturing and of energy production into capital intensive and highly efficient units. Although these have reduced the labor input per unit of produced output, other industries have been created (notably related to entertainment and recreation). Overall employment has not, therefore, declined in relation to total production. However, the nature of industry today is such that the employment opportunities for the unskilled are few.

The philosophical question which was not formally addressed by the full committee relates to the question of either instituting changes in the industrial sector to provide more jobs for the unskilled by deliberately reducing productivity by decentralization, or continuing existing policies which emphasize highly centralized efficient capital intensive basic industries.

History suggests that the latter is the best course, if the objective is to increase the overall standard of living. Of course, it does not preclude the development of additional cottage industries for those who prefer to exercise craftsmanship.

New England uses about 23,200 BTUs per dollar of value added in manufacturing, versus 44,000 BTUs nationally. In New England, 21.6 percent of energy used in manufacturing is in the form of electricity which compares with 10% nationally (1971 data, Eisenmenger-Syron paper). This is attributed to the high technical sophistication which characterizes much of the New England industry. The more energy intensive industries are commonly located elsewhere. Engineering and manufacturing skills somewhat moderate the regional disadvantage of high cost energy; at the same time this type of industry tends to depend more heavily on electric energy, which is used to enhance work's productivity. (See Table 45)

V. Discussion of Some Energy Constraints in Industrial Sector

Energy demand in the industrial sector of New England depends on many factors exclusive of regional population growth. One major consideration is that industries in New England as a group are not energy intensive. (Table 45)

Increase in industrial energy demand would occur as a result of growing population. However, other factors exist which tend to exert a negative influence on industrial growth, such as local taxes, environmental regulatory and licensing activities, relative cost of regional energy vs. national costs and the region's public attitude in developing additional energy capacity—particularly electrical. It is possible that when considered together, these factors could create an investment climate detrimental to the production of the energy growth within the New England industrial sector.

Over the past decade, development of New England energy resources has progressed slowly. These developments have been evident in several ways, specifically in establishing new baseload electric generating power plants, building oil refineries, promotion of offshore oil production and in exploring indigenous energy resources including wood, other biomass and solar. This slow progress has resulted in a regional dependency on oil imports. To overcome this dependency, coal has been promoted by the DOE as a fuel replacement for oil throughout the country, including New England. Utilization of coal must meet strict air and water pollution regulations as directed by state and federal agencies. These regulations could restrict the wide use of coal within the New England industrial sector. In addition, the infrastructure for expansive regional coal utilization is not well developed. Transportation modes for handling vast quantities of coal and for disposing of ash are not established. Doubt may exist within the industrial sector concerning the establishment of an effective infrastructure in a manner which would provide as efficient, reliable supply of energy. The future energy posture of New England appears uncertain, and may both discourage new industries from locating in the region and encourage established firms to leave.

Part of the region's energy dilemma stems from regional state and federal energy policies and regulatory activities, especially those involving energy, economic and environmental issues. Generally problems arise not from the policies and regulations per se but usually from their implementation and management. Improvements in the regulatory process could be achieved at the state level. As an example, the work of the Massachusetts Facility Siting Council to integrate energy need, economic viability and environmental impact questions into one review process should be monitored and considered for implementation on a regional basis.

EPA's air regulations, especially recent amendments to the Clean Air Act, could create limitations on industrial growth. Of particular concern is the Prevention of Significant Deterioration concept (PSD) and attendant offset policy. Under these amendments a new industry must meet more rigid requirements before it can locate and operate in any area and particulary where air pollution standards are in violation. Since these regulations are designed to improve air quality, some industries might consider locating in areas in which they could meet air regulations more easily than in New England. Part of this difficulty arises from the fact that current air quality in many sections of New England are in violation of EPA and state standards and therefore will require more pollution control equipment than in some other regions.

Many factors affect industrial energy demand. It is important to recognize that demand projections capture only a few of these. Other factors not included can affect the overall level of industrial activity and, thereby, industrial energy usage. Among such factors are energy costs, availability of labor force, markets for goods and services, taxes, and oil and gas deregulation. Although current status and interrelations among these factors might be known, their projections to the year 2,000 may be so doubtful as to be of little value for estimating future industrial growth. However, their potential influence on industry could be significant. Efforts to monitor these should be undertaken on a continuous basis to insure future industrial growth in conformity with established environmental standards and socio-economic needs for employment.

TRANSPORTATION SECTOR

Demand Estimation Projections

I. Overview

1) The transportation sector energy demand for 1985 is estimated between 788-830 x 10^{12} BTU (Table 41) which is equivalent to, or slightly larger than, 1975 consumption of 786 x 10^{12} BTU. This is a significant decline compared to consumption patterns projected to 1985.

2) The estimated transportation sector energy demand for the year 1985 is primarily based on increased efficiency of gasoline engines as mandated by the federal government for automobiles and personal use trucks. The vehicles account for 80% of the sector demand in 1975 and 70% in 1985.

3) The transportation sector energy demand for aviation and other fuels is anticipated to grow at a 2% combined growth rate from 1975 through 2000. These fuels will account for 20% in 1975, and 30% in 1985.

4) Modal shifts from automobiles to mass transit and non-powered vehicles anticipates a decrease in transportation sector energy demand by about 4% by 1985. This is a relatively minor impact on the future demand.

II. Alternative Transportation Sector Projections for 1985

Table 48
Estimates for Automobile and Personal Truck Gasoline Consumption 1985

	Case			
	Conservation/Demand Transportation Committee "Best Case"	DOE data "Best Case"	Enforcement Slippage Case	Conservation/Demand Transporation Committee "Best Case"
Automobiles (see (a))				
VMT x 10^6	71,289	77,451	77,451	71,289
M.P.G.	18.6	18.6	17.3	13.4
BTU/VMT	6,720	6,720	7,225	9,328
Personal Trucks (see (a))				
VMT x 10^6	4,332	4,337	4,337	4,332
M.P.G.	16.9	16.9	15.7	12.2
BTU/VMT	7,396	7,396	7,950	10,246
Gasoline Consumption (BTU x 10^{12})				
Auto and light truck	511.1	552.5	594.1	709.4
Less "modal shifts" see (b)	- 23.2	- 23.2	- 23.2	
Other gasoline consumption (see (c))	72.0	72.0	72.0	72.0
Total Gasoline	559.9	601.3	642.9	758.2
N.E. Energy Use In Transporation	747	788	830	945

[1]VMT assumes no change in 1976 use per vehicle; Conservation/Demand Committee's Transportation (CDTC) "Automobile Report," Tables 1, 3, 4. DOE estimates of *in-use-fleet* fuel economy.

[2]DOE estimates for number of vehicles, vehicle use, and fuel economy.

[3]M.P.G. enforcement slippage, with "best case" standards for new vehicles. This case mandates the same fuel economy standards (27.5 for new cars in 1985) as (1) and (2) but allows for decreased performance of vehicles because of poorer maintance of vehicles.

[4]DOE estimates; see CDTC "Automobile Report," Table 2.

A) Auto and light truck vehicle miles travelled × fuel efficiency (in BTU/VMT); efficiency estimates for 1985 are based upon automotive transportation recommendations on fuel standards. VMT for 1965 and 1975 are Department of Transportation (DOT) data.

Table 49

			1985	
	1965	1975	"Best Case" Low	High
Auto:				
VMT × 10^6	37,543	56,682	71,289	77,541
MPG	14.3	13.4	18.6	18.6
BTU/VMT	8741	9325	5952	5952
Light Truck				
VMT × 10^6	1,370	2,489	4,332	4,337
MPG	10.2	12.2	16.9	16.9
BTU/VMT	12255	10246	7396	7396

"Low" VMT projections for 1985-2000 are based on New England vehicles-sales forcasts by DOT. "High" VMT projections are based on vehicles-sales forcasts and a vehicle fuel-use model designed for study of fuel-economy alternatives by Department of Energy; it appears to show the expected elasticity of miles-travelled (increase) with cost-per-mile (decline) and is, therefore, apparently the more appropriate projection to use with the M.P.G. estimates given here. For further description of automobile and light truck energy consumption refer to Conservation/Demand Transportation Committee "Automobile Report."

B) The recommendations for affecting modal shifts, of the CDTC, are estimated to produce the following changes from historic-trend levels in 1985 (all in BTU × 10^{12}):

Table 50

Substitute:	Reduction in Mode:	Offsetting Increase in Mode:
Bicycle for Auto	auto : gas –3.5	none
Communications for Auto	auto : gas –1.4	none
Local Transit for Auto	auto : gas –13.1	Local Rail: Resid. +5.8
Intercity Bus for Auto	auto : gas –5.2	Bus: Diesel none +3.5
Communications to Air	air : jet –.6	none

The high and low estimates for gasoline have been reduced, accordingly, by 23.2 BTU × 10^{6} for 1985.

C) 1985 estimate based on FAA estimate of 1.4% annual growth of aviation fuels sales in New England 1975-1985 (giving 59.4 BTU × 10^{12} in 1985 for FAA-reported operations), and fuel savings of 1.5 BTU × 10^{12} resulting from recommendations on air transport of the Conservation/Demand Transportation Committee.

D) If the direct sales of fuels to the transportation sector in New England persisted in 1975-1985 at the growth rate of the 1965-1975 decade, this sector might be estimated to require 1075 BTU × 10^{12} rather than the estimate shown. The effects of the recommendations of the Conservation/Demand Transportation Committee, together with other price and policy influences on transportaiton demand and efficiency, are of major importance—anticipating a one-third "saving" of energy sales below the level of the trend established in 1965-1975. The sensitivity of this estimate to success in improving the fuel efficiency of the automobile fleet actually on the road in 1985 should be underscored. The guess that the automobile average miles per gallon for 1985 will be 18.6 (new car mileage efficiency standards of 27.5 MPG) rather than the observed 13.4 in 1975 account for more than three-quarters (261/346 BTU × 10^{12}) of the "savings." If the fuel economy standards for autos were relaxed from 27.5 MPG to 26 MPG (for 1985), and personal truck standards were comparably reduced, the estimated effect on energy use in transportation would be an increase of approximately 30 × 10^{12} BTU in 1985. (For every mile below the 27.5 standard that is not achieved for the new car fleet there is an increase in consumption of 20 × 10^{12} BTU).

CONSERVATION/DEMAND TRANSPORTATION COMMITTEE REPORT

INTRODUCTION

The Conservation/Demand Transportation Committee agreed that the best way to approach an examination of the transportation sector was twofold. First, we analyzed the four most consumptive modes (auto, truck, rail and air) with an eye towards maximizing their respective efficiencies. Second, we examined ways in which shifts from less efficient modes to more efficient modes could be encouraged.

We felt it important to distinguish between improving modal efficiencies and encouraging modal shifts. Through this process, modes that were inappropriate for examination in the modal efficiency section such as mass transit and bicycles lent themselves to an extensive examination in modal shifts.

In each section of examination a set of recommendations that the committee felt were significant was put forth.

RECOMMENDATIONS

I. Automobile

1) *Maintain existing fuel economy and emission standards for automobiles through 1985.*

2) *Develop more stringent fuel economy standards beyond 1985, with a goal by the year 2000 of 34 MPG for the new automotive fleet, or the technological optimum providing such standards do not adversely impact the emission standards of the Clean Air Act.*

3) *Improve light truck (under 8500 pounds) fuel economy by:*

   a) *Mandating more stringent light truck (under 8500 pounds) standards for model year 1981.*

   b) *Authorizing the National Highway Traffic Safety Administration (NHTSA) to develop progressively more stringent light truck fuel economy standards through 1985.*

   c) *Authorizing the NHTSA to consider light truck fuel economy standards beyond 1985.*

4) *Enforce the 55 mph speed limit, with no exemptions.*

5) *Continue car pool and van pool programs administered at the state and local levels, and provide funding for such programs.*

6) *Direct the Secretary of the Department of Transportation to enforce more stringently the requirement of a "comprehensive, coordinated, cooperative" (3-C) planning process (23 U.S.C. S134) when reviewing urban transportation funds, including the requirement of an Energy Impact Statement.*

7) *Require the Environmental Protection Agency to cut off highway funds if a state submits an inadequate transportation element of a state implementation plan (S.I.P.) to improve air quality in non-attainment areas. (42 U.S.C. S7506 (a)) Failure to develop transportation plans that minimize energy consumption should be interpreted as a violation of both of these statutes.*

8) *Provide substantial support for research and development of alternative sources of transportation energy such as gasohol, which do not have significant adverse environmental impacts.*

9) *Authorize the Department of Energy to maintain an emergency plan for rationing.*

10) *Driver education programs should incorporate energy conservation instruction in addition to safety training. Federal assistance in developing such materials for school and private instruction is recommended.*

Instruction should include gas-saving techniques in driving, trip cost information, transportation costs (both in dollars and petroleum), and an overall awareness to limit driving. The opportunities for the use of alternative modes of transportation should be explained and encouraged.[1]

II. Trucks

11) *Increase the federal research into improved efficiency in trucks.*

Fuel-saving improvements through technological development, such as aerodynamic design changes and engine modification, should continue, and results of such research should be available to truck operators, both large and small, through the Department of Transportation.

12) *Encourage the Interstate Commerce Commission to give high priority to energy conservation in its re-examination of trucking regulations, especially those affecting routing and rate structures.*

III. Trains

13) *Continue the Northeast Corridor Improvement Project (NECIP), and make every effort to achieve the original performance goals of the project.*

NECIP has been the crucial legislative issue regarding intercity rail passenger service affecting the New England region, and it is essential that the project be completed.

14) *Study the feasibility of restoring and improving the inland route so that the major population centers of Hartford, Springfield, and Worcester can be serviced by fast rail.*

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[1]This recommendation was approved by the Conservation Committee only.

15) *Encourage integreted rail/truck service (truck on freight car) to achieve the most energy efficient transportation services. Regulatory reform should be undertaken to remove any unfair advantages for one mode, and to promote optimum interface between rail and truck services.*

16) *Fund Amtrak sufficiently to enable it to provide routes, timetables, and fare structures that will attract ridership.*

Other forms of transportation (air, highways) receive government subsidies that are vastly larger than those received by passenger railroads. Also railway passenger and freight operations are conducted by two separate corporations, removing the possibility of subsidizing passenger service out of freight revenues. Realizing that few, if any, other countries operate deficit-free passenger service, and, finally, in view of the need to conserve energy by providing a viable passenger railway service, we have recommended the above.

IV. Air

17) *Revise Airline Flight Procedures.*

Tighten cruising and landing procedures (through the Federal Aviation Administration) to reduce airline fuel consumption. While maintaining noise and safety standards, specific operational changes should include: 1) reduced airline cruising speeds, 2) revised airport descent profiles, and 3) reduced delays when planes are on the ground.

18) *Provide NASA with adequate funding to research improved aircraft engine efficiency.*

There are a number of significant design and technological changes still in the research and development stage that could improve aircraft energy efficiencies in the 1990's. These include new engine designs and body designs that reduce weight and drag. NASA, which has the primary research and development responsibility, should be provided adequate funding to continue this work.

V. Modal Shifts

19) *Eliminate the "Contract Authority" which allows the Federal Highway Administration to obligate authorized highway funds prior to appropriation of the funds.*

Once obligated, the authorized funds must become a debt of the federal government. Most other federal programs must negotiate the legislative process twice before the expenditure of any funds: once to authorize a program and set maximum federal funding limits for a period of years in the future, and a second time actually to appropriate the authorized funds. Until the authorized funds are actually appropriated, the program cannot be implemented. Since all other transportation projects (long-term public transportation planning) cannot use "Contract Authority," they are at a distinct disadvantage to highway planning. Therefore, the funding structure for all transportation systems must be put on an equal footing if transportation planning is to be based on merit rather than funding availability.

20) *Consider energy conservaiton and alternative transportation modes inthe planning and construction of projects funded from the Highway Trust Fund including consideration of energy conservation and alternative transportation modes. In particular:*

a) *All highway categories incorporated in the Federal-Aid Highways Act should be opened up to allow funding of alternative transportation modes.*

b) *Money from the fund should be allowed to be used for operations and maintenance of transit systems under the same restrictions that now apply to UMTA.*

c) *When a locality decides to replace a planned interstate highway segment with a mass transit project, it should be funded with Highway Trust Fund monies, not with UMTA appropriations of general revenues.*

d) *In planning highway transportation projects, analysis of energy consumption should be one criterion for evaluating the project, much the same as environmental, social, and aesthetic impacts.*

e) *Congress should not authorize any deficit spending of the Highway Trust Fund.*

21) *Encourage the substitution of communications services for personal transportation. The technologies and services which can substitute for personal transportation should be encouraged and expedited.*

22) *Encourage the use of bicycles as an alternative mode of personal transportation and institute efforts to increase the safety of this mode. In particular:*

a) *Existing bikeways programs should be expanded, but with the recognition that most bicycle traffic takes place on existing streets and along high-volume routes.*

b) *Secure parking facilities for bicycles should be provided wherever they can encourage their use or increase their convenience. Secure parking facilities and provision for transporting bicycles on mass transit modes should be provided.*

c) *Use of bicycles on major traffic routes should be expedited, particularly at overpasses, bridge crossings, dangerous intersections, etc., and bicycles should be considered in all phases of transportation planning.*

d) *Public education is needed and should be directed to both the cyclist and the motorist, with the purpose of increasing bicycling safety.*

e) *The Department of Transportation or another appropriate authority should undertake a study of the potential for and problems of bicycle, moped, and other low-power vehicle transportation.*

23) *Expand and improve intracity and intercity bus service as a substitute for the automobile and for short air flights (under 400 miles). The highest priority items should be:*

a) *Studying existing problems of improving intermodal connections, such as more efficient rail-bus connections.*

b) *Upgrading the available facilities and services to make this mode more attractive.*

c) *Upgrading the vehicle fleet with newer, more comfortable, and more energy efficient buses.*

d) *Providing frequent and reliable express service along major routes, and encouraging ridership.*

24) *Develop policies to discourage the use of the automobile in urban areas where there are public transit services. These should include:*

a) *Increases in parking fees in congested areas, and provision for increased tolls in rush hour.*

b) *Promotion of auto-free zones, limitations on parking facilities in certain areas, and provision for parking along major mass transit routes.*

c) *Upgrading of traffic law enforcement, particularly in congested and high-flow areas, more stringent penalties for parking violations, and greater emphasis on collection of fines.*

25) *Investigate the potential in specific metropolitan areas of light rail as well as bus service as an alternative to the automobile.*

26) *Develop national land-use planning act. Vigorous implementation of such an act could result in a significant energy savings over the long-run because of the interrelationships of energy, land-use, and transportation.*[1]

AUTOMOBILE REPORT

I. Introduction

In 1975, 29.6% of all energy consumed in New England was used for transportation, and almost three-fourths of this energy fueled automobiles and personal use trucks. Currently, the region relies on petroleum to meet 80% of its energy needs, and a disproportionate amount, nearly 33%, fuels automobiles.

The automobile habit will be a difficult one to break. New Englanders own 6.5 million cars, averaging 1.62 per household. Moreover, in 1970, 65% of the region's work force was driving unaccompanied daily to their place of employment while only 11.7% of the work force carpooled. These figures indicate the severity of the transportation problem in New England, a problem which must be confronted if we are going to succeed in reducing our dependence on oil and reduce the impact of high energy prices.[2]

While the potential reduction in automobile fuel consumption is significant, the degree of fuel savings realized depends on how vigorously certain measures are pursued. In descending order of importance and practicality, improving fuel economy, reducing the amount of single-passenger automobile trips, and more conscientious driving on the part of the public can all contribute to substantial gasoline savings. Moreover, these improvements in automobile technology and practices can lessen the current detrimental environmental effects of the auto. Ultimately, the cost to the consumer will be much less than if we were to continue along our presently gluttonous energy path. The following are some of the possible measures that exist for saving energy through improved fuel economy and through policies that promote reductions in automobile travel as well as increases in load factors (i.e., amount of passengers in each vehicle).

II. Fuel Economy

A) Introduction

In 1976, New Englanders drove autos that consumed 4.5 billion gallons of gasoline, averaging 13.4 MPG.[3] If the New England fleet in that year had met the 1985 federally-mandated standard of 27.5 MPG, the region would have saved 2.3 billion gallons of gasoline, or more than half of the region's automobile energy consumption. On the other hand, if New Englanders continue to drive vehicles that obtain an average of 13.4 MPG, over 7.2 billion gallons of gasoline will be required to meet regional demand in 2000, a 65% increase in annual consumption. In contrast, fuel economy measures in

[1]This recommendation was approved by the Demand Committee only.

[2]All data above extracted from *The Regional Transportation Energy Conservation Data Book*, Oak Ridge National Laboratory, 1978. ORNL-5435.

[3] ORNL-5435.

effect through 1985 can result in a reduction in annual automobile energy demand by that year. Extension of fuel economy standards to the year 2000, when new cars would get 33.7 MPG and the average of all cars on the road would be 32.1 MPG, could result in a 25% reduction in automobile energy consumption over current annual levels. In both the 1985 and 2000 case, these reductions can occur without eliminating the anticipated growth in automobile sales and the consequent rise in annual vehicle miles traveled.

Technological changes in automobile design can, therefore, dramatically improve fuel economy. Lighter, smaller vehicles with modified engine and drivetrain designs will lead to significant fuel economy savings. In fact, such vehicles have helped improve the U.S. fleet mileage over the past few years. Small car sales have been largely responsible for the strong entry of foreign car manufacturers into the American market. These manufacturers have combined to take the lead in the field of improving automobile energy efficiency.

Volkswagon, for instance, has developed a prototype turbocharged diesel engine car that can obtain 60 miles to the gallon. A Federal Task Force, convened to study the prospects for motor vehicles beyond 1980, concluded that a new car fleet incorporating advanced engine designs, such as the Stirling engine, could reach a new car fleet fuel economy of 33.7 MPG in the year 2000.[1] (However, Stirling engine requires further development). Advanced diesel engines also fared well in their estimations, but uncertainties about the pollution effects of diesel particulates and its currently unacceptably high nitrogen oxide (NO_x) levels make the diesel option less attractive. From what we know today, the Stirling engine can probably meet all presently designated auto emission requirements. The resultant savings of such an improvement on the 1985 standards would amount to 798 billion gallons of gasoline nationally, (cumulative savings from 1975 - 2000)[2], or 44 billion gallons in New England alone.

B) Automobile Energy Demand

Estimates of the demand for automobile and personal use truck fuel depend on assumptions regarding vehicle efficiency, vehicle miles traveled (VMT), and load factors. For the purposes of discussion, we will assume that load factors do not change. Our VMT projections rely exclusively on vehicle purchase trends and do not account for an increase in the annual use of each automobile. (A more detailed discussion of VMT can be found in the next section.) Projections are based on the most recent data available from the Department of Transportation (DOT).[3] These are presented in Table 1 (modified for New England) and indicate a 53% increase in VMT from 1976 to 2000.

As a set of baseline data for calculating energy savings from fuel economy improvements, we have used the existing fleet efficiency for New England of 13.4 for automobiles and 12.2 for personal use trucks.[4] The resulting energy demand is presented in Table 2 and demonstrates, as expected, a 53% increase in the region's demand for fuel from 1976 to 2000 (see worst case data). Table 2 also illustrates the effects of fuel economy standards on gasoline consumption in New England. The best case data show emphatically the significant role fuel economy measures can play in New England. By

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[1]*The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980*, Vol. 2 the Task Force Report, 1976.

[2]Federal Task Force Report

[3]*Transportation Energy Conservation Data Book*, Oak Ridge National Laboratory, Edition 2, 1977. ORNL-5320.

[4]*Automotive Fuel Economy Program*, Third Annual Report to Congress, Department of Transportation, 1979 (soon to be issued).

Table 1
Projected Vehicle Miles Traveled (VMT) in New England
All Autos and Personal Use Trucks, 1976-2000[1]

	VMT (in millions)					
	1976	1980	1985	1990	1995	2000
Automobiles	60127	64584	71289	78362	83137	88203
	56712	**67332**	**77451**	**86680**	**98746[2]**	**110,811**
Personal Use Trucks	2547	3225	4332	5820	6626	7545
	2483	**3660**	**4337**	**4759**	**5164[2]**	**5568**
Total	62674	68079	75621	84182	89763	95748
	59195	**70992**	**81788**	**91439**	**103,910[2]**	**116,379**

[1] DOE projections in bold—adjusted for New England.
[2] Interpolated from 1990-2000 rate of growth

NEEC assumptions:
24 year average rate of growth (autos and personal trucks): 2.20%.
VMT compounded growth rate identical to auto sales growth rate:

	1976-1990	1991-2000
Autos	1.91%	1.19%
Personal Truck	6.08%	2.63%

DOE assumptions:
1975 for DOE baseline.
VMT average growth rate = auto sales growth rate + projected annual vehicle use increase. This results in a somewhat higher projection: 25-year rate of growth (autos and personal trucks): 3.86%.
The VMT per vehicle average growth rate for DOE
Autos — 1.17%
Personal Truck — 3.70%

Source: (for VMT compounded growth rate) *DOT 1979 Annual Report to Congress on Fuel Economy Standards* (prior to publication).

retaining existing standards for autos through 1985, establishing standards for personal use trucks, and extending all standards to 2000 with gradual improvements, a tremendous reduction in gasoline consumption from current levels occurs, an annual savings of 28% in 1985 and 58% in 2000.

Several studies have estimated the effects of the existing fuel economy standards on automobile and truck energy demand. Specific assumptions used in these studies and a more detailed discussion of each can be found in Appendix 1. We have relied on the Department of Energy's figures for obtaining average fleet fuel economy as a result of the mandated 27.5 MPG in 1985. DOE's data account for the differences between fuel economy obtained in use and fuel economy as measured by the EPA in their certification tests. DOE estimated that the 27.5 MPG standards will result in an overall U.S. fleet in-use average of 22.3 MPG for 2000. Using the DOE's national data, which has somewhat different assumptions regarding VMT, results in a comparable energy demand projection, when adjusted for New England. This projection is presented in Table 3, and indicates a 21% increase in fuel demand from 1976 to 2000.[1]

[1]DOE Comments on the Prospective DOT 1979 Report to Congress, 15 September 1978.

Table 2

Gasoline Consumption
Automobile and Personal Truck, 1976-2000
Best & Worst Cases, New England Energy Congress, 1979

	1976	1980	1985	1990	2000
AUTOMOBILE					
In-use Fleet Avg	**13.4**	—	**18.6**	—	**32.1**
Fuel Economy, MPG	*13.4*	*13.4*	*13.4*	*13.4*	*13.4*
Energy Consumption:					
Gal/Yr (millions)	**4490**	—	**3833**	—	**2748**
	4490	*4840*	*5320*	*5848*	*6582*
Bbl/Yr (millions)	**106.84**	—	**91.26**	—	**65.43**
	106.84	*115.23*	*126.67*	*139.24*	*156.72*
Bbl/Yr (thsnds)	**292.70**	—	**250.03**	—	**179.26**
	292.70	*315.71*	*347.04*	*381.47*	*429.37*
PERSONAL TRUCK					
In-use Fleet Avg	**12.2**	—	**16.9**	—	**25.0**
Fuel Economy, MPG	*12.2*	*12.2*	*12.2*	*12.2*	*12.2*
Energy Consumption:					
Gal/Yr (millions)	**208.80**	—	**256.33**	—	**301.80**
	208.80	*264.34*	*355.08*	*477.05*	*618.44*
Bbl/Yr (millions)	**4.97**	—	**6.10**	—	**7.19**
	4.97	*6.29*	*8.45*	*11.36*	*14.72*
Bbl/Day (thsands)	**13.62**	—	**16.72**	—	**19.69**
	13.62	*17.23*	*23.15*	*31.12*	*40.33*
TOTAL (Gal/Yr) millions	**4698.80**	—	**4089**	—	**3050**
	4698.80	*5104*	*5675*	*6325*	*7200*

Best Case in Bold.
Worst Case in Italics.

Sources: *Gasoline Consumption,* ORNL-5435
VMT growth rate, DOT (conversation with John Pollard)
MPG for 1976, ORNL-5345
Projected fuel economy for 1985, DOE Report
Projected fuel economy for 1990, autos — Federal TF Report
trucks — estimated

Table 3
Gasoline Consumption
Automobile and Personal Truck, 1975-2000
Best & Worst Cases, DOE Data, 1978[1]

	1975	1980	1985	1990	2000
AUTOMOBILE					
In-use Fleet Avg Fuel Economy, MPG	**14.1**	**16.5**	**18.6**	**20.1**	**22.3**
Energy Consumption:					
Gal/Yr (millions)	*4020*	*4092*	*4164*	*4303*	*4821* **3712**
Bbl/Yr (millions)	*95.52*	*97.24*	*98.97*	*102.69*	*114.54* **88.38**
Bbl/Day (thsnds)	*262.43*	*267.44*	*271.88*	*281.33*	*314.14* **242.14**
PERSONAL TRUCK					
In-use fleet Avg Fuel Economy, MPG	**12.9**	**15.0**	**16.9**	**18.3**	**20.3**
Energy Consumption:					
Gal/Yr (millions)	*192.98*	*244.19*	*256.66*	*260.29*	*274.82* **108.86**
Bbl/Yr (millions)	*4.60*	*5.81*	*6.11*	*6.20*	*6.54* **4.97**
Bbl/Day (thsnds)	*12.59*	*15.98*	*16.71*	*16.95*	*17.92* **13.62**

Best Case in Bold.
Worst Case in Italics.

[1] 1978 DOE data on the effects of a new engine, adjusted for New England

Assumptions:

1) New England automobile gasoline consumption and personal truck gasoline consumption remain constant with respect to their proportion of national consumption in 1976:
   NE automobile=5.56% of national
   NE personal truck=2.20% of national
   Source: ORNL—5435
2) 95.9% of personal trucks are light trucks and, conversely,55.03% of all light trucks are personal trucks.
   Source: Bureau of the Census, 1972 Census of Transportation
   Source of DOE data: (see DOE report title page five).

Table 4
Energy Demand Projections for New England Automobiles
Best and Worst Cases

Study	Baseline Year	Gasoline Consumption Gallons/Yr × 10^6		1985	1990	2000
NHTSA/DOT[1]	1975	4170		**3419**	**3002**	**3447**
				4003	*4059*	*4670*
DOE[2]	1975	4020		**4164**	**4303**	**3712**
				4164	*4303*	*4821*
Fed. TF on MV-1976[3]	1975	4347	(Otto)	**3920**	**3495**	**3836**
			(Diesel)	**3920**	**3410**	**3408**
			(Sterling)	**3920**	**3665**	**3494**
				5199	*5711*	*7074*
BNL/1976[4]	1972	4520		**3944**	—	**4549**
				4930	—	*6498*
NEEC/1979[5]	1976	4699		**4089**	—	**3050**
				5675	*6325*	*7200*

Best Case in Bold
Worse Case in Italics.

[1] National Highway Traffic Safety Administration/Department of Transportation, 1978, Passenger autos only
Worst case: No Fuel Economy Standards
Best Case: Current Standards

[2] Department of Energy, 1978, Passenger autos only
Worst Case: Existing Legislation
Best case: Introduction of New Engine in 1985

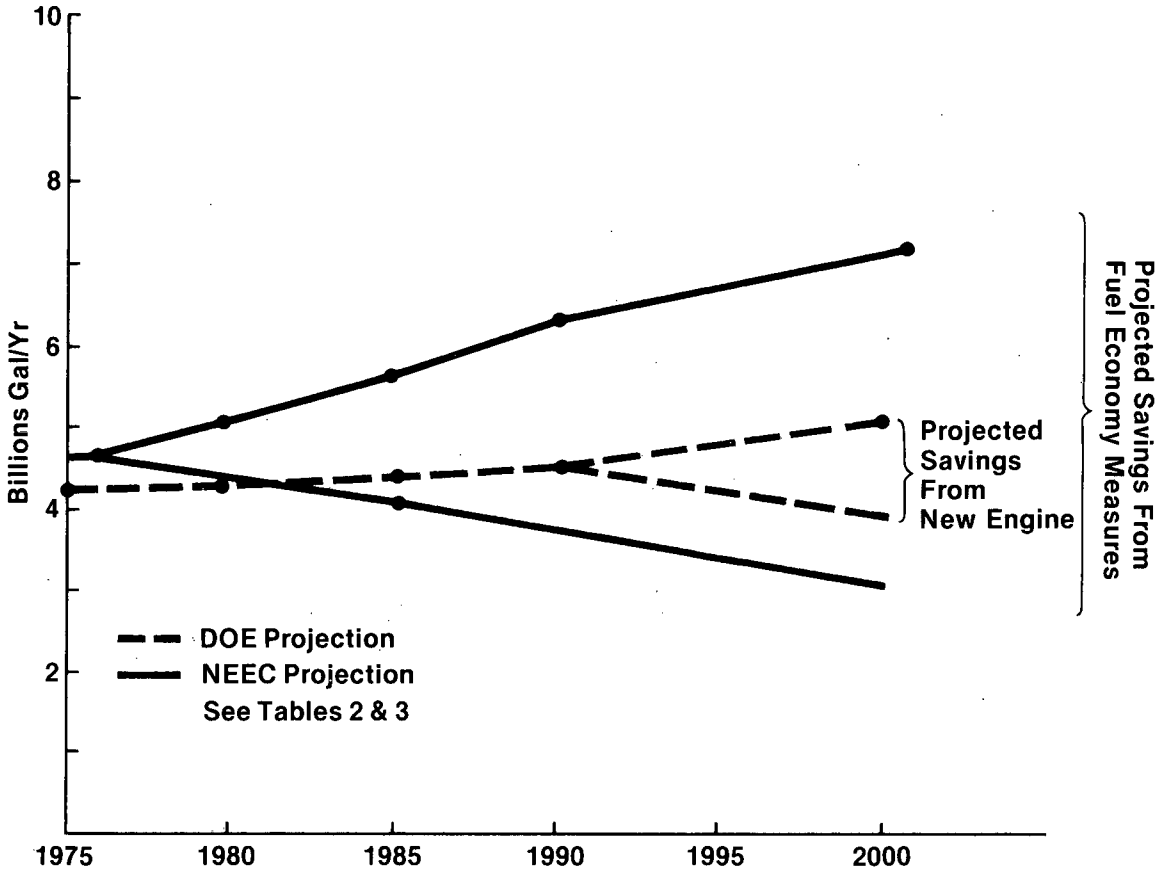
[3] Federal Task Force on Motor Vehicles, 1976
Worst Case: 15.6 MPG Average for total fleet
Best Case: Introduction of new technology, lighter vehicles, and improvements in various engine designs

[4] Brookhaven National Labs, 1976
Worst Case: No conservation or new technology
Best Case: Conservation and new technology

[5] New England Energy Congress, 1979, Autos and Personal Trucks
Worst Case: No new technology or energy conservation, 13.4 MPG for total fleet
Best Case: 33.7 MPG for new cars in 2000, zero growth rate in VMT per vehicle.

Table 4 presents a variety of fuel demand projections from several sources, including both best and worst cases. The differences reflect primarily differing assumptions about the fleet fuel economy that could occur. The best case that we have calculated assumes that the U.S. automobile fleet achieves 32.1 MPG in the year 2000. The resulting energy demand is 3.05 billion gallons of gasoline, or a new energy savings of 35% over energy demand in 1976. The various projections and savings are presented in Figure 1. (The vehicle miles traveled are shown in Table 1.)

FIGURE 1
New England Gasoline Consumption
1975-2000
Autos and Personal Trucks



Estimated fuel economy figures for average fleets in various years are taken from the DOE statistics for 1985, from the Federal Task Force Report for autos in 2000, and from rough estimates based on rates of economy improvement for personal use trucks in 2000 (see also Table 2). They are:

Table 5
Fuel Efficiency (MPG)

	1976	1985	2000	
Automobiles	—	27.5	33.7	New Fleet
	13.4	18.6[1]	32.1[2]	Total Avg.
Personal Use Trucks	12.2	16.9[1]	25.0[2]	Total Avg.

[1] DOE Comments on the Prospective DOT 1979 Report to Congress, 15 September 1978.
[2] Projected Efficiency

C) Likelihood of Achievement of Economy Standards

Both the DOT/National Highway Traffic Safety Administration Report to Congress (1978) and the Federal Task Force Report (1976) concur that achievement of the 1985 fuel economy standards for the entire new automobile fleet is possible. The DOT/NHTSA Report suggests that the maximum levels for years 1984-86 will possibly surpass the 27.5 MPG requirement. The Federal Task Force Report suggests that one of the following measures might have to be instituted to achieve the 1985 standards:

1) Reduce automobile accelerations below current norms (0 to 60 in 20, rather than 15, seconds)
2) Provide incentives that would permit smaller cars to take a larger market share
3) Adopt the light weight diesel in appreciable numbers, despite its unknown environmental hazard
4) Accelerate the development and upgrading of new transmissions
5) Introduce innovative automobile structures in the early 1980's.

The third option, widespread introduction of the lightweight diesel, is the only objectionable alternative of the five. General Motors Corporation already has taken major steps along the line of option five, and will be introducing a new downsized fleet for model year 1980.[1] (See Appendix II, Environmental & Economic Costs)

D) Impacts of Legislative Strategies for Increasing Fuel Economy

1) Maintain existing standards for automobiles

Conservation effects - see Table 2 and 4, NEEC and NHTSA/DOT data

Mileage Standards for New Automobile Fleet, 1978-85

1978 18	1982 24
1979 19	1983 26
1980 20	1984 27
1981 22	1985 ..... 27.5

If, for example, the 1985 fuel economy standards for autos were relaxed from 27.5 MPG to 26 MPG, and personal trucks averaged a comparably lower fuel economy, then New England would require an additional 236 million gallons of gasoline in 1985 for the same amount of automobile driving.

On the other hand, maintaining these standards will result in a national savings daily of 590,000 barrels of oil in 1985—over 500 million gallons of gasoline that year in New England alone—above the savings that the 1980 standard of 20 MPG would generate.[2]

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[1]*New York Times Business Section*, 21 January, 1979.

[2](For the 20 MPG national figure) Automotive Fuel Economy Program, 2nd Annual Report to Congress, January 1978. U.S. DOT/National Highway Traffic Safety Administration (NHTSA).

Current Fleet Fuel Efficiency For New Cars[1]

Year	Domestic Fleet Avg	Import Fleet Avg	Total Avg
1974	12.9	21.9	13.9
1975	14.4	24.5	15.6
1976	16.8	25.0	17.6
1977	17.6	29.2	18.6
1978	18.6	unknown (probably over 30 MPG)	19.7[2]

[1] Automotive Fuel Economy Program, 2nd Annual Report to Congress, January 1978. U.S. DOT/National Highway Traffic Safety Administration (NHSTA).

[2] DOT/NHTSA 3rd Annual Report to Congress, January 1979.

2) Mileage standards for two types of Personal Use Trucks — New Fleet

	1979	1980	1981
Two-wheel Drive	17.2 (under 6000 lbs.)	16.0 (up to 8500 lbs.)	18.0
Four-wheel Drive	15.8 (under 6000 lbs.)	14.0 (up to 8500 lbs.)	15.0

Source: Automotive Fuel Economy Program, 3rd Annual Report to Congress, January, 1979. U.S. DOT/National Highway Traffic Safety Administration (NHTSA).

3) Develop standards for personal use trucks beyond 1981 (see Appendix 1) See also, Table 1-4 and Figure 1.

4) Enforce 55 MPH speed limit:

New England Savings:

1980	1990	
103.1	89.5	(Millions gal/yr)

Source: Federal Task Force Report

5) More stringent fuel economy requirements beyond 1985 See Tables 2, 3, 4.

III. Vehicle Miles Traveled

A) Introduction

Vehicle Miles Traveled (VMT) are directly proportional to the amount of gasoline consumed. In other words, for each percent increase in the amount of driving we do, there is a corresponding percentage increase in the amount of gasoline consumed. Increased fuel economy will aid us in lessening our dependence on oil imports, but unless we create a policy atmosphere that discourages marginal automobile and personal truck driving, then a significant degree of our savings through economy measures will be negated. Historically, the national rate of growth for VMT has been

around 2.5% each year (from 1950 through 1975).[1] Much of this increase is attributable to more automobiles and personal trucks on the road. Some, however, results from an increased use of each vehicle as well.

Since the oil embargo, there has been a notable decline in the annual rate of growth for vehicle miles per vehicle. It is too early to assess whether the nation will resume its historic growth rate of VMT per vehicle. From 1965-72, VMT per vehicle increased at about a 1.2% level, but the resultant gasoline price increases from the oil embargo caused a 1.8% per annum decline in growth through 1975.[2] If we can maintain the present level of vehicle miles traveled per vehicle, we can allow the automobile industry to grow at a significant rate, and fuel economy measures, in turn, will have a substantial impact on reducing our oil need in New England.

B) Strategies for Reducing VMT Growth

There are basically four approaches to reducing VMT growth worth considering:

1) Reducing or eliminating marginal trips

2) Increasing passenger load factors per vehicle

3) Shifting to more energy efficient modes of transportation (considered in another report)

4) Regulating automobile capacity. In each instance, reducing VMT will be a much more difficult task than improving fuel economy. The alternatives to inaction, however, are potentially disastrous, including fuel shortages, lessened actual automobile efficiency because of traffic tie-ups and a continued degradation of air quality from automobile emissions.

C) Reducing Marginal Trips

Gasoline rationing and tax increases are two means that will result in lower VMT through a reduction in unnecessary driving. There is little agreement as to the precise effect of either of these strategies on VMT reduction. Tax increases will impose a greater hardship on low income groups than on the rest of the auto driving public.

D) Passenger Load Factor Increases

The greatest impact of load factor increases would be in urban areas. Car and van pooling are particularly promising techniques for reducing marginal trips. Some incentives might include:

1) Give carpools use of restricted lanes

2) Discount parking and tolls for carpools

3) Study possible tax credit opportunities for car poolers (this might be difficult to administer). The current rate of car pooling is about 25% of all auto commuters. Estimates indicate that a fuel savings of 5.5% can result from an increase in participation to 50%.

E) Controlling Automobile Capacity through Regulation

This would chiefly apply to urban areas. The Environmental Protection Agency requires states to provide implementation plans to improve air quality in areas that

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[1]DOT/NHTSA Report
[2]ORNL-5435

currently violate federal law. Transportation planning that encompasses strategies for reducing VMT can be required by the EPA as part of the implementation plan.

IV. Appendix I: Demand Reports

1) *National Highway Safety Administration (NHTSA)/Department of Transportation (DOT) Second Annual Report to Congress—1978*

This document covers the effects of mileage standards on automobile fuel consumption for the years 1981-84, following the announcement of these standards. The effects of potential fuel economy measures beyond that date will be covered in the 1979 annual report, due for release on 15 January 1979. This new report includes a modified, lowered growth rate for vehicle miles traveled (VMT) that was produced through sophisticated computer modeling.

	1975-1990	1990-2000
Automobiles	1.91%	1.19%
Light Trucks	6.08%	2.63%

The data from all federal reports had to be revised for New England. According to automobile gasoline consumption statistics, New England gasoline consumption in 1976 was about 5.56% of the total for the nation. Therefore, this factor was employed for determining projection figures for New England. The gasoline consumption statistics were derived from the Regional Transportation Energy Conservation Data Book, published by Oak Ridge National Laboratory in 1978.

2) *The Department of Energy Comments on the Prospective DOT 1979 Report to Congress—1978*

This document offered automobile gasoline consumption projections explicitly to show the impact of introducing commercial alternative engine designs in autos, notably the Stirling and gas-turbine varieties. DOE purports that by the year 2000, new engines could contribute to a 50% savings of gasoline consumption (see Table 2). Again, these statistics were adjusted for New England. DOE uses a higher VMT projection than DOT's. DOE's projection incorporates an assumed increase in VMT per vehicle whereas DOT does not.

3) *The Report by the Federal Task Force on Motor Vehicle Goals Beyond 1980* (issued in 1976)

This is a comprehensive three-volume report on which DOE extensively relied for its information in its comment paper. The report concentrates on fuel economy measures through technological improvements and concluded that such measures could reduce gasoline consumption by 40-50% in the year 2000. The baseline assumptions included an annual VMT growth rate of 2% and a continuation of the 1975 federal fuel economy standard for new autos of 17.5 MPG.

4) *Transportation Energy Consumption and Conservation Policy Options in The Northeast—1976* Brookhaven National Laboratory

Under contract from ERDA, Brookhaven produced the first comprehensive document that discussed automobile fuel projections for the New England region. This report projects a much higher amount of VMT than more recent reports do. It covers a variety of energy savings options and discusses, in percentages, how much each option is likely to save.

5) *New England Energy Congress Estimates*

At this stage, a baseline scenario was developed that relies on the Oak Ridge data cited above for 1976 statistics, and employs the soon-to-be-published DOT vehicle miles traveled growth rates. Initial indications show that, without including modal shifts, New England should be able to save well over 50% of the projected demand for automobile and personal truck fuel for the year 2000.

The data regarding personal use trucks should be interpreted cautiously. The initial data, modified by Oak Ridge, was obtained from a 1972 census of truck drivers. Criticism of the survey technique employed has been vociferous. Moreover, most data discusses light trucks (under 10,000 lbs. gross vehicle weight). Exceptions include Oak Ridge and Brookhaven. Thus, adjustments had to be made. The amount of light trucks used as personal vehicles, according to the Bureau of the Census in 1972, is 55%. Also, 95.9% of all personal trucks are light trucks. Thus, two assumptions were made that introduce errors into the data: 1) light truck data was adjusted by a factor of 55% and called personal use trucks; 2) vehicle mile growth in light trucks is wholly attributable to personal use.

Regardless of the quality of the data, it is extremely important that gasoline consumption by personal use trucks be addressed. In 1963, only 24.5% of *all* trucks were used for personal purposes. By 1972, this nearly doubled, to 41.2%.

The DOT predictions for light truck VMT until 1990 indicate an annual growth rate of 6.03%. Yet personal use trucks averaged less than 13.0 MPG in 1976, and light trucks are only mandated to reach 17.5 MPG by 1981. There are no further fuel economy regulations for such vehicles after that date.

V. Appendix II: Environmental and Economic Costs

As the economic costs of energy production from nonrenewable resources continue to soar, so do the other costs associated with production—particularly political, environmental, and social costs. We are forced to turn to foreign sources for oil, to extract oil from increasingly precarious environmental areas, and to price it beyond the range of more and more citizens who had previously learned to depend on the automobile for essential personal transportation. Therefore, the preeminently attractive alternative to rising energy costs in the transportation sector is energy conservation. The greatest room for conservation in that sector lies within the domain of the automobile. Conservation, through improved fuel economy, reductions in vehicle miles traveled, and greater passenger load factors, offers the most substantial benefits while entailing comparatively minimal costs to New England, politically, environmentally, socially, and economically. As stated in the 1979 DOT/NHTSA Report to Congress:

> ...a "socially responsible" automobile can be a near-term reality...(for) the production of vehicles with high fuel economy, excellent safety characteristics, and low emissions is not only feasible, but practical.[1]

A) ENVIRONMENTAL CONSIDERATIONS

1) Introduction

The New England region, with few indigenous liquid energy supplies, is especially sensitive to the high costs of energy production for transportation purposes. The extraction and refinement of petroleum for gasoline and the waste produced by its combustion and use pose severe threats to air, water, and land quality. Off-shore oil

[1] *Automotive Fuel Economy Program*, Third Annual Report to the Congress, U.S. DOT/NHTSA, January, 1979.

Table 6

Domestic Manufacturer Automobile Average Fuel Economy Projections
(Miles per Gallon)

	Model Year					
Manufacturer	1980	1981	1982	1983	1984	1985
AFE Standard	20.0	22.0	24.0	26.0	27.0	27.5
American Motors	21.5	23.6	24.6	26.8	28.7	29.5
Chrysler	21.8	24.3	25.9	26.8	28.9	30.1
Ford	21.7	24.7	25.3	27.6	29.1	29.7
General Motors	22.5	23.7	25.3	26.4	28.6	29.6

The case where the manufacturers could use no diesel engines was also considered. This case affects only Chrysler and General Motors. The Chrysler fuel economy values shown would be reduced by 0.1 mpg in 1984 and 1985 if diesel engine use should not be permitted. For General Motors, model years 1984 and 1985 average fuel economy estimates are 28.0 and 28.7 mpg respectively, without diesel engines (instead of those values shown above). (page 59, 1979 DOT Report)

Source: *Automotive Fuel Economy Program, Third Annual Report To Congress,* U.S. DOT/NHTSA, January, 1979.

production and shipping crude in secure tankers on the high seas present formidable concerns to the region. On the consumption side, dispensing gasoline from the pump to the consumer's tank as well as the more obvious problems associated with auto emissions contribute significantly to further environmental degradation.

Recent legislative initiatives, such as the Federal Clean Air Act of 1977, will somewhat mitigate this degradation. Also, the policies proposed and supported by the New England Energy Congress will further alleviate the environmental degradation caused by the automobile. As petroleum becomes a more scarce resource, however, the pressure increases to forego environmental considerations to secure transportation energy supplies or to meet federally mandated fuel economy requirements. The clash between fuel economy standards and auto emission standards is one of the most celebrated conflicts in transportation energy policy, for it is a clash that results from ever increasing costs between two desirable ends.

2) Diesel engines

Nowhere is the clash between fuel economy standards and emission standards more apparent than in the case of diesel powered passenger automobiles. The diesel engine offers inherently superior fuel economy to the conventional internal combustion engine (ICE): 22-52% better than the ICE of comparable power.[1] Its prime disadvantage is that diesel exhaust emissions contain both large amounts of particulates as well as dangerous nitrogen oxide compounds (NO_x). Present technological controls of the NO_x compounds actually result in an increase of the amount of hydrocarbon emissions. Until this problem is resolved, whether diesel engines can meet ambient air quality standards remains questionable.

The adverse health effects of diesel particulates are presently unknown and under study, both by the Department of Energy and the Environmental Protection Agency. The results of their research will be released sometime during the fall of 1979. There is, however, no need to evaluate diesel emission effects injudiciously or hastily, since, according to the 1979 DOT Report, all major domestic car manufacturers can meet the 1985 federally mandated fuel economy requirements without relying on diesel autos for their fleet averages (see Table 6).

[1]1979 DOT Report to Congress.

DOT did suggest that in the long-term, from 1985-2000, auto manufacturers will need to introduce an alternative engine to the standard internal combustion engine to meet even more stringent fuel economy requirements. This alternative engine, though, does not have to be diesel. Two other possible choices include the Stirling and the Brayton (gas-turbine) engines. Even if the choice were diesel, the technology and fuel could be modified to reduce particulate emissions. In the case of turbo-charged diesel engines, turbocharging, which enhances fuel economy, actually results in fewer emissions. The EPA has let it be known that the burden of proof rests with the automobile industry to show that the diesel engine does not constitute an "unreasonable risk" to health.

The present gaseous emission standards for automobiles in model year 1981, and the proposed EPA standards for diesel engine particulates are as follows:

Standard (gm/mile)

Year	Particulate emission	Gaseous emission
1981	0.6	.41 HC/ 3.4 CO/ 1.0 NOx
1983	0.2	

HC=Hydrocarbon
CO=Carbon Monoxide
NOx=Nitrogen Oxides

Source: 1979 DOT Report

The ability of diesel-powered vehicles to achieve both gaseous and particulate emission standards will depend on essentially two factors, engine size and automobile size. The brightest prospects are for diesel autos in the small car range, that is, 2500 lbs. and under. The DOT considers attainment for these vehicles "highly likely." In the mid-size range, 2500-3500 lbs., emission standards can be achieved, but only with considerable changes, including untested technologies such as oxidation catalysts and modifying the diesel fuel. Lastly, it is not evident that vehicles in the heavier range, over 3500 lbs., can achieve both the 0.2 particulate standard and the 1.0 NO_x requirement, with currently available technology.[1]

In conclusion, all domestic manufacturers and the larger foreign manufacturers can realize the current fuel economy standards through 1985 without any compromise of the presently mandated gaseous and particulate emission requirements. Diesel engines, and all new technology, must accommodate existing ambient air quality standards, not the other way around.

B) ECONOMIC CONSIDERATIONS

1) Introduction

Although the federally mandated 1985 fuel economy standards will not require a relaxation of emission standards or a reliance on a diesel fleet, it will require a substantial capital outlay by the automobile manufacturers. Yet, according to the DOT, and substantiated by the DOE in their comments on the 1979 DOT report, none of the four major domestic manufacturers will be incapable of raising capital as a consequence of the stringent standards.[2] According to the DOT Report, the industry's capital investment from 1978 through 1984 will be around $36 billion, or about 32% higher than it would have been without the standards. The DOT analyzed the cashflow for the big three

[1]1979 DOT Report to Congress.
[2]Ibid & DOE Comments on 1979 DOT Report.

manufacturers, General Motors, Ford, and Chrysler, concluding that the outlay is indeed attainable for each. DOT received a similar assurance from American Motors, which is currently engaged in negotiations with the Renault Corporation and therefore could not be economically assessed with certainty.

2) Consumer Costs

The consequent industry capital outlay for attaining fuel economy standards will be passed on to the consumer. Yet the cost increases passed on to the consumer for technological improvements and retooling will be more than offset by the subsequent savings in fuel costs over the lifetime of the vehicle. Added expenses will raise the price of a new 1985 automobile an average of about $400 over a new 1977 automobile. The 1985 car, however, will use $914 less gasoline over its lifetime—a net savings of over $500.The operating cost calculations by DOT were done prior to the latest OPEC price increases, so the price estimates used were conservative. Therefore, the actual savings per vehicle stands to be even greater.[1]

C) OTHER COSTS

Whereas the New England Energy Congress has recommended a year 2000 goal of 34 MPG for automobiles, the DOT Report has cogently argued the case for 50 MPG, or even more, by the end of this century. It is too early to tell what the financial requirements for these goals would be. DOT did conclude that although it would be unnecessary to modify fleet mixes or rely on alternative engines to the conventional ICE before 1985, both of these tactics will probably be required after that date. The exigencies of the energy crisis, especially regarding liquid fuels for transportation, require that we begin looking beyond 1985 today.

As stated in the 1979 Report:

> Beyond 1985, even a one-mile per gallon improvement in fuel economy per year for new cars will probably not be sufficient to offset increases in total demand for motor fuel. Thus, it is necessary to focus on the things that must be done to make major increases in average fuel economy (e.g. to again double the fleet fuel economy average to something like 50 miles per gallon, or its equivalent, before the new century).

VI. Appendix III: Rural Automobile Transportation

Rural transportation accounted for 36% of all highway motor fuel use in New England in 1975.[2] Therefore, although the most substantial savings of automobile transportation energy will occur in New England's urban areas, significant savings can be realized in rural areas as well. Moreover, since goods, services, and most places of employment tend to be concentrated in urban areas, adequate transportation for rural residents is essential, so these residents can be assured of access to goods and services, as well as jobs. An equally important alternative is to provide more goods and services within easy access of rural residents so it is less essential for them to depend on long distance travel to obtain their needs.

Whereas rural communities are best aware of their own transportation requirements, the state and federal governments should encourage the participation of rural community planners in projects designed to conserve transportation energy. Regional planning should include

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[1]1979 DOT Report to Congress.

[2]Source: ORNL 5345.

coordinating the free-flow of information and ideas, and the successes and failures of programs and policies between communities. Analogously, rural communities can serve well as experimental target areas for expensive or controversial programs that foster transportation energy conservation.

Rural communities should be encouraged to provide transportation services for isolated residents, including van pools and school busses, to obviate the necessity for dependence on the automobile. Lastly, state legislation and local ordinances that inhibit transportation energy conservation should be reevaluated. For instance, zoning ordinances that prohibit the use of one's residence as a place of employment should be reconsidered.

Rural communities, whose size and natural autonomy make them perfectly suited for energy conservation programs, can be instrumental in demonstrating the viability of energy conservation initiatives in New England.

TRUCK REPORT

The trucking industry consumes 23.3%[1] of the energy used in the transportation sector. The Energy Congress supports integrated rail/truck freight service to achieve the most energy-efficient transportation system possible. Each component of such an integrated system should likewise be as efficient as possible. Within the trucking industry, both technological and operational efficiencies can be improved.

I. Technical

Technical improvements for trucks are numerous and varied, with a wide range of savings potentials. The savings indicated in Table 7 cannot necessarily be realized for all trucks in a given class, but many trucks can achieve a significant improvement in their fuel economy. It would be virtually impossible to set performance standards for trucks (as is presently done for automobiles), for a number of reasons. First, the diversity of truck size and configuration (body type, engine horsepower, transmissions, optional equipment) make classification difficult, since heavy duty trucks are configured for specific applications. Second, the performance of an individual truck varies with the type and weight of commodity being hauled or service being performed. And third, given all the variables mentioned above (size, configuration, commodity weight, and service), uniform equitable standards would be all but impossible to regulate or enforce.

Rather than mandating performance standards, government agencies should provide for research and testing services for improved efficiencies in trucks, and distribute such information to the trucking industry and operators through DOT publications and trade magazines. If improvements can be shown to be relatively cost-effective, they will be adopted by operators. An example of this is the Voluntary Truck and Bus Fuel Economy Improvement Program, instituted after the 1973 oil embargo. Combining the efforts of labor, manufacturers, motor carriers, trade associates, trade press and three departments of the government (DOT, DOE, EPA), the program has achieved a savings of 1.7 billion gallons of fuel nationwide from late 1973 through 1977.[2] New trucks and buses accounting for the savings are those with fuel-efficient diesel engines, variable drives for cooling fans, radial tires and aerodynamic drag devices.

Another excellent example of information-sharing is the joint effort being conducted by the DOT and the Society of Automotive Engineers on Truck and Bus Fuel Economy Measurement Procedures. A data acquisition system[3] provides vehicle operating profiles of test trucks from on-

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[1]Transportation Energy Conservation Data Book, Edition 2, Oak Ridge National Labs, Oct. 1977, page 171.

[2]DOT - 11278 News Release, August 9, 1978

[3]On-Board Processing for Truck/Bus Fuel Economy and Operational Data Acquisition, R. Hunter, DOT; J. Baker & J. Juhasz, Rockwell International; Nov. 1978.

Table 7

Possible Truck Fuel Economy Improvements

Due to the variety of truck styles and operating modes, it is difficult to determine the overall effects of any one improvement. In the following table the low values of the ranges generally apply to local service and the high values to long-distance hauls.

Measure	Fuel economy improvement (%)		
	Truck class		
	I and II	VI	VIII
Substitution of a diesel for a spark-ignited engine	20-25	55-60	
Lean-burn engine	10-15		
Turbocharging	5-15		2-5
Stratified-charge engine	15-25		
Derating of diesel engine			1-6
Reduction of parasitic loads (especially cooling fan)	2-3	3-4	3-5
Tag axle			2
4-speed automatic transmission with lockup	7-15	0-10	
Continuous Variable-Ratio Transmission	12-30		10-15
Radial tires	2-3	2	6-9.5
Aerodynamic improvement			
10% reduction of drag	1-2	2	1-5.5
Streamlining of trailer			12
Full streamlining of tractor-trailer combination			30

Source: D. A. Hurter and W.D. Lee, Arthur D. Little, Inc., *A Study of Technological Improvements to Optimize Truck Configurations for Fuel Economy* U.S. Department of Transportation, Transportations Systems Center, Cambridge, Ma., Sept. 1975.

board measurements taken during normal fleet operations. The results are used to increase the overall understanding of the influence of various conditions on heavy duty vehicle fuel economy. Such information may then be used by operators to help them make the best decisions regarding their fleet makeup and operating procedures.

The potential contribution of alternative engines and fuels is not seen as being significant by the year 1985, and is undetermined for the year 2000. DOT and DOE are, however, currently studying the possibilities for such alternative fuels and engines.

II. Operational

In addition to the technical improvements to be made in the truck fleet, there are also substantial savings to be achieved through operations changes. These include improved driving techniques, adherence to the 55 mile-per-hour speed limit, and removal of operating constraints (such as ICC regulations).

Since the imposition of the federal 55 MPH speed limit in 1974, numerous claims have been made that large tractor-trailer combinations operate more efficiently at speeds above 60 MPH. To answer such claims, the DOT designed and supervised tests to determine the effect of speed on the rates of fuel consumption. The results of the DOT I-64, I-81 Fuel Consumption Tests[1] (Table 8) clearly show a significant increase in fuel consumption caused by increased speed.

[1]E.M. Cope, "The Effect of Speed on Truck Fuel Consumption Rates", DOT, Aug. 1974.

Table 8
Effect of Speed on Fuel Consumption Rates[1]

Vehicle Number	Miles per Gallon At Selected Speeds				Percent Increase in Fuel Consumption Caused by Increase in Speed				
	50	55	60	65	50-55	55-60	60-65	50-60	60-65
1	5.12	5.06	4.71	[2]	1.2	7.4	[2]	8.7	[2]
2	5.41	5.02	4.59	4.08	7.8	9.4	12.5	17.9	32.6
3	5.45	4.97	4.52	[2]	9.7	10.0	[2]	20.6	[2]
4	5.21	4.90	4.88	4.47	6.3	—	9.2	6.8	16.6
5	4.49	4.40	4.14	3.72	2.0	6.3	11.3	8.5	20.7
6	4.97	4.51	4.42	[2]	10.2	0.2	[2]	12.4	[2]

[1] Each figure listed in this table is the average of more than 20 timed runs on roadways with less than 1 percent grade. Fuel economy comparisons among trucks of different manufacturers should not be made on the basis of these data, for reasons stated in the preface.

[2] The governor setting that controls fuel injection did not permit this vehicle to be operated at 65 miles per hour.

The findings of that DOT test were hotly contested by the trucking industry, which argued that the tests did not adequately reflect actual fleet operations. In response to that criticism, DOT instituted another test, dubbed the "Double Nickle Challenge." Thirty-two independent owner-operator truckers participated on a voluntary basis, driving their own rigs, which represented all truck and engine types normally operated by independent truckers.

In three days of testing "big rig" fuel economy, results[1] showed that at 55 MPH, fuel savings improved by as much as 27% over higher speeds for 26 of the tested vehicles. In 6 tests, fuel economy improved from 1.6 to 9% for speeds between 59 and 64 MPH. (See Table 9 for results of the individual runs.) The results of this demonstration show that 55 MPH saves fuel, and further, the tests helped to remove the arguments concerning government data versus truckers' claims. Similarly, fuel economy tests run by United Parcel Service in Columbus, Ohio (October 27, 1977) had the following results:

Tractor-Trailer A	(55 MPH average)	7.39 gallons	7.05 mpg
Tractor-Trailer B	(65 MPH average)	9.76 gallons	5.33 mpg

Their tests showed a 32.22% savings in fuel was achieved by the unit that held to the 55 MPH speed limit as opposed to an identically equipped truck travelling at 65 MPH.

The Secretary of Transportation reported in August, 1978[2], that adherence to the 55 MPH national speed limit by truckers saves 400 million gallons of fuel a year. 100% compliance with the national speed limit in the trucking industry could save more than 1 billion gallons a year nationally.

[1] DOT — 11978 News Release, August 8, 1978

[2] DOT — 11278 News Release, August 9, 1978.

Table 9
DOT Double Nickel Challenge

Trucker #	Hi-Speed Run		55 MPH Run	% Saved
	MPH	MPG	MPG	
1	59.2	4.66	5.08	9.0
2	62.2	6.16	6.68	8.4
3	66.0	4.18	5.28	26.3
4	63.2	4.51	5.02	11.3
5	62.0	5.75	6.99	21.6
6	61.0	4.79	5.45	13.8
7	64.2	4.93	5.84	18.5
8	62.2	4.57	5.81	27.0
9	61.6	4.90	5.93	21.0
10	65.6	4.50	5.57	23.8
11	66.2	4.62	5.56	20.4
12	61.4	5.10	4.97	-2.6
13	63.0	5.67	5.58	-1.6
14	63.6	5.58	6.28	12.5
15	62.4	4.90	4.46	-9.0
16	61.4	5.95	6.05	1.7
17	60.0	4.87	5.06	3.9
18	59.4	5.65	5.16	-8.7
19	64.8	4.38	4.39	0.2
20	61.0	4.37	4.59	5.0
21	59.8	4.42	5.10	15.4
22	62.6	5.78	6.66	15.2
23	61.6	4.55	5.33	17.1
24	62.0	4.33	5.01	15.7
25	64.6	4.63	5.06	9.3
26	63.4	4.62	5.37	16.2
27	59.2	5.63	6.38	13.3
28	63.8	5.68	5.55	-2.3
29	62.2	6.34	7.40	16.7
30	60.8	4.95	5.67	16.4
31	64.2	4.27	4.78	11.9
32	59.0	4.66	4.59	-1.5

The Interstate Commerce Commission, often criticized in the past for being among the most protective of regulatory agencies, is beginning to take a new look at regulation of the trucking industry.[1] Historically, regulation of truck routes and freight rates was intended to protect regulated industries from excessive competition. Furthermore, the regulations were designed to ensure equal treatment for small and big shippers alike by charging them the same rates for the same service, regardless of how much more it actually cost to handle small shipments.[2]

Today, however, there is a strong movement towards realistic pricing,that is, rates for different types of shipments should directly reflect the costs of handling them. Such deregulation of pricing may initially require vigorous federal monitoring to prevent some big carriers from indulging in predatory pricing, but today's sophisticated shippers are unlikely to be attracted to truckers offering nothing more than low rates.

[1]Ernest Holsendolph, The New York Times, November 21, 1978.
[2]Burck, Charles G. "Truckers Roll Toward Deregulation", FORTUNE, Dec. 18, 1978.

In addition to removing pricing regulations, the ICC is examining the numerous regulations affecting truck routing. The Motor Carrier Act of 1935 attempted to regulate truckers much the same as railroads, and the regulators approached this task by spelling out the precise service routes of trucks in their operating certificates.

On November 20, 1978, the ICC reviewed its regulation of intercorporate transportation, and abolished its rule that banned companies that haul their own goods by truck from transporting goods for other shippers. The move could place hundreds of vehicles at the disposal of shippers, and help to fill up otherwise empty backhauls. Numerous other provisions, such as circuitous routing, the required use of gateways, and exempt commodities regulations, likewise need to be fully re-examined.

The goal of deregulation of the trucking industry is to create an environment where competition yields the best array of prices and services, and leads to increased energy efficiency in the transportation network. The efforts within Congress and the Administration to achieve this goal are encouraged and fully supported.

III. Appendix: Rail and Truck Freight

While the nation has witnessed a severe decline in rail traffic over the last thirty years, the Northeast Region has lost rail service at an even greater rate than the national average. Carloadings for the Northeast dropped 4.3% in 1977, compared to a 0.7% decline for the entire nation.

The railroad decline has been attributed to the inability of rail to serve its customers as well as trucks can. There are certain improvements that could be made through Congressional legislation and regulatory reform that would somewhat ameliorate that situation. Because of its energy savings potential, it is essential to retain rail freight service in New England as a link of a vital national rail network.

Rail freight is much more energy efficient than truck freight for transporting bulk goods over long distances. Per net ton-mile, rail freight consumes only 687 BTU, compared to 2343 BTU for trucks. Furthermore, truck freight accounted for 23.87% of all transportation energy consumed in the U.S. in 1976. This contrasts to only 2.76% for rail freight.

Congressional action must center on three strategies:

1) Promote cooperation between truck and rail, to allow each to perform its best services most effectively;

2) Eliminate unnecessary competition between rail and truck freight service which only results in energy waste;

3) Bring regulatory procedures into line with energy conservation objectives.

Removing restrictions on trucker's use of piggyback service would meet all three strategy criteria. Piggyback service (Truck on Freight Car (TOFC) and Container on Freight Car (COFC)) combines the advantages of truck freight service with those of rail. For the short haul, goods would travel on highway. For the long haul, they would travel by rail. This service would use two to three times less energy than conventional truck service by substituting more energy efficient rail mileage for less energy efficient truck mileage.

Other advantages of piggyback, according to the Council on Wage and Price Stability, include:

1) More direct shipments of goods;

2) Improved service;

3) Reduced highway congestion, air pollution, and maintenance costs;

4) Eventual lower shipping rates.

In 1976, however, only 5.9% of all domestic rail freight carloadings were piggybacks. Among many factors responsible for this are existing Interstate Commerce Commission regulations that restrict truckers' use of piggyback. ICC regulations currently forbid regulated truckers from travelling to a city to use a piggyback service unless the trucker has already been granted an ICC operating authority for that city. Moreover, if the piggyback mileage is not at least 80% of the mileage the truck would travel via its authorized route, the ICC forbids truckers from using that service. This 80% figure was scaled downward from an original 85% figure in 1976. It was modeled after the 20% mileage rule, established by the ICC in 1974.

Over 17,000 trucking companies are subject to ICC regulation. The ICC gives top priority to maintaining competition in the trucking industry, even if such competition interferes with other national objectives, i.e., energy conservation, and even if the regulations lead to inefficient operations. Its discouragement of piggyback service is merely one example of these regulations.

A whole series of regulations affecting piggyback, gateway passage, and superhighway travel are all based on the arbitrary figure of 20%; exceeding this level supposedly adversely affects competition, although this has never been shown, nor has it even been tested. The 20% figure was set for removing gateway restrictions in 1974. The previous year a group of truckers petitioned for its removal. They claimed that eliminating the circuitous routing of gateways could save each year:

1) 100 Billion Vehicle Miles;

2) 200 Million gallons of fuel;

3) $1 billion in operating expenses;

4) 100,000 tons of pollutants from diesel emissions.

The ICC responded by forbidding truckers from using gateways if the gateway mileage exceeded the authorized route mileage by 20%. This restriction does not apply to shipments under 300 miles. Regarding superhighway travel, in 1975 the ICC used the 20% criterion to restrict truck travel on superhighways if the mileage reduction from the authorized route remained below that figure.

RAIL PASSENGER SERVICE

Time and cost constraints have placed considerable pressure on Northeast Corridor Improvement Project (NECIP) planners. It is now questionable whether they will meet their revised goals with the funding authorized by Congress and within the alloted time. There are several ways that this project might go forward more efficiently.

If feasible, a return to the original work plan, as originally specified by Congress, should occur. Estimates showed that it would cost $4.3 billion to rennovate the Northeast Corridor System. This rennovation would cut the trip time between Washington and New York to 2 1/2 hours. It would cut the time between New York and Boston to three hours. The system envisioned would provide service for thirty million passengers annually, an increase from the 1975 level of 9.6 million passengers.

The Railroad Revitalization and Regulatory Reform Act of 1976 revised these proposals downward. Congress authorized only $1.6 billion, and the consequent improvement goals were more modest as well. The Act relaxed the trip-time goals to 2 hours and 40 minutes between

Washington and New York, and 3 hours and 40 minutes between New York and Boston. Passenger load estimates have been eased to only 21.8 million passengers, a drop of 30%.

The Act stipulated that NECIP improvements should be completed by 1981. However, the changes will make this extremely difficult. James Cagwood[1], NECIP director for DeLeuw, Cather/Parsons, the designers of the project, testified before Congress that the result of design change has led to a condition known as *fast-tracking*: substantial planning concurrent with design and construction.

Fast-tracking involves many risks that further threaten cost constraints and the quality of the work on the project. Those that Cagwood enumerated were:

1) Redundant design efforts,
2) Wasteful expeditures on construction activity,
3) Increase of project costs because of:
    a) Reduced productivity that results from track use constraints.
    b) Other productivity shortfalls,
    c) Escalating signal and electrical equipment and material costs, and
    d) Revised forecasts of program management costs, and
    e) Increased labor costs (because of time losses).

This has created a dismal situation for the project, because improvements have now been "reduced to the bare minimum" necessary to meet trip-time goals. Also, there will not be any major expansion of system capacity along the Corridor.

These problems could be rectified by a return to the original project plan. In the interest of energy conservation, this return would make rail service along the Corridor far more attractive. It would also enable rail passenger service to compete more effectively with other passenger transportation modes.

If NECIP must continue under such severe constraints, then expenditures on improvements of dubious value should be reconsidered. One such improvement is electrification. Seventeen percent of the current trimmed NECIP budget — $305 million — is set aside for electrifying the remaining non-electrical portion of track between New Haven, Connecticut and Boston, Massachusetts.

In the NECIP Final Programmatic Environmental Impact Statement, published in June 1978, the advantages that electrification offers were cited. They are:

1) Environmental advantages,
2) Excellent acceleration/deceleration characteristics,
3) Independence from a single fuel source (diesel),
4) A savings of 176,000 barrels of oil annually, and
5) Eliminating the locomotive change at New Haven.

[1]Statement of James A. Cagwood, Project Director for NECIP, DeLeuw, Cather/Parsons, before the subcommittee on Government Activities & Transportation of the House Government Operations Committee, June, 1978.

According to numerous studies, each of these points are questionable. The Massachusetts Executive Office of Environmental Affairs[1] (Mass. EOEA) criticized the electrification plan for a variety of reasons, not the least of which is its environmental disadvantages. The Massachusetts EOEA claims that the only advantage would be the consequent savings of petroleum. However, this savings in oil must be balanced against the increased air pollution and public safety implications of relying on more coal-fired and nuclear generated electricity. Moreover, according to Battelle Columbus Laboratories, which prepared an enviromental assessment of the NECIP plan, it will be necessary to expand present generating facilities or construct new ones in order to electrify the rail line.

A study by Peat, Marwick, and Mitchell[2] finds yet further fault with electrifying the rail system. This study suggests that the total energy savings is not clear-cut (the Mass. EOEA predicts a 3% increase in total use), while the escalating costs of electric power make it less attractive economically. Moreover, it suggests that the petroleum savings would be relatively minor, since all diesel fuel used in rail transportation accounts for less than 4% of the petroleum used in the transportation sector.

Sufficient debate about the environmental effects and fuel savings of electrification exists to consider less expensive alternatives for accomplishing similar goals. Since the acceleration and deceleration between New Haven and Boston could not account for that much time, improving it somewhat at such a great expense may not be necessary.

If it is absolutely impossible to return to the original trip time goals and schedule, then Congress should consider authorizing a Government Accounting Office (GAO) investigation into the effectiveness of improvements within the limits of its restricted budget. The GAO could examine why estimates on Corridor improvement have varied so greatly over the last decade. They could determine whether electrification is really a significant advantage and whether its benefits are worth such a large share of such a limited budget. Numerous possibilities exist. The Massachusetts EOEA has suggested one possible alternative to complete electrification of the line that was not even mentioned in the final environmental impact statement. The EOEA proposal recommends a combination of diesel/electric and electric locomotives. These locomotives would run on diesel electric engines until they reach the electrified portion of the line when their pantigraphs would be raised and a switch would be made to electric power. This would entirely negate the loss in time which results from locomotive changes.

In the interest of energy conservation, it is essential to provide public transportation systems that the public will use and that will contribute substantially to lowering the region's demand for energy.

AVIATION REPORT

Civil aviation consumes 7% of New England's transportation energy. This includes both the air carriers (scheduled and unscheduled airlines and general aviation) and business and private planes. General aviation aircraft comprise 99% of the total, national fleet. The air carriers, however, consume approximately 90% of the aviation fuel. In New England fuel consumption in 1976 was 9.12 million barrels (51 x 10^{12} BTU), and commercial air transportation consumed 90% of that total (Table 10).

I. Growth Projections

Air operations in New England are expected to grow in the future. The Federal Aviation

[1]Statement of the Secretary of Environmental Affairs on the Draft Environmental Impact Report regarding NECIP, Massachusetts Executive Office of Environmental Affairs, December, 1977.

[2]Peat, Marwick, Mitchell, *Energy & Economic Impacts of Projected Freight Transportation Improvements*, November, 1976.

Table 10
Aviation Fuel Consumption in New England (1975)

	Jet Fuel 10^6 Bbl.	Gasoline 10^6 Bbl.	%	Total 10^6 Bbl.	
Air Carriers	8.28	0.01	91	8.29	
General Aviation	0.53	0.30	9	0.83	
Total	8.81	0.31		9.12	(51.7×10^{12} BTU)

Source: Oak Ridge National Laboratory, *Technical Energy Conservation Data Book II,* October 1978.

Table 11
Aviation Fuel Consumption Growth (1975-2000)

A. No Conservation	1975 10^6 Bbl.	1985 10^6 Bbl.	2000 10^6 Bbl.
Air Carriers	8.29	9.27	10.95
General Aviation	0.83	1.24	2.14
Total	9.12	10.51	13.09
B. With Conservation	**1975 10^6 Bbl.**	**1985 10^6 Bbl.**	**2000 10^6 Bbl.**
Air Carriers	8.29	9.01	10.14
General Aviation	0.83	1.24	2.14
Total	9.12	10.25	12.28

Source: Oak Ridge National Laboratory, *Technical Energy Conservation Data Book II,* October 1978.

Administration projects that between 1975 and 2000 general aviation activity will increase 160% while air carrier operations will grow 34%. Because the carriers consume the bulk of the fuel, aviation energy consumption is estimated to climb 42% to 13.09 million barrels in 2000 (Table 11). This represents an annual growth rate of 1.4%. It is important to point out that the growth projected for New England is substantially less than that forecast for the rest of the nation where fuel consumption is expected to more than double by 2000.

II. Conservation Potential

Air transport is the most energy intensive mode for moving passengers and freight (Table 12). As a result, growth in aviation activity will tend to have a larger impact on the region's transportation energy consumption than will growth in other modes. Rising fuel prices, though, have already forced air carriers to improve efficiencies. For example, since 1973 passenger miles flown per gallon of fuel have increased 18 percent. This has been accomplished through the higher efficiency of new planes and a series of improvements in operations and flight procedures.

There are, however, still more steps that can be taken to improve the energy efficiency of air travel. These include:

	Energy Savings
A. Operational Measures	
- Flying at optimal cruise speed	
- Increased airline load factors	
- Revise descent profiles	6%
- Reduce terminal delays	
B. Technological Improvements	
- Change in fleet mix	12%
- Improved engine design	13%

Source: Charles Phillips, U.S. Department of Transportation, Transportation Systems Center, Cambridge, Masssachusetts (personal communication).

Table 12
Energy Consumption Patterns

A. Energy Intensity for Passenger Travel

Year	Passenger Load Factor	BTU/ Passenger-Mile[1]
1971	50	8290
1972	54	7590
1973	54	7650
1974	56	6870
1975	55	6870
1976	56	6440
1977	57	6260

B. Energy Intensity for Cargo Transport

The average energy intensity for cargo transportation—25,000 BTU/ton-mile.[2]

[1] Oak Ridge National Labs, *Energy Intensity and Related Parameters of Selected Transportation Modes: Passenger Movements*, ORNL #5506, January, 1979.

[2] Personal Communication with J.K. Pollard, U.S. Dept. of Transportation, Transportation Systems Center, Cambridge, Massachusetts.

The energy savings from these efficiency improvements would substantially reduce the anticipated growth in airline fuel consumption. As a result, total consumption would increase to only 12.28 million barrels in 2000 and the annual growth rate would drop to 1.2% (Table 11).

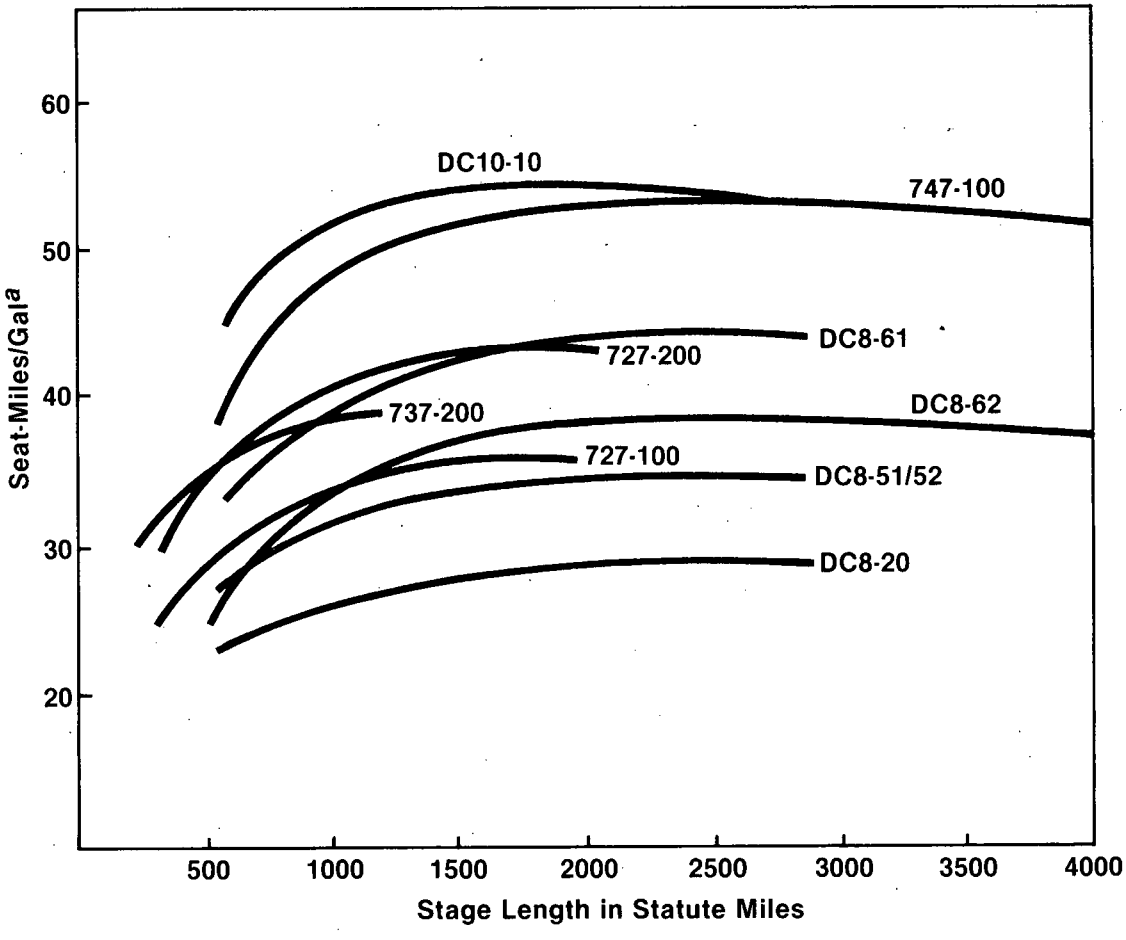
Additional fuel conservation can also be achieved by reducing the total number of passenger and freight miles flown. The short flights of less than 500 miles represent a particularly attractive opportunity for savings. As Figure 2 illustrates, fuel efficiency of nearly every plane drops significantly for trips of less than 500 miles. Furthermore, these short flights consume more than 30% of all the fuel used by the airlines (Table 13). The improvement of alternative modes such as intercity rail in the Boston to Washington corridor could reduce the demand for these inefficient short flights, and thus reduce transportation fuel consumption for the region.

Table 13
Airline Fuel Consumption by Stage Length

Miles	%
0-500	31
501-1000	22
1000-1500	14
1501-2000	12
2001-3000	12
3001+	9

Source: Oak Ridge National Laboratory, *Technical Energy Conservation Data Book I*, October 1977.

FIGURE 2
Aircraft Energy Efficiency



Aircraft Energy Efficiency vs Stage Length for Various Aircraft

[a]10 seat · miles/gal = 13,500 Btu/seat · mile.

Source: L.J. Williams, NASA Ames Research Center, *Air Transportation Energy Efficiency*, presented at the Fourth National Conference on the "Effects of Energy Constraints on Transportation Systems," Union College, Aug. 1-5, 1977, Fig. 13.

MODAL SHIFTS REPORT

I. Introduction

This paper presents estimates of the potential improvements in the efficiency of transportation resulting from shifts between the various modes. Conservation due to modal shifts is distinct from conservation resulting from technical or institutional improvements and from behavioral changes which reduce the demand for transportation services. Historically,this country has exhibited a strong pattern of shifting to more energy intensive and convenient modes of travel. In conjunction with generally high levels of transportation services, this trend has resulted in the most energy intensive transportation system in the world, relying for the most part on automobiles for passenger transport and trucks for cargo. Although more efficient modes are known and in current use in this country, it is extremely difficult to determine the extent to which shifts to these modes can be accomplished. Very little data is available on the potential for modal shifts, and even less on the efficiency of particular measures to achieve that potential.

The approach used here is to present an array of the existing transportation modes, ranked in accordance with their energy efficiency. These modes are then evaluated in terms of the likelihood and value of shifts to the more energy efficient modes. A gross ranking of the most attractive modal shifts and a discussion of possible scenarios for achieving certain levels of shifting are then presented. Due to the complexity of the truck/rail issues for cargo transport and to the fact that these were considered at least briefly in the NEEC *Preliminary Report* (Conservation), passenger transportation only will be discussed.

II. Criteria for Modal Shifts

Table 14 presents the array of passenger transportation modes for urban and intercity passenger traffic, ordered from worst to best in terms of energy efficiency. The table provides numerical data (national averages) on the efficiency, in BTU's per Passenger-Mile, the gross traffic in 1976 in billions of PM's, and the percentage of total transportation energy use accounted for by that mode. There are some discrepancies in the data available from various sources on these parameters, particularly for the non-automobile modes, so for consistency, the most up-to-date and complete source was used. New England-specific data was not available and it could exhibit somewhat different traffic levels and efficiencies, particularly for the non-auto modes. The most glaring entry in Table 14 is the one that indicates that one-third of our transportation energy is used for the least efficient mode of urban passenger travel, the automobile. Surprisingly, intercity automobile travel is one of the more efficient options, although intercity bus is close to three times more efficient. It should be pointed out that the measure of energy efficiency used does not account for the total energy required to build and maintain the transportation system. Fuel consumption is estimated to account for about 60 percent of all the energy required in the transportation sector including vehicle manufacture, road construction, etc.,[1] and the total energy demand created by any particular system is more important than simply the fuel consumption. However, for our purposes, fuel efficiency will have to suffice, as comprehensive data on total energy use is not available. One observation which can be made is that indirect energy inputs for the automobile system dominate total energy for the transportation system.[2]

Table 15 presents a list of the criteria which must be used to evaluate the various transportation modes along with a listing of the factors important to each criterion and a ranking of

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[1]Dennis Hayes, *Rays of Hope* (Norton: 1977) p. 105 says transportation indirectly consumes 17% of total U.S. energy. 15% is the figure mentioned in *Efficient Electricity Use*, ed. Smith (Pergamon: 1976) p. 136f.

[2]David Large, in "Hidden Waste" in the *Energy Conservation Training Manual* by the Conservation Foundation (1975) p.II-80, calculates that auto fuel consumption is 61.7% of the total auto-related energy demand, and that is fairly close to the 60% quoted above.

Table 14

Existing Passenger Transportation Modes (1976 data)

Passenger Mode	Energy Efficiency (BTU's/PM)	Traffic (Billion PM/YR)	% of Total Trans. Energy
Urban			
Automobile	5,464	1,176	33.1
Bus (transit)	2,890	19	.3
Rail (commuter)	2,357	6	.1
Rail (transit)	2,234	12	.14
Bus (school)	745	75	.3
Walking[1]	500	U	U
Communications[2]	200	U	U
Bicycle[1]	100	U	U
Intercity			
Air	6,491	192	6.4
Rail	3,123	4.5	.1
Automobile	2,837	1,183	17.3
Bus	1,075	17	.1
Communications[2]	600	U	U

[1] *Cyclateral Thinking*, Urban Bikeway Design Collaborative, Cambridge, MA 1976, p.33, and *Rays of Hope* by Denis Hayes (Norton:1977) p.116.

[2] Communications is included as a mode of transportation in the sense that the use of communications equipment, including phones, telex, data transmission, video-phones, etc., can substitute for personal travel. As a reference, see *Efficient Electricity Use*, ed. Craig B. Smith for EPRI (Pergamon:1976) p.331ff.

Source: *Changes in Transportation Energy Intensiveness 1972-1976*, by John K. Pollard, DOT-TSC, April 1978.

Table 15

Criteria for Passenger Transportation Modes

	Criteria	Factors	Relative Importance: Social	Relative Importance: Individual
EFF	Energy Efficiency	BTU's/PM	3	7
C$	Consumer Costs	Includes fuel, amortization insurance, usage fees, etc.	5	5
S$	Social Costs	Includes equipment and infra-structure paid through taxes, subsidies, etc.	1	8
SP	Speed of travel	Travel time point to point	6	1
CON	Convenience to dest.	Number of interfaces or transfers, proximity to actual destination, etc.	7	3
COM	Comfort	Personal comfort, privacy, etc.	9	2
Flex	Flexibility	Scheduling options, change of destinations, etc.	8	4
ENV	Environmental	Primarily air pollution, but also noise, land use, etc.	2	9
SAF	Safety	Safety	4	6

Source: George Gantz, New England Energy Congress

Table 16
Attractive Passenger Travel Modal Shifts

Modal Shift	Average Savings (BTU/PM)	General Attractiveness	Significant Barriers
Urban			
Auto to Bicycle	5,364	high	Lack of facilities, comfort, distance, speed.
To Communications	5,264	med	Technology, acceptance.
Auto to Walking	4,964	low	Speed, comfort, distance.
Auto to Commuter Rail	3,107	med	Lack of facilities, flexibility.
Auto to Other Transit	3000	med	Lack of facilities, speed, flexibility.
Intercity			
To Communications	5,891	high	Technology, acceptance.
Air to Bus	5,416	med	Speed, services.
Air to Auto	3,654	med	Speed.
Rail to Bus	2,048	low	None.
Auto to Bus	1,762	high	Comfort, convenience, flexibility.

their relative importance to society and to individuals making choices on modes of transport. The ranking is the opinion of one individual and is presented here as an example. The criteria are not totally independent, particularly the cost items, but it is clear that there is a tremendous disparity between costs and benefits as perceived by society and as perceived by consumers. This disparity is a fundamental problem in any attempt to improve the energy efficiency of the transportation system by modal shifts. The goal of modal shifts are societal benefits, primarily those resulting from oil savings, while the means to achieve that goal must involve benefits to individuals (human nature being what it is). Table 15 indicates that personal priorities are exactly the reverse of societal priorities. It should be noted that the rankings in Table 15 are relative and do not reflect that actual importance of a particular criterion. For example, speed, convenience, comfort and flexibility would be very close in absolute importance to cost for an average individual, while environmental effects, particularly, would have barely any importance. Ideally, each of these criteria would be evaluated quantitatively with respect to the variety of modal shifts available, and this could probably be done, at least with reference to surrogate measures. However, for our purposes, a qualitative assessment will have to suffice.

A number of potentially attractive modal shifts are presented in Table 16, and evaluated according to energy savings, general attractiveness, and the existence of major barriers. It should be noted that many of the most attractive modal shifts will probably involve intermodal connections, but for the sake of simplicity, these have not been included in Table 16. Each of the modal shifts identified is discussed briefly below, with particular attention paid to the trade-offs involved in making such a shift. In addition, the magnitude of potential energy savings available from particular modal shifts is identified in those cases where data was available. These savings are summarized in Table 17.

III. Urban Passenger Travel Modal Shifts

A) Automobile to bicycle

There are some substantial disadvantages to using bicycles which will limit their utilization in New England. Among the more important concerns are safety due to the lack of safe roadspace and recognition for bikes, comfort in cold or inclement weather

Table 17
Potential Energy Savings From Selected Modal Shifts

Modal Shift	Magnitude of Shift	Energy Savings[1] (10^{12} BTUs/YR) National 1985	National 2000	New England 1985	New England 2000
Urban					
Auto to Bicycle	1985-1.3% of auto trips avoided. 2000-2.4% of auto trips avoided.	62	83	3.5	4.6
Auto to Communication	1985-0.5% of work trips avoided. 2000-5% of work trips avoided.	25	255	1.4	14.3
Auto to Transit	Various measures. Impact estimated by BNL.	U	U	7.3	9.6
Intercity					
to Communications	1985-0.5% of air trips over 1500 miles avoided. 2000-5% avoided.	17	171	.6	6.3
Air to Auto	10% of all air trips diverted (mostly short)	—	70	—	2.6
Auto to Bus	1985-Bus service doubled 2000-10% of intercity auto trips avoided.	30	208	1.7	11.6
Total Savings Potential				14.5	49.0

[1] The savings are calculated from the base year 1976 and not from forecasts of the respective modal energy demands in the years 1985 and 2000.

and during exertion, speed of travel and limits on feasible distances, and the general lack of facilities for bikes. In all other ways, bicycles are superior for urban trips of up to five miles or so, and for very short trips or in very high density areas with parking problems, bicycles even outrank automobiles on speed of travel and convenience.

Energy savings as a result of shifting to bikes can be immense, if even a fraction of urban auto travel is diverted to bikes. One estimate (cf. *Cyclateral Thinking*, Urban Bikeway Design Collaborative, Cambridge 1977) is that 10% of all urban auto trips less than five miles (30% of urban auto travel) with favorable weather conditions (65% of time) could be diverted to bicycles. Based on 1976 automobile energy consumption data, that would result in a yearly savings of 136 x 10^{12} BTUs/Yr nationally. A more realistic figure (cf. U.S. DOT *Summary of Opportunities* 1976) projects that in 1985 bicycle use could save 62 x 10^{12} BTUs/Yr and in 2000, 83 x 10^{12} BTUs/Yr can be saved. For New England, this corresponds to savings of 3.5 x 10^{12} BTUs in 1985 and 4.6 x 10^{12} BTUs in 2000.

It should also be pointed out that bicycles can mix very readily with other modes of transportation if facilities for bike parking or transport on other modes are available. Such developments would tend to increase the savings from bicycle use as well as increase savings from use of transit facilities.

B) To Communications

With respect to urban transit, communications services can serve to replace automobile or other trips in certain applications. Such substitutions are currently

restricted to things like phone orders or payments, and remote banking (i.e. at supermarkets). (Postal services may also play a role in reducing personal transport, but their impact is not likely to change substantially in the near term and therefore they will not be considered here.) In the future, the range of applications where communications can substitute for transportation will expand tremendously. In particular, telecommunications technology is constantly improving and the potential markets are far from saturation. Some of the potential substitutions and their expected commercialization dates are listed here:

Telecommunication Substitution	Date Available
Work Trips - white collar	1985-90
Education - Adult classes	1980-90
Shopping - General	1985-90
Shopping - Groceries	1980-90
Education - Library Services	1985-90
Work - Company File Access	1985-90
Education - Tutoring	1980-90
Education - Computer aided	1982-87

Source: *Efficient Electricity Use*, ed. Craig B. Smith, for EPRI, 1976 p. 332.

For applications such as these; communications provides tremendous energy efficiencies, equivalent to something like 200 BTU/PM. With respect to computer work trips, if one percent of such trips could be replaced by communications services, national energy savings would approach 51 x 10^{12} BTUs/Yr. For purposes of comparison, we will assume that by 1985, only 0.5% of commuter trips are avoided, but by the year 2000 improvements in communication technology and increases in energy costs will increase the level of replacement by an order of magnitude, to 5% of current commuter trips. The national savings would amount to 25 x 10^{12} BTUs/Yr in 1985 and 255 x 10^{12} BTUs/Yr in 2000, and the New England equivalents would be 1.4 x 10^{12} BTUs/Yr and 14.3 x 10^{12} BTUs/YR respectively.

C) Automobile to walking

Data from Oak Ridge *Regional Transportation Data Book*, ed. 1, 1978 indicates that in New England, 9.2% of the work force walked to work in 1976. In addition, most transit trips (7.8% of work trips) and many auto trips involve some degree of walking to and from final destinations. Although the passenger miles travelled are not known, this indicates that walking already constitutes a sizeable element in the transportation system. In high-density areas, particularly, walking is a speedy and inexpensive way to get around. Although walking is not likely to make a significant dent in transportation energy use, it could be encouraged in many areas and it could play an ever important role as an adjunct to increases in transit modes.

D) Automobile to commuter rail

Commuter rail is a potentially very attractive and energy efficient mode of passenger transport in urban areas. It can be combined with other modes for greater convenience, it is sufficiently quick, and can be quite comfortable. For long distance commutes to the central city, commuter rail service compares quite favorable with automobile commuting. Unfortunately, there are two major barriers to increased service and it is unlikely that this mode will become a major element in our transportation system in the near or intermediate term. One barrier is due to the fact that heavy rail equipment is not flexible and can provide only high-density corridor service to the central-city core. Modern land development has taken place in such a dispersed manner that few, if any, new heavy rail corridors are feasible. The second barrier is that heavy rail facilities are very

expensive, prohibitively so in all but the highest density corridors. For these reasons, this modal shift is not likely to improve transportation efficiency in the near term, although improvements in existing corridors could have a minor positive effect.

E) Automobile to other transit

The major barriers to commuter rail are still valid but less critical to the lighter rail and bus transportation modes known as transit. Transit modes provide relatively efficient service in urban areas, particularly in high density areas, and although they currently account for less than 3% of urban passenger travel, their potential contribution is much higher. Although these modes are more flexible than commuter rail and generally provide excellent local service, they are, as a result, somewhat slower,and the speed of travel becomes an important factor, particularly for longer distances or trips involving transfers. The major objectives of a transit system must be to provide service with good frequency and reliability to as many areas as possible while still maintaining adequate load factors. The problems are not trivial.

Several sources provide estimates of possible increases in use of transit modes, although none is specific to New England and the data in various studies is rarely comparable. An example of some of the more useful data is taken from Brookhaven's study of Transportation Conservation Potential in the Northeast and is presented below after being adjusted to New England. The three measures were assessed independently and therefore cannot be summed. The "total" savings assumes that 50% of each measure is achieved.

Action Taken to Improve Transit	Savings (10^{12} BTUs/YR)	
	1985	2000
No Fare	5.9	7.8
Double VMT	2.5	3.2
Commuter Parking Tax	6.2	8.2
Total	7.3	9.6

The measures available to encourage transit expansion are hardly limited to the three mentioned here. In fact, in the material we received concerning the Washington, D.C. Metro Planning Study, 62 individual measures were identified. The major emphasis in such measures must be aimed at increasing the speed, comfort and convenience of transit while lowering the consumer costs, at the same time as consumer costs for automobile traffic is increased and the amenities of urban automobile transport are reduced.

IV. Intercity Passenger Travel Modal Shifts

A) Communications

The major drawback to replacing intercity travel with communications is that people like to travel and they like to see things and meet one another face-to-face. The growth in communications in modern times has not been a modal shift from travel, but rather an increase in demand for communications services. As communications costs and energy use are very low, however, it could substitute for travel in limited circumstances, several of which were mentioned above. Perhaps the only way to overcome the barriers is by increasing the costs of intercity travel and by supporting the development of better technologies for personal communications. Telecommunication services appear to have the greatest potential for replacing very long distance air travel.

Computer conferencing, direct video communications, and perhaps videotaping of professional seminars, etc., will eventually provide more convenient ways of transferring information than individual long distance travel. Energy efficiencies can be expected to be an order of magnitude or so greater than for air travel. Considering the fact that one-third of all aviation fuel with stage lengths of greater than 1500 miles, if we assume that 5% of such trips are replaced by telecommunications services, the national savings would by 171×10^{12} BTUs/Yr, or 6.3×10^{12} BTUs/Yr for New England. For comparison purposes, we will assume this level can be achieved by the year 2000, and one tenth of this level can be achieved by 1985.

B) Air to bus or auto

The biggest liability in such a modal shift is the time involved. Air travel over long distances is very fast and provides a totally different service than ground transport. Whereas it takes 5 hours or so to cross the continent by air, it takes 5 days to do so on the ground. Unless air travel gets terribly expensive due to high energy costs, long distance travel is likely to continue to take place in the air. However, a great deal of opportunity exists for replacing shorter trips by bus or auto service. For short flights, the speed of travel by air is very sensitive to ground connections and the time involved in transfers. Also, air travel becomes quite expensive for the minimal time savings that result. If 10 percent of air travel could be diverted to ground transportation, say the auto, without changing auto load factors, the yearly savings in energy would be close to 70×10^{12} BTUs/Yr nationally.

C) Automobile to bus:

This modal shift provides significant efficiency improvements and appears to be a significant opportunity. Buses currently account for about 1.2% of intercity passenger travel, whereas autos are 84.7% of the total. The major disadvantage of this shift is in terms of comfort, convenience and flexibility. These could be improved considerably if attention were paid to bus service amenities, routing and scheduling. At present intercity bus service in major urban areas suffers from poor intermodal connections, but it also suffers from slowness due to frequent stops and the use of minor travel routes. These liabilities could be largely removed if intercity bus ridership increased substantially, thereby increasing the demand for express service, increasing service to currently isolated areas, and increasing demand for destination connections. Consumer costs of bus service is also a problem, particularly since most individuals contemplating a trip only consider the costs of gasoline for their car. Costs should become more attractive with increasing ridership and with education. If the assumption is made that 10 percent of intercity auto travel is diverted to bus, the national yearly average energy savings would amount to 208×10^{12} BTUs/Yr. By 1985, we will assume that intercity bus service doubles, generating energy savings of 30×10^{12} BTUs/Yr nationally. New England savings would be 1.7 and 11.6×10^{12} BTUs/Yr respectively.

V. Appendix: Highway Trust Fund/Mass Transit

The Highway Trust Fund was established in 1956 to provide funds for the construction of the Interstate Highway System and to accelerate the expansion of existing neglected rural roads. In large measure, these purposes have been achieved. Recognizing the critical liquid fuel situation, we must now question whether expansion of the Highway Trust Fund, above and beyond maintenance costs, and the placing of restrictions on the use of such monies to designated highway categories runs against the grain of our urgent need to conserve energy. More appropriate action, in our judgement, would entail increased revitalization of mass transit systems in New England, while discouraging inessential automobile use.

The 95th Congress, in its final days, passed the 1978 Highway Transportation Act which authorizes the following expenditures on highways:

Fiscal Year	Billions of Dollars
1979	8.40
1980	8.90
1981	8.90
1981	9.40
1982	8.15
Total Fiscal Years 1979-1982	34.85

Two points regarding this authorization deserve mention. First, while most of this money is allocated from anticipated Highway Trust Fund revenues, a small portion has been allocated from other sources. This will only serve to perpetuate a trend toward federal, state, and local subsidies for highway costs that clearly contradicts the goal of energy conservation.

The Federal Highway Administration's *1974 Highway Statistics* indicates that a large disparity exists between direct expenditures on highway construction, maintenance, and administration, on the one hand, and revenues raised through user taxes and tolls on the other. In 1973, New England spent $1.43 billion on highway construction, rehabilitation and maintenance while fees for the use of these roads covered only $0.93 billion of this expense, 35% disparity. The remaining one-half billion dollars came from general funds, property taxes, bond proceeds, and miscellaneous sources.

This disparity between revenue and expenditure leads to the other concern implied in the $34.85 billion authorization, that is, deficit spending. No deficit spending was authorized in the 1978 Highway Transportation Act, a policy we support. Deficit spending discourages the use of mass transit by:

1) Increasing financial support of less energy efficient vehicular traffic over more energy efficient transportation modes competing for the same federal funding,

2) Further weakening the link which ties road user payments to the full costs of highway rehabilitation, and

3) Providing money for new road construction which will perpetuate the attractiveness and convenience of the automobile as the chief transportation choice.

Another way to promote mass transit is to create more flexibility in the use of highway money so it can fund public transportation. Currently, funds for most categories in the *urban highway system* under the Federal-Aid Highways Act can be used for mass transit *capital assistance*. But even more flexibility is needed to promote the use of mass transit and discourage the use of the automobile. Providing the states with Highway Trust Fund money which must be restricted to highway expenditure guarantees that a state or locality will spend this money on highway projects, even if more desirable energy conserving transportation options are available. A consistent Federal policy would require states and localities to choose from a variety of alternative transportation modes rather than limiting such choices to highway construction and improvement.

Similarly, Highway Trust Fund money now available for capital costs should be made available for transit operating assistance. In nearly all instances, New England states and localities would better serve the region by revitalizing and improving existing mass transit systems rather than purchasing and constructing new ones. Existing systems could be improved through expansion of feeder lines, satellite parking, and shuttle service, where appropriate.

Decision makers ought to be able to choose among project alternatives based on the merits of the project rather than committing themselves to restricted options because of federal funding constraints. Such shared funding could be modeled after the Urban Mass Transit Act restrictions. These allow 50% of UMTA grants for use toward operating assistance. Included in such operation changes should be the establishment of no fare, low fare, and off-peak fares to attract riders.

Lastly, energy analyses will and must continue to play a most significant role for choices between transportation projects. Therefore, it is imperative that such analyses accompany any project plan before funding is allotted for that project. These analyses would be similar to environmental impact statements. They should compare the energy efficiency of the transportation project to all other means for performing the same transportation task.

ENERGY CONSERVATION COMMITTEE

DELEGATES

Bonnie B. Anderson
Energy Committee Member, League of Women Voters, Portland, ME—consumers

Jeremiah M. Baker
Business Agent, Steamfitters Local 603, Springfield, MA—labor

William H. Beardsley (Committee Vice Chair)
Assistant to the President, Bangor Hydroelectric Co., Bangor, ME—utilities

Charles H. Burkhardt
Executive Vice President, New England Fuel Institute, Watertown, MA—small business

Josiah S. Cushing, II
House Counsel, Massachusetts Co-operative Bank League, Boston, MA—finance

Mary Hanf Dawson
Member, National Energy Committee, League of Women Voters of the United States, Boston, MA—consumers

Charles F. Feledy
Director, Corporate Energy Programs, United Technologies Corp., Hartford, CT—industry and manufacturing

Sylvia S. Field
Past President, New England Coalition on Nuclear Pollution, Cambridge, MA—environmentalists

Richard C. Hill
Professor of Mechanical Engineering, University of Maine, Orono, ME—educators

Ruth A. Hunter (Chair, Transportation Subcommittee)
Senior Project Engineer, U.S. Department of Transportation, Cambridge, MA—government

Alan S. Johnson (Chair, Residential Subcommittee)
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John S. Krikorian, Jr.
Assistant Professor of Electrical Engineering, University of Rhode Island, Kingston, RI—educators

David Lavine (Committee Chair)
Chair, Joint Energy Committee, Connecticut General Assembly-Hartford, CT—government

David J. MacFadyen (Chair, Commercial/Industrial Subcommittee)
President, Technology & Economics, Inc., and The Energy Bank, Inc., Cambridge, MA—R&D

Judith Mauzaka
Energy Consultant, Mansfield, CT—low income

James F. O'Malley
Director of Marketing, Public Service Corp. of NH, Manchester, NE—utilities
Ann Roosevelt
New England Regional Representative-Friends of the Earth, Inc., Boston, MA—environmentalists
LTC Karl F. Schmid
Director, Facilities Engineering, Fort Devens, MA—unaffiliated
Carl Spang, Jr.
Energy Programs, New England Municipal Center, Durham, NH—low income
Frederick A. Szmit
General Manager, Boise Cascade Corp., Brattleboro, VT—industry and manufacturing

Resource Consultants

Robert A. Beaudry
Sales Manager, City Coal and Oil, Nashua, NH
Cameron D. Beers
Director, Administrative and Special Services, The Gillette Company, Boston, MA
John P. Hoar
Manager, Real Estate Utilities, Polaroid Corp., Cambridge, MA
Stephen J. Keating, Jr.
Director, Energy Management Division, State Department of Administrative Services, Hartford, CT
Henry Link
New Horizons Dept., The Water Bureau, Hartford, CT
Arthur R. Osborn
Executive Vice President, Mass. State Labor Council, Waltham, MA
C. Russell Shaw
Director, Energy Conservation, Erving Paper Mills, Erving, MA
Jay Silverston
Vice-President, XENERGY, Inc., Lexington, MA
Joseph Zimmel
Consulting Engineer, Energy Management Division, State Department of Administrative Services, Hartford, CT

STAFF RESEARCHER

Ann Carey
David M. Ross
Technical Consultant

EXECUTIVE SUMMARY

The Conservation Committee defines energy conservation as consisting of both the reduction of consumption and the increasingly efficient use of scarce energy resources. Given New England's overwhelming dependence on a single energy source (oil represents 80 percent of total New England supplies) and the resulting problems of supply vulnerability and high cost, the need for conservation is critical and the benefits of conservation are many. As such, energy conservation should be given the highest priority among energy policy decisions.

The committee acknowledges the direct relationship between conservation and the development of alternative sources. With the goal of reducing consumption of scarce energy

resources, renewable sources can be viewed as conservation measures and conservation measures can be viewed as an alternative source of supply. While the Conservation Committee has focused on measures to reduce consumption and increase efficiency of use, it also recognizes alternative energy sources as desirable and necessary conservation measures.

With the region's demanding winters and high fuel prices, conservation measures are particularly cost-effective. Significant gains in reducing consumption will not only result in important savings for individuals, but will also assist industry and business and improve New England's competitive position.

While the adoption of many conservation measures is not inexpensive, it is important to remember that there are large economic benefits inherent in investments in energy conservation, especially for a region such as New England. The development of a viable conservation industry to meet the region's needs for conservation goods and services would impact favorably on economic development and community revitalization. Any reduction in the consumption of energy reduces the flow of dollars to non-New England producers and reduces the need for expanded capital investment in expensive technologies. Conservation, by almost any standard, is often the lowest cost approach which will be needed to meet energy demand over the next few decades, and should make the supply of energy more abundant by reducing waste and demand via education, improved housing and appliances, and more efficient industrial usage of energy. Such improved energy efficiency can become the basis for economic competition.

In the face of ever-rising energy prices, the committee recognizes the need for financial assistance to those least able to cope with rising energy costs. Low-income consumers, whose expenditures are already strained to cover essential needs, lack the flexibility to reduce demand, and lack the resources to implement such measures as housing improvements to cut their energy consumption. While other programs are being developed, the committee recommends the continuation of the Crisis Intervention Program until such time as a more permanent solution can be adopted. In addition to emergency fuel assistance, expansion of the Low Income Weatherization Program is needed to assure the winterization of as many dwellings as possible. Both programs are essential for assisting low-income consumers in reducing their energy needs without undue suffering.

The committee approached the task of outlining energy conservation measures by examining the varying aspects and needs within distinct energy sectors: residential, industrial/commercial, and transportation. Each sector has different patterns and different mechanisms to encourage conservation. Potential conservation measures are numerous, and the committee established a "means" test by which to evaluate their legislative need, feasibility, potential for passage, time frame, and balance of regional interests. Using these criteria as guidelines, the Conservation Committee developed its recommendations. Several recommend Congressional action, while others call for administrative changes in existing programs and regulations to facilitate greater energy conservation.

The focus within the residential sector was to formulate policies that would increase the incidence of conservation by residential consumers. Assuming that residential consumers want to conserve and have the economic incentive to do so, the committee established that there are barriers that discourage that behavior. The major barriers identified were: 1) lack of information, such as what measures to take, the energy savings of those measures, and where to get such services; 2) lack of standards to assure quality and safety of conservation products; and 3) lack of financing for home improvements.

The recommendations generated by the committee are aimed at eliminating those barriers, and include: 1) expanded programs of grants, low interest loans, and tax credits; 2) increased funding and greater flexibility for the Low Income Weatherization Program; 3) energy education programs (run by State Energy Offices) to provide relevant, reliable information; 4) widespread availibility and improved federal guidelines for the utility audit program; 5) establishment of

product and workmanship standards; and 6) consideration of the job creation potential in the evaluation of conservation programs.

Complementing the committee's work in the residential sector is the Energy Congress' inter-committee Residential Package. This package has the endorsement of the Conservation Committee and the reader is urged to review it. (See pages 365—380.)

The basic concerns within the industrial/commercial sector are: 1) to improve and protect the economic viability of New England commerce and industry; and 2) to reduce consumption of critical fuels (especially oil and gas). There is a compelling economic argument for industrial and commercial energy conservation, given the private sector's response to cost-effective measures. To assist businesses (both large and small) in making energy conservation investments, the committee recommends: 1) the establishment of an energy clearinghouse which would provide decision-relevant information on conservation measures, and maintain a network to put business and industrial representatives in touch with conservation service suppliers; and 2) government research efforts aimed at improving the energy efficiency of existing buildings.

The preliminary discussions within the transportation sector addressed both passenger and freight transportation by all modes. Consideration was then narrowed to those modes in which conservation efforts would yield the maximum fuel savings.

Passenger transportation, by far the largest segment of energy consumption in the transportation sector, is dominated by the automobile. In order to achieve significant fuel savings, a concerted effort is needed to: 1) reduce the total vehicle miles travelled by auto; 2) shift to more energy efficient modes of transportation; and 3) dramatically improve the efficiency of autos. The committee focused on *incentives* to improving transportation efficiency, but recognizes that two compelling *disincentives*, a substantial gas tax or rationing of fuel, may be inevitable if savings are not realized.

The committee recommendations aimed at increasing the efficiency of passenger transportation include: 1) increased auto (and light truck) fuel economy standards through the year 2000; 2) enforcement of the 55 MPH speed limit; 3) continued car and van pool programs; 4) promotion of mass transit through improved service and access, and through auto disincentives (parking restrictions, auto free zones, etc.); 5) evaluation of energy consumption in the planning of highways and urban transportation systems; 6) completion of the original performance goals of the Northeast Corridor Improvement Project to provide fast, convenient intercity rail passenger service; 7) encouragement of bicycle use through improved bikeways and increased safety; and 8) substitution of communications services for personal transportation.

Freight transport in New England is served by both rail and truck services. A viable rail network and efficient truck operations should form the most efficient, integrated system possible. To enhance energy conservaiton in freight transportation, steps must be taken to: 1) improve the rail network; 2) step up the technological research into improving trucks; and 3) remove regulatory barriers that hinder competition as well as cooperation between these two modes.

To achieve more energy efficient freight transportation, the committee recommends: 1) better rail service through improved technical and operating procedures; 2) increased federal research into the improved efficiency in trucks, and the dissemination of results to truck operators; 3) consideration of energy conservation as a high priority by the Interstate Commerce Commission in review of its trucking regulations; and 4) promotion of integrated rail/truck service through increased interface and removal of any unfair regulatory advantages (such as routing or rate structure) for one mode over the other.

During the final months of the Energy Congress, the committee worked jointly with the Demand Committee on transportation issues. A joint report was endorsed by both committees and the reader is urged to review it. (See pages 291—329.)

While the Conservation Committee worked to develop program and policy recommendations in areas of consensus, there were distinct areas where agreement could not be reached. Although no action was taken on these topics, nor policies advised, this is not to imply that these issues are of no concern to the committee or New England as a whole. Rather, they are identified here as areas where continued dialogue is needed to determine the best, balanced recommendations for action. The major unresolved issues identified by the Conservation Committee were: artificial pricing of energy; utility rate reform; deregulation of natural gas; crude oil taxation, with the distribution of those tax dollars to conservation projects; accelerated depreciation of industrial capital expenditures; negative versus positive incentives; and community model programs, to demonstrate the local impacts of energy conservation and alternatives development on the economy, through job creation and economic development.

RECOMMENDATIONS

I. Residential

1) *To overcome the financial barriers of residential energy conservation, expanded programs of grants, low-interest loans, and tax credits are recommended.*

The financing of conservation measures presents a particular burden to the individual consumer, and programs should include support and incentives for all income groups. Congress should study various monetary and non-monetary mechanisms for funding energy conservation programs.

2) *Congress should study the regional impacts of energy policies, the elasticity of energy pricing, energy price structures, and the end uses of energy.*

Accurate understanding of how energy policies affect consumers is needed in order to develop equitable programs dealing with all aspects of energy. Artificial pricing does not necessarily enhance conservation; however, end users should be charged for their contributions to the cost of energy production. If, however, national policies result in energy prices set above market and yield excess profits, resultant revenues should be used for conservation programs, including development of alternative technologies, technologies for increased production, and for minimizing the effect on low-income consumers.

3) *The National Weatherization Program is recognized as a major, long-term low-income energy project, and Congress should continue funding and give priority to its implementation.*

At the present rate of activity, it would take a minimum of 25 years to retrofit the approximately 340,000 low-income housing units in need of weatherization in New England. Therefore, funding should be increased to expand the per unit limit and the retrofit services provided, allow for integration with basic housing rehabilitation, and

expand administrative services. Different labor force arrangements should be examined; the present program suffers from reliance on temporary and unskilled CETA labor.

4) *Congressionally mandated energy education programs should continue, with the State Energy Offices responsible for their coordination and implementation. Such programs should be designed to reflect the needs of specific population groups within each state.*

Lack of relevant information is a barrier to energy conservation, and effective educational programs must be developed and coupled with financial incentives for conservation. At the state level, programs can be targeted to specific population groups, such as rural single family homes, or urban multi-unit complexes.

5) *The use of complete home energy audits should be continued and their availability increased. To protect consumers, Congress should require audit firms or persons performing audits to make certain disclosures as to the interest the firm or person might have in the resulting recommendations. Further, all heating suppliers should participate in any mandatory audit programs.*

6) *The federal government should be responsible for establishing product standards and workmanship guidelines for energy conservation materials, and the present efforts to determine such standards are endorsed.*

7) *As mandated in the National Energy Act, Congress should establish mandatory appliance efficiency standards. Additionally, prominent labeling of appliances with information pertaining to energy consumption should be required.*

When establishing efficiency standards, the federal government would do well to follow the model of several state programs, which establish mandatory minimum performance standards for each type of appliance, and require that all appliances for sale after a certain date meet that minimum level.

8) *The impact on job creation of various conservation measures should be considered when evaluating conservation programs.*

The resulting jobs due to production of conservation materials, installation, distribution and sales can help stimulate the local economy. Findings from the hearings held by the Alternatives Committee support the theory of job creation through conservation and alternatives.

9) *The Conservation Committee endorses the Residential Energy Package as example program recommendations that qualify under the principles of conservation outlined above.*

II. General

10) *The Conservation Committee strongly recommends the restoration of the Crisis Intervention Program funding to prevent a recurrence of winter fuel emergencies.*

When examining specific measures to encourage energy conservation, the committee also recognizes that rising energy costs impact more severely on low-income consumers. Low-income people spend a disproportionately high percent of their income on energy; such expenditures are almost entirely for essentials, and the low-income household has little opportunity to reduce consumption. The repercussions of not being able to meet ever higher winter heating bills, such as shut-offs and refusal of delivery, pose a real threat to life, especially to the elderly. The Crisis Intervention Program is a short-term approach to the energy problem. However, it is necessary until low-income housing is sufficiently weatherized, and substantial public assistance and utility rate reform is enacted.

III. Industrial/Commercial

11) *To facilitate the sharing of ideas regarding energy conservation in business and industry, an "energy clearing house" should be established as a source of reliable, decision-relevant information that identifies appropriate improvements and the best alternatives for making those improvements.*

Small businesses often don't have the financial or technical ability to lower their energy use, while larger businesses are conducting similar product and service evaluations, and both could benefit from information sharing. To assure that businesses can make cost-effective decisions, such information should include referral on services, product evaluation, and networking so that businesses can share their knowledge.

12) *Building energy conservation is one of the most comprehensive approaches to conservation available to all commercial and industrial buildings. Energy conservation programs, including government research efforts, energy performance standards, and financial incentives, should address existing buildings with an emphasis equal to that presently applied to new structures.*

The rate of replacement of the New England building stock is relatively low; thus over the near-term (25 years), existing, less energy-efficient structures will continue to dominate the building stock. In addition, the problems of improving the existing building inventory are more complex and difficult than the problems of constructing better new buildings, emphasizing the need to specifically address the retrofit of existing buildings.

IV. Transportation

The Conservation Committee worked in conjunction with the Demand Committee to develop a joint report on Transportation. The findings and recommendations of that report are fully supported by the Conservation Committee. (For a complete listing of recommendations and documentation, see pages 291-330.)

RESIDENTIAL SECTOR

I. Introduction

The focus within the residential sector was to formulate policies that would increase the incidence of conservation by residential consumers. The basic premise accepted by the Committee is that residential consumers want to conserve energy, that is they have the economic incentive to do so. Assuming conservation to be the normal expected behavior of residential consumers, the committee then examined the scene to detect any barriers to that behavior. The recommendations generated by the committee would be aimed at eliminating any barriers that were discovered.

Analysis of potential barriers to conservation was based on information provided by focus groups, by utilities, and taken from a survey done for the Massachusetts Energy Office.[1] The major barriers identified were: 1) lack of information, that is, what can be done by the homeowner or renter as opposed to what requires a contractor, what measures yield the greatest savings in terms of payback, where should a person go to find a reputable dealer; 2) lack of standards to assure that a contractor is qualified, products are safe, and installation is done correctly; and 3) lack of financing, especially access to the money market to secure the upfront capital for home improvements.

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[1]*Survey of Massachusetts Residents' Attitudes Toward Conservation*, prepared for the Massachusetts Energy Office by Decision Research Corp., Wellesley Hills, Massachusetts, June 1978.

In attacking those barriers to residential energy conservation, the committee worked within the context of what could be accomplished within the next few years. Realizing that the National Energy Act would cover many of the concerns raised here, the committee felt that a purpose could be served by both reinforcing what was being done or by filling in gaps.

Lack of information was approached from the perspective of how to provide the consumer with reliable information. Although there are many sources of information (utilities, installers, auditors, the government) consumers tend to distrust information which may come from self-interested sources. In terms of general information flow, the state energy offices are presently involved in such programs, and should continue to be the central focus of such programs as the Energy Extension Service. Furthermore, information programs should be designed to target specific population groups, such as rural single family homes, or urban multi-family complexes.

Turning to the barrier of lack of standards, it was believed that even with information, consumers are reluctant to make major expenditures for conservation because they are afraid that the savings claims are inaccurate, that the workmanship is shoddy or unsafe, or that the products are dangerous. The responsibility for establishing minimum standards rests with the federal government, while responsibility for enforcing the standards should lie with the states. The National Energy Act, specifically the utility audit portion, provides for such a devision of responsibility. In addition, the efforts of the Federal Trade Commission to regulate unsubstantiated or inaccurate claims about savings and products are encouraged. Likewise, the Consumer Products Safety Commission should continue to define product and installation standards.

The financing of conservation measures in the residential sector presents a particular burden to the individual consumer. Even with adequate information about conservation, and even with the security of safe and adequate products and services, the consumer may not have the resources to provide the necessary up front capital to finance improvements. Financial assistance must be available to all income levels, with programs designed to meet the specific requirements of each segment of the population. Therefore, the continuation of the various grant programs for low-income consumers, including the weatherization program and community development block grants, is essential. Further, the establishment of low-interest loans and tax credits are necessary to assist moderate and upper income consumers.

A final concern of the Conservation Committee was the need for some financial relief for those least able to cope with rising energy prices. While not technically a conservation measure, the committee was concerned that the issue may not be adequately addressed in any other context. The issue is the continuing problem that low-income consumers have in gaining access to energy. We felt that while other energy programs are being developed, we had an obligation to recommend to Congress that the Special Crisis Intervention Program be continued until such time as a more permanent solution can be adopted.

II. Financial Barriers

Financial assistance for energy conservation measures is especially needed in the residential sector, where homeowners and renters often lack the capital to make necessary improvements to save energy. A variety of financial incentives are needed to encourage conservation among low, middle, and upper income groups.

Tax credits, such as those recently passed in the 1978 National Energy Act, are supported by the Conservation Committee. They stimulate those who can afford the upfront cost to make the investment in conservation measures, and reduce the payback period for such an investment.

Low-interest loans enable more middle income homeowners to finance home energy improvements. Federal or state guarantees for long-term loans for insulation and other improvements should be adopted. The Farmers Home Administration and the Veteran's Administration already provide such guarantees, and there is no reason why guaranteed loans should not be available for everyone.

Grants are extremely important in meeting home improvement needs of low-income households. Such housing is often in critical need of insulation, and a disproportionately high percent of the low-income person's earnings is already going for basic energy needs. Grant programs such as the weatherization program discussed later, should be expanded and vigorously implemented.

Funding for these incentives should be more thoroughly examined so that equitable measures can be devised to raise needed revenues. Conservation measures should be, in part, aimed at higher income consumers, who can reduce excess consumption, but should not result in higher energy prices for low-income persons. Possible sources for such funding, as discussed by the committee, include: bank and/or utility involvement, utility rate restructuring, transfer of funds from other federal programs, income and/or energy taxes, or general revenue.

III. Energy Pricing Policies

Congress should study the regional impacts of energy policies, elasticity of energy pricing, energy price structures, and the end uses of energy. Accurate understanding of how energy policies affect consumers is needed in order to develop equitable programs dealing with all aspects of energy.

In the discussion of the residential energy sector, the committee attempted to understand the behavior of the consumer, and whether the establishment of incentives to conserve or the institution of penalties for not conserving could alter that behavior. One potential disincentive, a price increase, was examined at length. Although intuitively, many members felt a price-demand relationship does exist, and that energy prices should be increased to capture that elasticity, a brief survey of some sources indicated at least some doubt. For example, some preliminary studies of time-of-day pricing impacts on residential usage patterns maintained that there was little impact on demand. In addition, the demand from low-income consumers was seen as relatively inflexible; they would, therefore, be severely impacted by a price rise.

The committee is concerned that a price increase, although intended to yield a decrease in demand, would result only in placing a greater burden on consumers with little attendant conservation impacts. The committee is further concerned that any policy of increases might affect the New England economy more adversely than other parts of the country, since gas and oil (both domestic and more importantly imported) the most likely would be prime targets for pricing policies.

In view of the lack of evidence regarding the elasticity of energy demand, artificial pricing of energy is not seen as encouraging conservation. Until there is greater understanding of the regional impacts of energy policy, price structures and elasticity, energy rates should reflect their replacement costs.

If, however, national policies do result in artifically high energy prices, such revenues should be distributed for conservation programs, development of alternative technologies, and for minimizing the impact on those who can least afford higher energy prices: the elderly and the low-income consumers.

In addition to an understanding of the elasticity of demand, a serious review of the end uses of energy is needed. Matching energy types with appropriate uses, such as natural gas for high temperature industrial processes or residual heat for steam power and space heating, can increase the efficiency and reduce the waste in energy use.

Pricing policies, such as subsidies for conventional energy sources and rate structures that encourage consumption, need re-examination. Energy rates should reflect the cost to the consumer equal to the burden placed on the system. Utility rate reform is long overdue and the committee supports the intent of the National Energy Act to encourage states to review: declining block rates, which may promote wasteful energy consumption; peak load pricing, to discourage

unnecessary use and spread the usage out; lifeline rates, so that peak load pricing does not overburden elderly and low income households; and load management, which spreads out use and reduces the need for new plant construction.

IV. National Weatherization Program

The federal weatherization program formally began in January 1975 (under the rubric of "winterization") when the Congress authorized the Community Services Administration (CSA) to operate the Emergency Energy Conservation Services Program to lessen the effects of rising energy prices on low-income households and to reduce energy consumption.[1] In August 1976, Congress authorized the Department of Energy (DOE) to establish a supplementary home weatherization program.[2]

In FY 1978, Congress appropriated $65 million each to CSA and DOE to carry out weatherization activities. For FY 1979, Congress appropriated $199 million for weatherization to DOE, an amount the President recommends be appropriated to DOE for FY 1980. The amount, if any, that CSA will receive for FY 1979 and FY 1980 for its weatherization program is presently unresolved, but the President has proposed that the program be discontinued and run entirely by DOE.[3] The weatherization program is intended to allow low-income households to save money on home heating costs through the addition of energy saving improvements such as insulation, caulking, weatherstripping, storm windows and doors, and home and heating system repairs.

Weatherization projects, whether funded through CSA or DOE or a mix of the two, have been operated principally by Community Action Agencies (CAAs) which administer local efforts by assembling work crews (primarily through Comprehensive Employment and Training Act (CETA) labor), procuring materials, and controlling weatherization work performance.

The most immediate problem affecting the viability of the present federal weatherization program throughout the country, and particularly in New England, is the lack of a predictable labor force. The present situation is so precarious that unless immediate corrective measures are taken, the program will come to an operational standstill, leaving thousands of low-income households to face continually escalating energy costs with no defense but diminishing and unreliable crisis intervention allocations.

CAAs have mainly been required to rely upon CETA labor to carry out their weatherization activities. Such labor, however, provides too few slots for weatherization personnel, too little training for the majority of workers—who are unskilled—too little pay for those workers who are skilled, too brief a work assignment to enable workers to either gain experience or establish an identification with the CAA, the program, or weatherization as a trade, and far too much uncertainty as to future funding levels.[4] Of these problems, the most crucial concerns the actual

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[1]Community Services Act of 1974 (P.L. 93-644; 42 U.S.C. 2809, Sec. 222(a)(12). Under the Act, the Director of CSA was authorized to provide financial and other assistance for programs and activities including an energy conservation and education program, the winterization of old and substandard dwellings, emergency loans and grants, emergency fuel, research for alternative fuel supplies, alternative transportation designed to save fuel, and programs for legal and technical assistance related to energy.

[2]The Energy Conservation and Production Act (ECPA) (42 U.S.C. 6861(b)). The DOE weatherization program was recently amended by Sections 231-2 of the National Energy Conservation Policy Act (NECPA) (P.L. 95-1751).

[3]Congress placed CSA's FY 1979 appropriations under a continuing resolution. However, the Office of Management and the Budget (OMB) indicated it would seek a rescission of the CSA's FY 1979 weatherization funding. The General Accounting Office (GAO) then indicated in an informal opinion that the legislative history made such rescission unnecessary since, in the view of the GAO, the legislative intent was to delete the CSA's weatherization appropriation from the continuing resolution.

[4]New England Community Action Program Directors Association (NECAPDA), *Weatherizing New England* (February 1979) (paper prepared for the Low Income Caucus, New England Energy Congress).

availability of CETA and skilled supervisory labor. Without federal funding for weatherization labor, contractual program goals simply cannot be met.[1]

The unavailability of adequate labor in New England is well documented in a DOE memorandum dated August 3, 1978, from Robert F. Philpott, Region I Director, Conservation, Solar and Resource Application, to Mary M. Bell, National Director, Weatherization Assistance Program. That memorandum states that as of October 31, 1978, while 686 CETA slots were needed to achieve DOE weatherization goals, only 179 such workers, or 26 percent of those needed, were available. Although these figures may be atypically low because CETA contracts for FY 1978 were expiring at this time (manpower status in the region as of June 30, 1970 was 511), the same DOE memorandum and CAA experience indicate the problem is a continuing one. Most Region I Prime Sponsors are being asked to scale down their programs for FY 1979.

While it is evident from these figures that replacements for the expiring slots are imperative, the grantees estimate that an additional 354 slots will be needed over and above the 332 replacements in order for the CAAs to gear up their programs to a manpower level that will ensure that the regional weatherization goals are achieved. Given the present manpower level, along with the projected attrition rate, subgrantees will fall significantly short of the projected target of weatherizing 20,815 dwelling units by the end of the first quarter of 1979. Preliminary reports for the period ending June 30, 1978 indicate that the six grantees in the region have weatherized approximately one-third of the units projected in the state plans for the period. Although the slow start-up in Region I has not been due solely to labor problems, the labor projections for the remainder of the fiscal year, as well as for FY 1979, will certainly compound an already difficult situation.

The pessimistic projections set forth in the DOE memorandum of August 3, 1978 have clearly come true. Of the 1040 New England CETA slots DOE indicated were necessary to meet its 1979 weatherization goals, 524 slots, at most, are presently available; and only 124 additional slots above this total can be reasonably anticipated to be available in the foreseeable future. Thus, a maximum of 62 percent of New England's labor needs for weatherization can be met at any one time. At certain times during FY 1979, this percentage of accessibility will be far less.

CETA labor, available to perform weatherization activities in FY 1979, is even more critical across the country than it is in New England (though, in light of the exceedingly serious nature of the situation regionally as well as nationally, such comparisons may not be terribly meaningful). Recently, a nationwide survey conducted by the CSA of every CAA in the U.S. shows that while the projected FY 1979 need is for 21,772 CETA workers, only 41 percent (8,875) of these workers will actually be obtainable. Moreover, since the Department of Labor's budget for FY 1980 proposes over a 50 percent cut in the number of CETA workers, long-term prospects for adequate weatherization in New England and the U.S. as a whole are insecure at best.

Unless Congress acts to ensure that additional labor funds are allocated to perform weatherization activities, the present situation will continue to deteriorate. Though CSA's weatherization regulations have a waiver provision which permits its weatherization funds to be used for labor, these funds will terminate shortly due to the Administration's decision to discontinue the CSA weatherization program. No FY 1979 DOE funds are available to meet labor needs on this discretionary basis.

To date, no existing DOE regulations address themselves to this problem. Energy Conservation & Production Act (ECPA) states that financial assistance under the program is to be used for the purchase of weatherization materials "to the maximum extent practicable". While this

[1]In the absence of a federal definition of a completed unit, care must be exercised when judging the success or failure of state and local weatherization projects by merely comparing numbers. For example, minimal time and materials spent on units will net higher figures (though often lower energy savings) than will more expensive, time-consuming, labor-intensive work.

statutory language appears to offer discretionary authority to meet exigencies, DOE officials do not interpret it as permitting expenditure of any weatherization funds for labor.[1]

The Department of Labor (DOL) entered into an interagency Memorandum of Understanding with DOE and CSA in August 1977, in which DOL indicated it would encourage prime sponsors to use CETA funds in support of a workforce for weatherization projects. Unfortunately, efforts by DOL to implement this interagency agreement have not resolved the problem, and more importantly, DOL has no standing or regulatory authority to require prime sponsors to earmark CETA slots for weatherization.[2]

For the same reason, the recent language contained in Section 233 of the National Energy Conservation Policy Act (NECPA) is not likely to be effective. This language requires the Secretary of Labor, after conducting a labor inventory and identifying shortages, to take steps "to the maximum extent practicable" to assure that federal weatherization activities are supported by sufficient numbers of public service workers, trainees, and volunteers. In effect, this new law does no more than codify the existing interagency agreement and does not provide the Secretary with any legal authority to remedy the situation he finds in conducting the weatherization program review.

Total reliance on temporary and unskilled CETA labor, in addition to an apparently overambitious completion schedule, places the weatherization program in a tenuous position. It can either maximize production or maximize training opportunities, but rarely both. CETA should therefore be seen as a supplemental, not a primary, labor source for the weatherization program.

Even if the Secretary of Labor could use his limited authority under NECPA to fill labor shortfalls in the weatherization program effectively, serious long-term labor problems would remain unresolved. Primary among these historic long-range problems, as substantiated by CAA experience as well as the General Accounting Office (GAO) in its report on the weatherization program, are those regarding lack of sufficient managerial and fiscal training at the staff level, the need for predictable skill and performance levels from the crews, and the difficulty of attracting and keeping qualified personnel due to noncompetitive wage scales.

A second major problem area undermining the effectiveness of the federal weatherization program concerns the lack of flexibility in program regulations.

Although DOE has amended its regulations recently and NECPA will provide additional assistance, restrictions severe enough to prevent effective weatherization still exist. Major restrictions involve limitations placed on expenditures and activities per unit, current levels of funding, and relationship to major housing rehabilitation.[3]

Under current DOE regulations, a maximum of $800 may be spent on each dwelling unit weatherized. While this may seem a tremendous gain when compared with the former $400 limitation, further analysis reveals that this $800 figure is intended to be all-inclusive. That is, under the new cost accounting system, expenses for administration, transportation, storage, purchase of tools and equipment, repairs, and supervisory labor must all be included in this total amount. Operationally, the DOE funds remaining after compliance with the new cost accounting system have been suggested to be at best equal to, and possibly less than, those formerly available for the materials per unit investment under the old regulations. In any case, there is little assurance that

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[1]42 *Federal Register* 27899 (June 1, 1977); 43 *Federal Register* 34493 (August 4, 1978); 44 *Federal Register* 31 (January 2, 1979).

[2]GAO Report, *Complications In Implementing Home Weatherization Programs for the Poor* (August 2, 1978); Memorandum of David Entin, Massachusetts SEOO, to SEOO Directors, September 1, 1978.

[3]There are other issues of concern which must be addressed soon but which go beyond the scope of this paper. These include: (1) weatherization of the rental market; (2) the federal agency which should be the primary funding source; (3) expansion of the weatherization program to assist people presently just beyond the scope of income eligibility; and (4) the status of conservation education, alternative technology, legal and technical assistance, and related programs defunded with the shift of weatherization funds to DOE from CSA.

sufficient funds exist to achieve "optimal" weatherization and thereby a significant reduction in fuel consumption nationwide. While NECPA does permit this $800 limit per dwelling to be waived in special circumstances by DOE, it is likely that the requirements for the waiver provision will be rigidly interpreted, and in any event, the procedure will be cumbersome at best.

In addition, limitations are set for the maximum amount allowed to perform repairs ($100). Where is there provision for the purchase of needed insulation blowing machines (which can cost up to $1,000) or replacement parts for furnaces in excess of $50? The $100 repair limit effectively places a necessary fuel burner retrofit program in direct competition with other necessary repairs, since now both must total $100 or less. Fuel burner retrofit—a simple tune-up and recalibration process—costs approximately $30 per unit and has a tremendous payback (an average of $75 in the first year, $37 in the second year, $19 in the third). This operation has proven successful in New Hampshire and should become standard weatherization practice for all program operators.[1]

The primary purpose of the weatherization program should be, quite simply, to lower the fuel bills of low-income people. This goal will not be achieved if the program continues at its present funding level and retains artificial spending limitations and program restrictions. For example, if $250 is spent on materials per unit, the expected reduction in consumption is approximately 14 percent. To date, average materials expenditures have reflected this figure. With a high inflation rate and steadily rising energy prices, these minimal savings will disappear within a year or two unless progressive definitions, standards, and investments are applied. Maine reports that in 1978, work remaining was reported in 52 percent of the houses served. The average cost in materials was $398 per house. In addition, over 28 percent of the houses had work remaining in excess of $300.[2]

If this program is, as has been claimed, a serious federal effort at conservation for low-income people, optimal weatherization measures must be undertaken. This can only be accomplished by increasing current funding levels, dropping artificial limitations on eligible activities, and giving more autonomy to local administering agencies.

Given workable standards, increased technical aid, and quality control, the major decisions regarding the way to weatherize a unit must be left to the local program operator. Otherwise, program inflexibilities such as limitations of expenditures may prevent the use of the most cost-effective weatherizing measures, which often vary from region to region and even from house to house. NECPA's standard set of procedures should be elaborated in greater detail to determine what these most effective measures are, but DOE should then allow local agencies to determine the actual work priorities within these general standards. This practice will provide the necessary flexibility to meet the varying needs of local programs, whether urban or rural, large or small.

Most homes eligible for weatherization are in need of substantial rehabilitation before basic infiltration measures can be undertaken.[3] The 1975 census figures show that one-half of all the homes in New England were built before 1940 and many are in need of repair. Since the low-income population is 30 percent more likely to live in these structures than are households of higher incomes, this data suggests that three-quarters of all low-income people in the region live in such substandard housing.[4] The general estimation of CAA field experience is that this percentage is probably conservative.

Currently, weatherization programs are prohibited from providing major housing rehabilitation. Clients are either turned down outright or are referred to other agencies, with

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[1]*Impact of the New England Regional Commission's Low Income Winterization Project* (August 4, 1978) (prepared for NERCOM by Urban Systems Research and Engineering, Inc.).

[2]Maine Division of Community Services Weatherization, *Summary of Recipient Characteristics* (1978).

[3]NECAPDA Report, *Op. Cit.*

[4]The Grier Partnership, *The New England Energy Consumer* (January 1979).

spotty and haphazard results and followup. There is a real lack of program coordination on this level at present.

There is cause to believe that the current DOE restrictions are based upon an archaic model. When CSA began its weatherization activities in 1975, the program was merely a supplement to a larger CSA-sponsored housing program. This housing program has since declined, along with a substantial allocation for staff and administrative support. Consequently, the growing weatherization program was left with inadequate funding in these areas.[1]

In the past, DOE has assumed that its subgrantees could rely on other funding sources to obtain the necessary labor, vehicles, equipment, and storage space. With impending CETA cutbacks and the potential elimination of CSA from involvement in weatherization activities altogether, this support base is no longer feasible. And in New England, the valuable supplemental funding provided by the New England Regional Commission (NERCOM), currently $500,000, appears likely to be discontinued in FY 1980.

Although weatherization is a long-term approach to conservation for low-income people, it is not a permanent solution and completed work should receive routine maintenance. Many factors indicate the need for expanded program funding: the number of eligible homes remaining to be weatherized, the need to accelerate completion of weatherization of these homes, deterioration of other housing units, and probable increases in efficiency standards as time passes.[2]

The life span of weatherization materials must also be considered (i.e., weatherstripping, 2-10 years; oil burner tune-ups, 3 years). It is estimated that 10 percent of the effectiveness gained by weatherization is lost each year.[3]

The issues discussed above—lack of a predictable workforce and lack of flexibility in federal regulations—are the subjects most often cited by program administrators as major problem areas in the weatherization program.

> It is necessary to realize that what is called the weatherization program has from the start been not one program, but an amalgam of elements of several.... The program is an antipoverty program, an energy conservation program, a housing rehabilitation program, and an employment program. These objectives are not necessarily inconsistent, but they cannot all be maximized at once.... The program is pieced together by several different federal agencies acting under different laws and overall priorities.[4]

Failure to establish an effective weatherization program will continue unnecessary waste of energy and increase the present deprivation of low-income and elderly citizens. As the most effective conservation measure available to low-income households, weatherization must be recognized as a major, long-term energy program. Funding should be increased to expand the current per unit expenditure limit and retrofit services provided, and allow for integration with basic housing rehabilitation. The labor problem and weatherization of the rental market require immediate and serious attention.

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[1]NERCOM Study, *Op. Cit.*

[2]There are approximately 340,997 low-income housing units in need of weatherization in New England. Of these, 102,566 are owner occupied, 238,431 are rentals. As of June 1978, only 27,000 homes had been weatherized. At the present rate of funding, a conservative completion date for these units has been estimated at 25 years.

[3]NERCOM study, *Op. Cit.*

[4]Baldwin, Fred, *The Weatherization Program: A Policy Perspective* (April 1977) (report prepared by the Syracuse Research Group for CSA).

V. Energy Education Programs

A major barrier to residential energy conservation is a lack of relevant information on the part of consumers about how to conserve energy. To meet this need, effective educational programs must be developed and coupled with the financial incentives now being offered to consumers.

The existing state energy offices should have primary responsibility for coordinating and implementing educational programs. Energy information and education networks are fairly well established in the New England states, yet their services should be expanded both in breadth and depth with respect to conservation. Special attention must be given to designing programs to reflect the needs of specific population groups within each state.

To further conservation, the public must be informed about the *means* for saving energy. Energy programs should include energy hotlines, information phamplets, television spots, community seminars and workshops, and educational programs in elementary and high schools.

The public must also be informed about the *need* for conservation. Information on the increase in general welfare possible through conservation (the ramifications for employment, foreign policy, and environmental quality, for example) should be presented in terms identifiable by the general public.

The state energy offices should operate energy education programs through local, decentralized offices, with the federal government providing technical support information. Such offices are more accessible and responsive to community needs and concerns, and can target their programs to specific population groups, such as urban apartment dwellers or rural single family residences.

In addition, state energy offices should act as *public advocates* on energy questions affecting consumers. They should be not only a source of information and data for citizens, but also an interpreter of regulations and enforcer of standards and regulations. An active role by the state energy offices could help assure consumer representation and protection of the public interest.

VI. Energy Audits

Home energy audits are seen as an integral part of any comprehensive energy program, and their availability should be increased. The National Energy Act requires utilities to offer to inspect a home and recommend and arrange for installation of conservation measures; the Conservation Committee recommends that all heating fuel suppliers should participate in any mandatory audit program. Also, to protect consumers, audit firms or persons performing audits should be required to make certain disclosures as to the interest the firm or person might have in the resulting recommendations.

With the passage of the National Energy Act, a large number of utility audit programs will be starting soon, and there is a clear need to determine an optimal structure for these programs. The type of information that is really useful to a homeowner, the potential savings of conservation measures, and the methodology of audits must be established.

Utility audit programs in many cases do not strongly promote retrofit.[1] A typical result of an audit is a set of recommendations and a sheet of paper listing contractors whom the homeowner may contact. Much better results from these programs could be obtained if retrofit were made more integral to the program. Also, there is some doubt regarding the interests of utilities in energy conservation. These doubts could be alleviated through vigorous audit implementation and follow-up. To assure implementation of an economic and effective program, the federal government must provide specific guidelines for the states to follow.

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[1] Peter Hogarth, *Survey and Analysis of Residential Energy Audit Activities in the US*, Prepared for the Office of Technology Assessment, by Technology and Economics, Inc., May, 1978.

VII. Appliance Efficiency Standards

Under the 1978 National Energy Act, the federal government is responsible for establishing mandatory efficiency standards for appliances (such as refrigerators, water heaters, air conditioners, televisions, kitchen ranges and ovens). Appliance improvements would result in savings of energy and savings of dollars to the customer over the life of the appliance.

The technology of appliance efficiency improvement is known today, and many energy-saving design changes can be made with only a small increase in the initial cost of the appliance. Hoskins and Hirst, for example, in *Energy and Cost Analysis of Residential Refrigerators*[1], compared energy use vs. retail price for a variety of design changes in a model refrigerator-freezer. They showed that a substantial reduction in energy use can be achieved with a few basic changes and at a minimal cost increase.

Federal guidelines were first outlined under Title III of the Energy Policy and Conservation Act (P.L. 94-163) which established an energy conservation program for consumer products other than automobiles. Those guidelines were amended by the National Energy Conservation Policy Act (P.L. 95-619), which requires the Department of Energy to prescribe energy efficiency standards for nine types of appliances by December 1980. Efficiency standards are defined as performance standards, which means that DOE will establish the *minimum efficiency level* required to be achieved by each unit of a product type or class, but will not prescribe the methods, designs, processes, or materials to be used to achieve any particular efficiency level.

These amended performance standards are much more workable than the original guidelines, which based voluntary efficiency improvement targets on the 1972 average consumption level (which proved almost impossible to calculate for each appliance type). The new act allows for the phasing-in of standards over a period of up to five years through the establishment of intermediate standards. The original voluntary program often resulted in long delays in establishing standards when target levels were not achieved. To avoid such problems, DOE should strive to establish the highest performance levels realistically achievable now, and aim to raise those levels over the five-year period as technology provides further improvements.

The new act designates the Federal Trade Commission (FTC) as responsible for developing and administering a labeling program, requiring that manufacturers label each covered product with energy consumption information to assist consumers in making purchasing decisions. Prominent labeling should include the minimum efficiency level established for the appliance, as well as the consumption level of that particular model. In addition, labeling should show the range of efficiency achieved for the appliance so that the consumer can determine where that particular model's performance falls within the range.

VIII. Conservation and Job Creation

The impact on job creation of various conservation measures should be considered when evaluating conservation programs. The development of a viable conservation industry to meet the region's needs for conservation goods and services is supportive of regional economic development. Such development could create employment opportunities, stimulate the local economy, and reduce the out-flow of dollars to non New England suppliers.

The Conservation Committee recognizes the work of the Jobs Subcommittee of Alternative Energy Committee as directly related to the interests of conservation. Of particular interest is their report, "Employment Impacts of Energy Use and Production" on page 184.

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[1] Oak Ridge National Labs, January, 1977.

Table 1
Number and Percent of Households With Incomes Below 125% of Poverty
New England and States
1975

	Number of Households	Percent of all Households
Maine	67,000	18.8%
New Hampshire	37,000	13.4
Vermont	33,000	20.8
Masschusetts	265,000	13.5
Rhode Island	52,000	16.5
Connecticut	118,000	11.4
New England	572,000	13.9%
United States	12,564,000	17.3%

Source: U.S. Bureau of the Census. *Current Population Reports, Consumer Income. Money Income and Poverty Status in 1975 of Families and Persons in the United States and the Northeast Region by Division and States.* Series P-60, No. 110, March 1978.

Table 2
Average Percentage of Before Tax Income Spent on Energy
1976

	Home Energy Consumption	Gasoline Consumption	Total
First Decile (less than $3,000 yearly)	20.2%	9.6%	29.8%
Tenth Decile (above $30,000 yearly)	2.0%	2.2%	4.2%

Source: Thurow, Lester, *Distributional Impacts of Carter Energy Proposals,* Massachusetts Institute of Technology, prepared for the Joint Economic Committee, May 1977.

IX. Crisis Intervention

Federal involvement in crisis intervention began in 1975, when Congress authorized the Community Services Administration (CSA) to operate the Emergency Energy Conservation Services Program to lessen the effects of energy prices on low-income individuals and families and

to reduce energy consumption.[1] The initial nationwide allocation for crisis intervention was $16 million.

The beginning of the energy crisis in 1973, with its soaring fuel costs, placed an enormous burden upon low-income residents, who total 17 percent of the nation's population and comprise nearly 14 percent of the New England population. (Table 1)

This segment of the population (the working poor, elderly, disabled, unemployed, and recipients of public assistance) has been least able to conserve energy due to a combination of deteriorating housing conditions and an already low energy usage, which is based almost entirely on the essentials of space and water heating, cooking, refrigeration, and lighting.[2] The poor have no "discretionary income"; they have little opportunity to vary consumption levels, and often must choose among essentials.

The average percentage of income spent on energy by the poor is in marked contrast to that of the more well off. (Table 2) Any excess usage among low-income consumers is normally the result of poorly insulated homes and inefficient appliances. Consequently, "any increase in the price of energy will cause a reduction in real living standards that is seven times as large for the poorest decile as for the richest decile."[3]

New England in particular is faced with a potential emergency situation every winter. Its houses are among the oldest in the country; more than half were built before 1940. Low-income people are most likely to live in them. The region's 79 percent dependence on oil as a primary heating source (92 percent in Maine) well exceeds the national average of 26 percent. New England weather is 37 percent colder (66 percent in Maine and Vermont) than the average U.S. temperature.[4]

The cost of the four basic necessities (energy, food, medical care, and housing) rose 10.8 percent during 1978 compared with the Consumer Price Index increase of 9.0 percent. (Table 3) The cost of all four necessities is expected to rise sharply during 1979. "Interest rates may rise to 14 percent, food prices are likely to go up 6 to 10 percent, and energy prices could skyrocket if gasoline and crude oil are decontrolled. (The price of gasoline is already predicted to rise by at least 7 cents per gallon in the coming year.) Little improvement is expected in the health care and overall housing costs."[5]

Heating oil bills for an average household in New England have increased from $340 per year at the end of 1971 to $810 at the end of 1977. A 10 percent increase per year (due to inflation, the price of domestic crude and OPEC crude) will bring the average heating oil bill to about $1,030 a year within less than a two-year period. Such an increase does not take into account non-product costs such as insurance, real estate taxes, labor, vehicle replacement, deliveries, equipment replacement, etc. In general, indirect energy costs and usage (i.e., products which require energy

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[1]Community Services Act of 1974 (P.L. 93-644, 42 U.S.C. 2809, Sec. 22(a) (12)). Under the Act, the Director of CSA was authorized to provide financial and other assistance for programs and activities including an energy conservation and education program, the winterization of old and substandard dwellings, emergency loans and grants, emergency fuel, research for alternative fuel supplies, alternative transportation designed to save fuel, and programs for legal and technical assistance relating to energy.

[2]The Grier Partnership, *The New England Energy Consumer* (paper submitted to the Low Income Caucus, New England Energy Congress, at the request of the New England Regional Energy Project, January 1979).

[3]Thurow, Lester, *Distributional Impacts of Carter Energy Proposals*, Massachusetts Institute of Technology (paper prepared for the Joint Economic Committee, May 1977).

[4]The Grier Partnership, *Op. Cit.*

[5]National Center for Economic Alternatives, Washington, D.C., Press release dated February 4, 1979.

Table 3

Increase in the Cost of Basic Necessities — 1978

Breakdown	Annual Rate For 3 Months Ending March	Annual Rate For 3 Months Ending June	Annual Rate For 3 Months Ending Sept.	Annual Rate For 3 Months Ending Dec.	Yearly Average
Food	15.7%	20.9%	2.6%	8.0%	11.8%
Shelter	11.4	12.8	13.2	8.8	11.5
Medical	8.7	7.5	8.7	11.0	8.9
Energy	5.4	12.3	8.4	6.6	8.1
				Yearly Total	10.8%

Source: *National Center for Economic Alternatives*, Washington, D.C., February 1979. The energy category includes only direct residential fuel, retail automotive fuel and residential utility costs but not the energy component of food production, transportation, packaging, distribution, manufacturing, rents, and hospital operation, which have been heavily impacted at the wholesale level by such factors as the 10.9% increase in gasoline prices and the 24.9% increase in the interstate natural gas prices.

Table 4

1977-78 Federal Emergency Energy Assistance Program (EEAP) Funds to New England States

Connecticut	$3,775,000
Maine	3,140,000
Massachusetts	7,030,000
New Hampshire	3,370,000
Rhode Island	2,990,000
Vermont	2,180,000
New England Total	$22,485,000

Of this total amount, $3,374,000 was not expended due to the legislative cut-off date.

Table 5

1978-79 Federal Crisis Intervention Program (CIP) Funds to New England States

	'77-'78 Funds[1]	'78-'79 Funds	Total
Connecticut	$325,000	$237,000	$562,000
Maine	267,500	235,500	503,000
Massachusetts	772,500	522,000	1,294,500
New Hampshire	130,000	111,000	241,000
Rhode Island	117,500	76,500	194,000
Vermont	132,500	105,000	237,500
New England Total	$1,745,000	$1,287,000	$3,032,000

[1] Last year's unexpended EEAP funds to be added to this year's total.
[2] Figures represent Part 1 of the $200 million CSA allocation of $15 million nationwide. The release of Parts 2 and 3 is based upon stringent regulations and appears unlikely at this writing.

Source: Pratt, Robert. Director/New England Congressional Caucus, January, 1979.

Table 6
Estimated Total Energy Expenditure By Low-Income Households in 1978 Compared to Amount Obligated Under EEAP
New England

Estimated aggregate energy expenditure by low-income households (@ $1,121 per household)	$641,212,000
Total amount obligated under EEAP in 1977-1978	$17,833,347

Source: The Grier Partnership, *The New England Energy Consumer*, January 1979.

to produce, transport, store, and/or sell) are considerable and will add substantially to the financial burdens of poor and middle income households.[1]

The original $16 million crisis intervention allocation helped 49,000 families nationwide. It was followed by the coldest winter in 60 years and the distribution of $163 million to 2.6 million households under CSA's Special Crisis Intervention Program (SCIP). These funds, however, were not disbursed until the summer of 1977. An additional $160 million was spent during FY 1978, assisting 2.7 million households, under the Emergency Energy Assistance Program (EEAP).

Since the FY 1978 EEAP, Congress placed CSA's FY 1979 appropriation under a continuing resolution. Currently, although $200 million have been allocated for the 1978-79 heating season, Community Action Agencies (local agencies who administer the funds) are assured of receiving only $15 million due to new, stringent criteria for disbursement.[2] This $15 million and an additional $30 million of unspent funds from last year's $200 million EEAP allocation (now called EEAP Extended[3]) are the only certain Federal funds available to meet an energy need which has grown, not declined, over the past year. (Table 4) (The remainder of the $200 million allocated for the FY 1979 Crisis Intervention Program, beyond the initial first round of $15 million, is available only under complex criteria which threaten to make program administration extraordinarily difficult and, in the estimation of some observers, to limit actual expenditures to $40-$50 million.[4] (Table 5) All six New England states have applied for a portion of the second round of these funds but have at this writing no guarantee of receiving them.)

$17.8 million of EEAP funds were distributed in New England last year, assisting approximately 81,000 households. While this may appear to be a substantial figure, 81,000 represents only 14 percent of the 572,000 households in the region below 125 percent poverty level. The $17.8 million represents only 2.8 percent of the annual energy costs (estimated at approximately $1,121 per household) for the entire 572,000 low-income households, about 19.6 percent of the energy costs of the assisted 81,000 households.[5] (Table 6)

A) Crisis Intervention: An Overview of Administrative Problems

Federal energy crisis intervention programs have been characterized by allocation

[1]Memorandum from Charles Burkhardt, Executive Vice President, New England Fuel Institute, to the Conservation Committee, New England Energy Congress, regarding the need for a crisis intervention program (October 3, 1978).

[2]The original regulations for the FY 1979 Crisis Intervention Program were printed in the *Federal Register*, Vol. 43, No. 250, December 28, 1978, p. 60466. The subsequent amendments can be found in the *Federal Register*, Vol. 44, No. 15, January 22, 1979, p. 4480.

[3]Regulations for the CSA Emergency Energy Assistance Program (Extended) were published in the *Federal Register*, Vol. 43, No. 224,November 20, 1978, 54115.

[4]See regulations cited above

[5]The Grier Partnership.

Table 7
Timetable of Events
Emergency Energy Assistance Program (EEAP) — 1978

December 6, 1977	— Congress votes, in the House, to include EEAP in its Supplemental Appropriations (HR 9375) by a vote of 182-181.
February 22, 1978	— Congress votes to approve Supplemental Appropriations Act containing EEAP.
February 28, 1978	— President Carter signs Appropriations Act.
March 8, 1978	— CSA publishes final rule for EEAP in the Federal Register. Eligibility for clients at 125% of poverty, elderly at 150%. Funds to be obligated by May 1, 1978, expended by May 30, 1978.
mid-March, end of March 1978	— CAAs begin obligating EEAP funds.
March 22, 1978	— Regulations governing eligibility are changed to make eligible only persons at 125% of poverty and all persons receiving SSI regardless of income.
April 5, 1978	— New regulations finally published in the Federal Register.
April 6-12, 1978	— Agencies lobby for an extension of the May 1 deadline for obligation of funds.
May 1-5, 1978	— Extension of obligation period from May 1 to May 20.
May 20, 1978	— End of obligation period.

Source: Benner, Katherine, Emergency Energy Coordinator, Low Income Planning Agency, January 1979.

lags, unrealistic deadlines, last-minute revisions in regulations, and inadequate levels of support for administration and technical assistance. These problems have had the effect of annually delaying the program's onset and giving grantees inadequate time to plan, implement, and administer it. For example, legislation for the SCIP was passed in May 1977; program dollars, however, weren't available until that July and were spent against a September deadline. The appropriation for EEAP was initially held up from December 1977 until February 1978 by the attachment of funds for the B-1 bomber and subsequent legislative controversy; agencies began obligating funds in late March against a deadline of May 1, 1978. (Table 7) The EEAP restrictions were sufficiently unrealistic and arbitrary to be grounds for a successful class action against CSA.[1]

The successive crisis intervention programs described above indicate the absence of a clear and consistent federal policy concerning the kinds of energy emergency to which programs are intended to respond, and the types of assistance that should be available. Changes and confusion have apparently arisen from the ad hoc nature of each program: each program was approached on a theoretically "one-time" basis. Now that the need for a permanent program has become clear, difficulties in program administration in the past can be used to illustrate some of the policy parameters which must be worked out for any program to be successful.

CSA's crisis intervention programs have been administered under the general mandate to CSA to "lessen the impact of the high cost of energy on [low-income

[1]Grieg V. Olivarez, 12 *Clearinghouse Review* 373 (October 1978). The district court found that the program termination was unreasonable and did not leave enough time for potential applicants to learn of and apply for assistance. The court also found that the April amendments, which disqualified persons over 60 years of age with incomes between 125 and 150 percent of poverty were illegal because they were not preceded by the 30-day comment period. The court stated that CSA had the responsibility to provide applicants denied assistance with notice of denial and an opportunity to appeal.

individuals and families, including the elderly and the working or 'near poor,' defined roughly as within 125 percent of poverty guidelines] and to reduce individual and family energy consumption."[1] This responsibility of crisis intervention programs to "lessen the impact of the high cost of energy" has been interpreted differently for each of the major federal programs. While to some extent, such administrative flexibility is essential, both to meet changing conditions generally and to permit local responsiveness, the broad divergence of successive interpretations of this mandate may indicate the need for greater specificity in future legislative efforts to mandate any permanent program's overall policy direction and/or emphasis. Illustrations of the above-mentioned divergences of interpretation appear below.

B) Definition of "energy emergency"

1) SCIP funds were disbursed as a state entitlement based on a four-part formula considering (a) severity of winter, (b) number of poverty households, (c) number of elderly low-income households, and (d) fuel costs. States had discretion in setting specific procedures; but generally, a client was considered to be facing an energy emergency if she or he had large bills outstanding and could document an inability to pay them.

2) States' allocations under EEAP were triggered by a state's documentation that an energy emergency existed, based on (a) number of households without fuel or heat, (b) natural disasters interfering with access to fuel, (c) shortage or unavailability of fuel, and/or (d) unemployment caused by energy shortages. As documentation of an energy emergency, clients were required to provide a shutoff notice, a notice of refusal to deliver fuel, or other evidence of an emergency need.

3) The FY 1979 Crisis Intervention Program (CIP) addresses only a very narrowly defined "energy emergency" and is the most restrictive of the federal programs to date, in terms of both state and client responsibility for documenting the existence of an "emergency."

CIP funds are to be channeled to the states in a first round based on a criterion of "population-weighted average annual heating degree days," and in a possible second round based on the existence of either a winter-related energy emergency or a winter-related disaster. The criteria for release of the first round of $15 million recognize verbally that "normal winter weather in some areas of the country may be severe enough to cause an energy-related emergency," but the allocation is so small a portion of the $200 million available that it is inadequate to meet the energy crises caused by even normal winter temperatures, and appears to be arbitrary.

Low-income households are eligible for assistance with utility and fuel bills under FY 1979 CIP only in areas where shutoffs are not legally prohibited. This denial of energy assistance where protective no-shutoff policies have been legislatively established is based on an unreasonably rigid interpretation of an "energy emergency," i.e., that the client must, in effect, be facing an immediately health or life-threatening situation.[1] As such the provisions involved set a dangerous precedent for energy policy and low-income needs.[2]

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[1]The regulations as originally published required that an eligible household not only be facing a health- or life-threatening emergency but also be experiencing substantially increased energy costs. Sec. 1061.52-2 (policy) and Sec.1061.52-7(3) (program eligibility), footnote 2, page 350.

[2]For example, Missouri stopped legislative hearings on the possible implementation of a shutoff moratorium upon learning of the new crisis intervention regulations. Although the regulations may be interpreted to allow payment of bills once the moratorium is over, it is unrealistic to believe that such limited funds will be available several months from now.

C) Types of Assistance Offered

Through SCIP, eligible clients could receive up to $250 in assistance as a payment on an overdue utility or fuel bill, or $50 as a cash rebate if the client had paid a utility or fuel bill at great sacrifice. Last winter an attempt was made to diffuse what were perceived to be "income transfer" and "utility subsidy" aspects of crisis intervention through the EEAP regulations. These latter rules specified that assistance would be available not only for utility/energy bills but also for other necessities for which a client might lack resources due to very high energy bills (i.e., food, medical expenses, temporary shelter, and furnace repair were available under EEAP). However,unclear procedures for documenting "need" for these other classes of assistance, and the time-consuming process of arranging vendor payments, made it difficult for agencies to administer assistance other than with fuel/utility bills.

In the regulations for this winter's crisis intervention program, sharp distinctions are made between eligibility for direct assistance with an energy bill and eligibility for other kinds of assistance. Persons applying for assistance with a utility bill must supply documentary evidence of income eligibility; those applying for other kinds of assistance (food, medical care, temporary shelter, etc.) need only certify that stated income is accurate. Persons living in areas where there are legal prohibitions on utility terminations are not eligible for assistance with a utility bill, but they are eligible for other kinds of assistance. If an applicant needs assistance with a bill from a non-regulated fuel dealer, these regulations require the administering agency to establish: (1) that the applicant has less than one week's supply of fuel; (2) that fuel cost is "significantly higher" for the applicant; (3) that delivery is not possible without payment; *and* (4) that the applicant is unable to pay for the fuel.[1] These verification requirements are excessive and make it prohibitively time-consuming to assist households which rely on heating fuel for space heat. By contrast, a household needing assistance with a bill from a regulated utility can adequately document program eligibility with a shutoff notice.

In large part, assistance with food and medical bills, etc., has been made available to address the needs of low-income people who have paid utility/fuel bills at the sacrifice of other necessities.[2] To be meaningful, however, such assistance must be available at the time those necessities are being sacrificed. Perhaps such an approach might be implemented through a permanent, annualized program (see text below). There are increasing numbers of low-income households, however, who cannot, even in sacrificing other necessities, meet the rising costs of energy; the needs of this growing sector of the population can be met only through some type of cash payment to energy vendors.

D) Future Prospects and Possibilities

There has been much talk of a continuing crisis intervention program, with extensive programmatic changes and permanent funding. In 1977, the Carter Administration proposed, without success, that the authority of the Department of Health, Education and Welfare be expanded to provide such aid. Clearly, attention must be given to a problem which will not disappear although, at present, there is danger that

[1]Regulations, footnote 2, page 350, Sec. 1061.52-3(c) with reference to condition (2) in the accompanying text, at this writing the question as to what fuel cost must be "significantly higher" than remains unanswered.

[2]And to meet the terms of a Senate amendment which requires that eligibility not be based solely on delinquency in payment of fuel bills. *Congressional Record 281,* August 1, 1978, pp. 12212-12213.

the funding to address it may.[1] Although "much more effort needs to be devoted to finding ways of conserving energy in the United States, this is not the only issue: maldistribution and inequities must be addressed, as well as present and future shortages."[2]

One approach to this problem is to continue crisis intervention as a permanent interim program, established under a sunset law provision. Such a program might be funded through 1983, for example, and could have a mandatory review at that time to determine program effectiveness and continuing need. In addition, certain mechanisms should be required to be in place at the time of review before the program could be discontinued. Discontinuation of the crisis intervention program would be contingent upon the establishment of alternative protection for low-income energy users. Such protection might include:

1) *An expanded weatherization Program.*[3] This program should be amended to allow more flexibility, given an annual budget in the range of $960 million, and set a program target of 500,000 weatherized units a year. Weatherization is the most effective low-income conservation measure and keeps money in the region in which it is distributed.[4]

2) *An integrated policy relating to winter utility shutoff moratoria.* The issue of utility shutoffs, while related to the winter survival question for low-income people, may be dealt with separately from crisis intervention, up to a point. But neither states nor private companies which implement a winter moratorium on utility shutoffs should be penalized by subsequent denial of crisis intervention funds.

3) *Collection and analysis of detailed statistical information from utility companies or other sources, so as to gauge the dimensions of the problem more precisely.*

4) *Further consideration of the issue of appropriate utility rate structure.*

5) *An increase in the utility/energy allotment for recipients of public assistance.* In New England, energy costs have risen four times faster than welfare payments since 1973. Many poor and elderly households pay between 60 and 80 percent of their income for shelter and heat.[5] These energy costs (and their inevitable escalation) must be calculated into welfare budgets.

6) *A broader program that would address all energy needs and assist clients including the poor and the near-poor.* This paper does not endorse the use of fuel/energy stamps; however, if national policies result in the introduction of

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[1]The Carter administration has proposed a crisis intervention allocation of $40 million for FY 1980. This figure would represent a fraction of expenditures under both SCIP and EEAP. Meanwhile, the Department of Energy (DOE) has absorbed CSA's weatherization funding. CSA allocations for skilled supervisory labor, conservation education, appropriate technology, and legal and technical assistance have been drastically reduced, making CSA's future energy role unclear. Thus far, DOE's approach to the energy crisis includes a policy of inducing conservation through higher prices, an approach which presumes elasticity of demand and could be devastating to low-income consumers unless effective programs are implemented to cushion the impact of such price increases.

[2]Newman, Dorothy, *The American Energy Consumer*, Ballinger Publishing Co., Cambridge, MA. 1975.

[3]See accompanying paper on Low-Income Weatherization Program, page

[4]Urban Systems Research and Engineering, Inc., has estimated that a dollar invested in weatherization in New England will result in $2.11 of economic output by all sectors of the New England economy (spent on local labor; materials; and other goods by freeing the household's resources from expenditures on fuel, etc.). The same dollar spent on crisis intervention is estimated as resulting in approximately $.35 in economic opportunity (as a direct payment to fuel companies and utilities). Urban Systems Research and Engineering, Inc., *Impact of the New England Regional Commission's Low Income Winterization Project* (August 4, 1978).

[5]Fitzpatrick, Thomas, *Connecticut's Energy Crisis Intervention Program: Coordinating Diversity*, State of Connecticut, Office of Policy and Management (April 1978).

such stamps, they should be used for broader purposes than the payment of fuel and utility bills. Oil (possibly including gasoline), wood, and coal should also be considered legitimate energy expenses. Recipients should not be limited to recipients of public welfare; consideration sbould be given to other groups including the working poor, the elderly, handicapped, and perhaps others. Rising energy prices will inevitably augment the eligible population.

7) *Alternative energy sources should play a larger role in the low-income community.* Small-scale energy systems (including passive solar housing designs) should be made more accessible; this will require both financial assistance (i.e., grants to households, federal housing projects) and technical expertise.

8) *Integration of crisis intervention recipients into more long-term and comprehensive energy programs.* Further steps should be taken to maximize the low-income household's energy efficiency and independence. Each client receiving emergency assistance should register for weatherization and home rehabilitation services and receive counseling in conservation measures and self-advocacy techniques. Such an approach has been attempted by some Community Action Agencies, but has been thwarted by administrative difficulties as mentioned above, staff shortages, and related problems (such as long waiting lists of eligible applicants) with other programs.[2] The incorporation of services into a one-stop services center approach would remedy an existing fragmentation of services. On this model, crisis intervention assistance would act as a self-referral/outreach mechanism, augmenting outreach resources by bringing emergency energy problems to the attention of the provider of more long-term services. Community Action Agencies, the primary administrators of many of these programs currently, suffer from limited staff, training, and program funds, regulatory programmatic restraints as described above, and long client waiting lists. Consequently, a firm commitment at the federal level is a necessary first step toward the successful operation of any major integrated low-income energy policy.

Four aspects of the current "income transfer" model of crisis intervention have made its reception by Congress and federal policy-makers problematic:

1) The energy emergencies it is designed to relieve are perceived as a regional rather than federal problem;

2) The program itself may act as a disincentive to paying utility bills;

3) The program operates as a subsidy for utility and oil companies without addressing the longer-term crisis;

4) The vendor payment aspect of crisis intervention is perceived as "welfare" at a time when income transfer assistance programs are unpopular.

The foregoing analysis illustrates the national scope of the energy crisis in its particular impact on the low-income segment of the population. Inflation, especially as reflected in the cost of necessities, is not limited to one region, although living expenses in the Northeast are historically higher than in other parts of the country. Colder climates also exacerbate the inability of the consumer to make ends meet.

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[1]See, again, accompanying paper on the Weatherization Program; see also, New England Community Action Program Directors Association (NECAPDA), *Weatherizing New England* (paper prepared for the Low Income Caucus, New England Energy Congress, February 1, 1979).

Table 8
Local Model of
Annualized Crisis Intervention Program

1) CAA's outreach workers determine the financial situation of household.
2) CAA's outreach workers, with vendors, determine fuel and utility needs for 12 month period.[1]
3) CAA's outreach workers determine what the household can comfortably pay monthly for fuel and utilities for a 12 month period.[2]
4) CAA's determine, with vendors, monthly balance needed to insure household fuel and utilities for a 12 month period.[3]
5) Household will make their pre-determined amount monthly payments directly to the vendors.
6) CAA's will pay pre-determined monthly balance to vendors once verification is received that household has paid their monthly payment.
7) CAA's will make no monthly payment if household has failed to pay their amount.[4]
8) If household moves before 12 month period was completed, vendors would be required to reimburse CAA's for any balance not used.
9) Any balances left after the 12 month period was completed, vendors would be required to reimburse CAA's for any balance not used.
10) This type of program would guarantee fuel and utilities for the household with no threat of shut off or refusal of fuel deliveries for a 12 month period.
11) Monthly follow up and recertification of income would insure the success of this type of program and eliminate abuses.

Notes:
A) All eligible households would automatically be processed for weatherization assistance.
B) No welfare recipient would be eligible for the program, however, HEW could institute its own program with a similar format.
C) Poverty guidelines for elderly low-income households would be extended from 125% to 150% of the current guidelines.

[1] Based on previous two (2) years' consumption.

[2] Based on present household income and previous two (2) years' of payments made by household.

[3] If utility and fuel prices rise drastically, CAA's will readjust their payments to insure no interruptions of service.

[4] Unusual large expenses or emergency medical expenses will be seriously considered as a reason for household not making a monthly payment. CAA's will have the option to cover the household's monthly payment on a one time basis during the above substantiated conditions.

Source: Ouillette, Richard, Energy Coordinator, Thames Valley Council for Community Action, Jewett City, CT., January, 1979.

Future federal and state commitments to the integration of crisis intervention with other existing and/or new programs, the expansion of the nature of the program, and alternative means of protecting low-income people from rising energy prices (as discussed above), are necessary to decrease the welfare taint of the current program and to insure ongoing support. No indefinite, ongoing subsidization of fuel and utility bills appears to be any more tenable than advisable at the present time. In the short run, however, some programmatic measures should be undertaken to allow the program to operate more efficiently and effectively. For example, the elderly tend to be hurt by the current no-escrow clauses, which allow payment only of overdue bills. Typically, many of the elderly receive automatic fuel delivery, struggle to make payments, and then suffer from a lack of available cash. Escrow provisions (along with an extended income guideline of 150 percent of poverty for the elderly) might be instituted. A sliding scale for eligibility might also be useful.

In addition, consideration might be given to institutionalizing the crisis intervention program on an annual basis. Regulations must be made workable and nonambiguous consistent with needed administrative flexibility responsive to local conditions. The program must also be adequately funded to permit operational continuity until the review in 1983, thereby acknowledging the fact that the "energy crisis" is a chronic problem for low-income households. An annualized program would also avoid the time lags and administrative crises which have characterized the federal programs previously discussed. (For a suggested format presented for purposes of illustration and discussion, see Table 8.)

Total discontinuation of crisis intervention could have a devastating effect on the low-income population, particularly since the new OPEC price increases have begun, decontrol of crude oil prices is under consideration, natural gas prices are being deregulated, and prices for home heating fuel and gasoline continue to rise under existing regulations.

INDUSTRIAL/COMMERCIAL SECTOR

I. Introduction

The basic concerns within the industrial/commercial sector are: 1) to improve and protect the economic viability of New England commerce and industry; and 2) to reduce consumption of critical fuels (oil and gas).

Energy consumption within the industrial and commercial sectors accounts for approximately 20% of the total consumption in New England. In commercial buildings, energy consumption is characterized by greater fuel consumption for space heating and a lower share of electricity for equipment in total energy use. Within industry, competitive pressures have shifted the mix of prevalent industries to those that are less energy-intensive; yet higher average fuel prices make energy conservation even more important and cost-effective in the New England region.

The potential for energy conservation is very high in both production processes and building modifications; however, rather than look at specific technological improvements, the Conservation Committee has concentrated on ways to encourage the implementation of such measures. There is a compelling economic argument for industrial and commercial energy conservation, given industry's response to cost-effective measures. Assisting businesses (both large and small) in making energy conservation investments requires a network to aid in the sharing of information, and federal assistance for research and development programs.

II. The Energy Broker: A Marketer of Energy Conservation to the Small Business Community

A. Introduction/Background

The New England economy has been greatly affected by the increasing costs of imported oil. 80% of all energy consumed in the region is oil and fuel costs average 26 percent higher than other areas of the country. A strong need exists to trim energy waste through conservation. The commercial sector consumes 25% of all energy and has enormous potential for savings. Realizing these savings would impact favorably on the region's economy. The larger corporations are able to control energy costs by the hiring of energy managers or consultants to analyze their energy consumption. However, small businesses do not have the time to keep up to date on the most energy-efficient products/processes or the inclination to hire experts to solve an unperceived problem. Small businesses have adjusted to the higher cost of energy and have not yet addressed energy conservation as one of their best investment opportunities. Prior federally funded conservation programs were designed to create awareness of the energy problem with little attention given to implementation of conservation alternatives. Recognizing the environment in the small business community, the New England Energy Congress proposes the development of an aggressive regional organization to stimulate energy conservation in small business operations.

The energy broker, as the organization will be referred to, will provide decision-relevant information with a follow up mechanism designed to maximize the utilization of recommended conservation alternatives. The energy broker's function will be continuous involvement in the decision-making process from responding to the initial inquiry to analyzing and recording the results of actions taken.

B. Statement of Work

The energy broker will be the cohesive agent combining the efforts of state energy offices, manufacturers of energy saving/efficient products, energy auditors and consultants, and energy managers of larger corporations to provide an easy-to-use, efficient energy conservation service to the small business community.

Proposed Actions:

A) Compile a data base consisting of:

1) A library of manufacturers' energy efficient/saving products (specifications, costs, etc.),

2) Listings of auditors, consultants, and organizations/agencies in the energy conservation field,

3) Product, process and service evaluations conducted by larger corporations, government programs, and other small businesses.

B) Organize a network of energy experts for contact on specific problem solution.

1) Energy managers of larger corporations

2) Energy auditors/consultants

3) Manufacturers' sales representatives

C) Develop an inquiry processing mechanism.

1) Energy broker toll-free number

2) Computerized data base accessed by interactive remote terminals

3) "Fact Sheets" with decision relevant information

4) Field expert contact for problem-solving information not on file

5) Referrals to vendors for follow up sales calls

6) Financing availability, if required

D) Divise a feedback process for evaluation.

1) Action taken—if not, why?

2) Results—energy/dollar savings

3) Service—evaluate energy broker, vendor, and product/process recommended

E) Publicize the service to small businesses.

1) State energy offices

2) Energy broker

Initial activities will concentrate on developing a data base of decision relevant information on energy conservaiton products/services. This function will be performed by the energy broker working with the various components of the energy field. Particular emphasis will be placed on gathering the energy analyses performed by larger corporations with the intent of sharing the results with smaller operations. State energy offices will draw on existing knowledge of and contacts with manufacturing and service personnel for the compilation of an energy product and service file. For simplicity of use, the data base will be computerized and accessed by interactive remote terminals.

Occasions will occur, especially at the inception of the service, when sufficient information will not be on file to respond to an inquiry. For this reason, a network of energy experts will be organized for the energy broker to contact on specific problem solving. The energy broker and the state energy offices will work jointly on the formulation of this network of corporate energy managers, auditors/consultants, and manufacturer sales representatives.

Following the development of the data base, an inquiry processing mechanism will be devised. The forthcoming narrative will explain the inquiry processing mechanism diagrammed in Figure 1.

The processing mechanism is composed of five functions:

1) processor,

2) recorder,

3) pursuer,

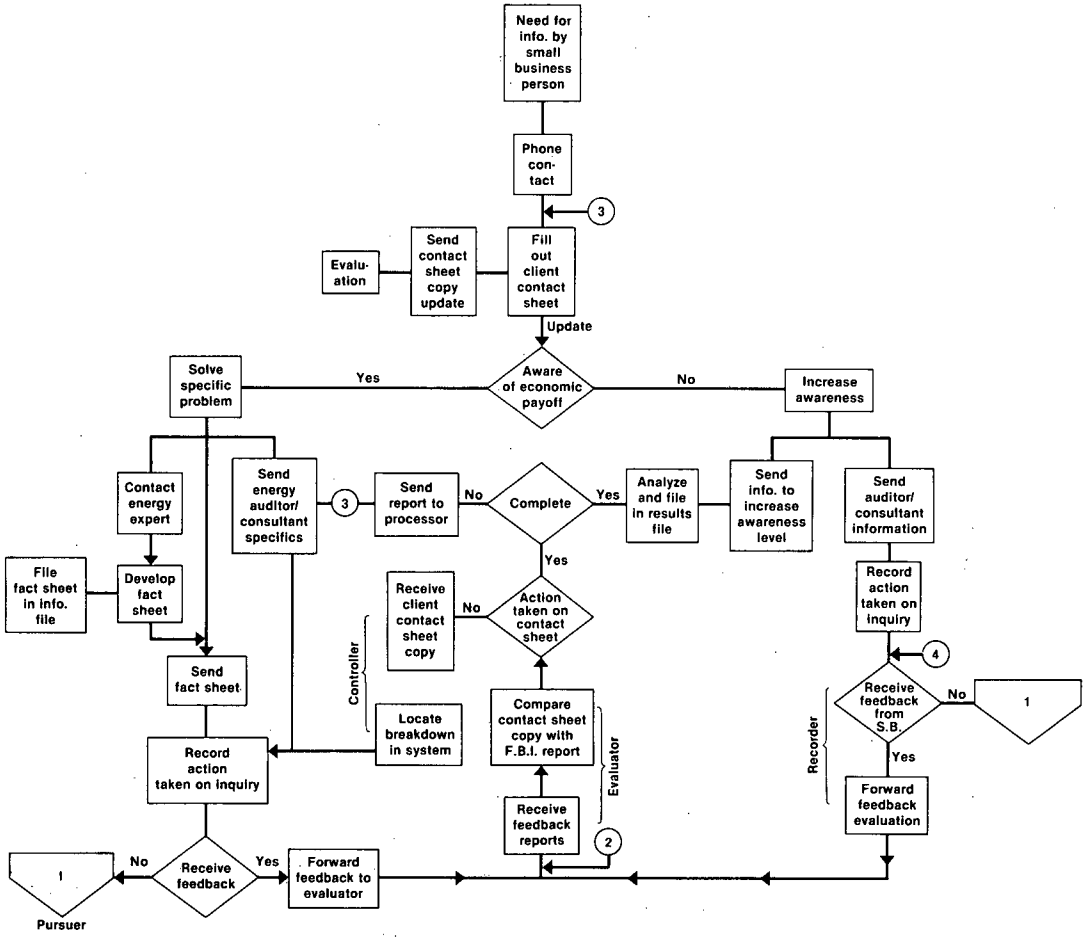
4) evaluator,

5) controller.

The energy broker will be accessed by a toll-free number. The processor will log in all inquiries and decide where the individual is in the decision-making process.

Initially, two options exist dependent upon the business person's awareness level of the energy conservation concept. The client contact sheet will be either directed toward awareness enhancement or problem solving. Awareness of the energy conservation "payoff" can be increased through contacting professional energy auditors/consultants for an analysis of the business operation. If the client does not desire to pay for an

FIGURE 1
Inquiry Processing Mechanism



extensive analysis, the energy broker will send information applicable to the particular business operation.

For problem solving, the choices will be:

1) Contact an energy auditor/consultant on a specific quistion,
2) Forward "fact sheets,"
3) Contact an energy expert in the specific area if the question cannot be answered from information on file.

"Fact sheets," a major product of the energy broker, will consist of decision relevant information including evaluations conducted by other corporations/organizations and listings of products/services that can achieve the desired results. If the problem is not covered in the data base, a member of the network of energy experts will be contacted by the energy broker, a fact sheet developed and forwarded to the client and information filed for subsequent use. In all cases, the energy broker response will be registered by the recorder, providing an opportunity to tract information most requested for directing future data gathering activities. In addition, this

function will record all feedback reports from the small business person. A feedback report will be included in the information forwarded to the client with the expectation that the individual specify action taken and return this report to the recorder. The function of the recorder will be to keep track of all outgoing information and incoming reports. If within a specified time period no report is received, the recorder forwards the client contact sheet to the pursuer for follow up. Otherwise, feedback reports are sent on to the evaluator. The pursuer will provide the aggressiveness required to stimulate energy conservation. To accomplish a final disposition of the inquiry, the pursuer will contact the business which have not returned the feedback reports. The anticipated results are: (See Figure 2)

1) The energy broker involvement stops since the business is no longer interested in pursuing energy conservaiton,
2) The pursuer assesses a need for vendor contact for the business to act,
3) The business will fill out and return the report,
4) The business requires additional information.

If the business person is no longer interested, the pursuer will fill in the client contact sheet with the reasons for disinterest and forward the report to the evaluator. The pursuer may determine a need exists for personal contact by the recommended vendors for the business to take action. In this case, the recommended vendors will be apprised of the inquiry and will be expected to make contact with the individual. A subsequent report from the vendor with the results of the client contact will be forwarded to the evaluator. If the vendor does not follow up on an energy broker referral, the vendor will be contacted and a "failure to follow up" report forwarded to the evaluator. Most likely the financial incentive will be a sufficient motivator for vendor follow up. However, the report will provide the control function for the broker to determine vendors who are not following up on referrals. The question will then have to be answered whether the vendor should be included in future "fact sheets."

Possibly the business person's inaction stems from insufficient information sent out by the energy broker. The contact sheet will then specify this addition need and be referred back to the processor.

The next step in the processing mechanism will be evaluation. All the feedback reports from the recorder and the pursuer will be compared with the client contact sheets to determine if action has been taken by the energy broker. If a specified period of time has elapsed and no feedback report is in hand, the client contact sheet copy is forwarded to the controller. The function of the controller will be to locate the original contact sheet and determine the breakdown in the process causing the delay.

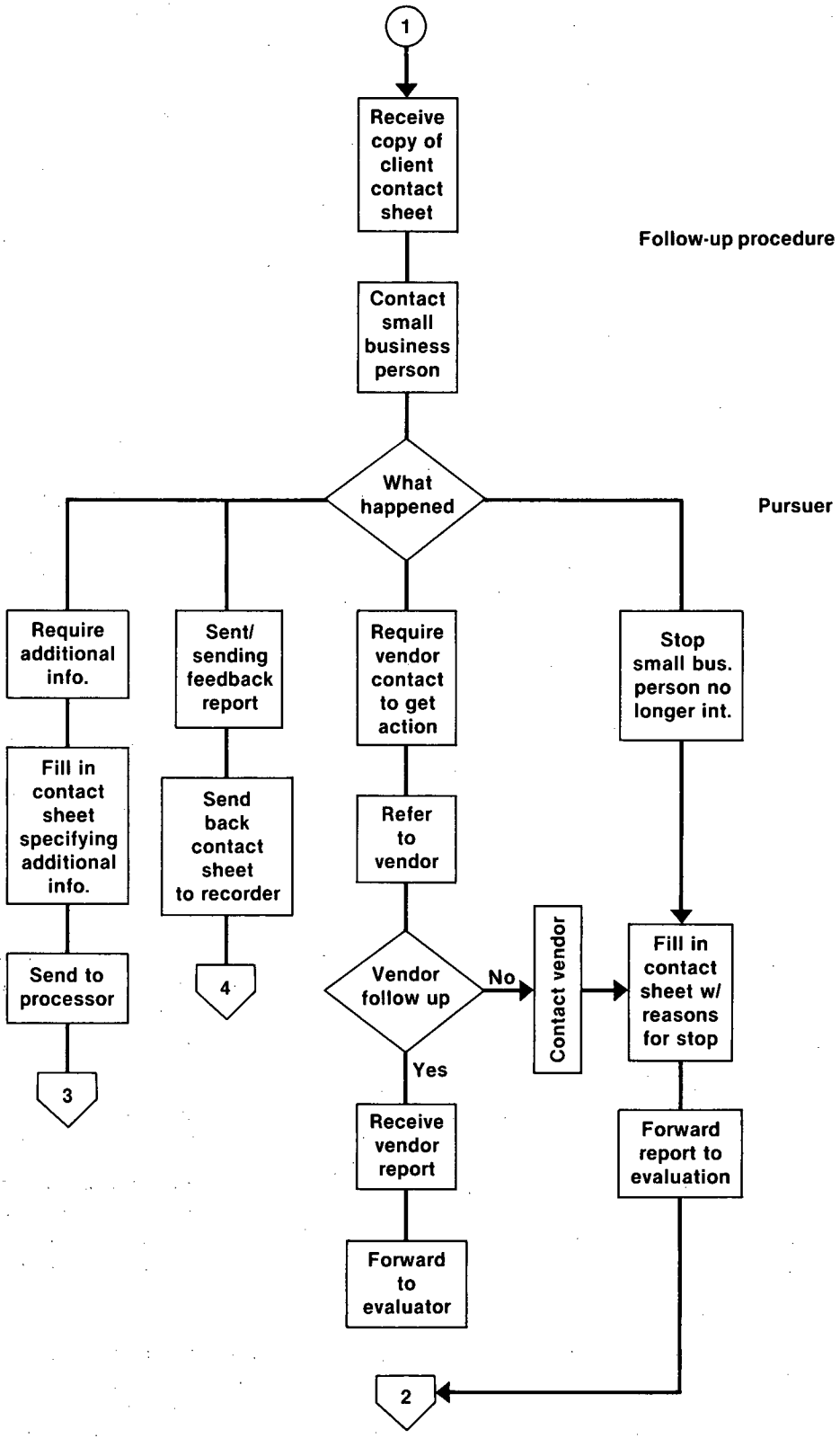
Having received the feedback report, the evaluator will judge whether the action taken by the business person can be considered "complete." Either the report will be analyzed and filed in the result file or sent back to the processor for further action.

The inquiry processing mechanism will emphasize final disposition of all small business person requests. The goal of the energy broker will be an efficient system that educates and reminds the individual of the energy conservaiton "payoffs" and that simplifies energy conservaiton decision making for the small business person.

C. Contractor Qualifications

Key ingredients to the success of the energy broker are objectivity and credibility. The contractor must be considered knowledgeable and impartial for the small business person to have complete confidence in recommendations made. Therefore, the contractor should be a private, not-for-profit organization with a demonstrated

FIGURE 2



*No feedback report is received from the small business person.

performance in the energy field. The contractor should have the ability to assume a major task and effect results. Since the energy broker will be developed to augment existing state energy conservation programs, the contractor should have a good working relationship with the state energy offices. The contractor should have the qualified staff to organize and initiate this program and the computer capabilities required for implementation. The contractor should be capable of replicating this program regionally and possibly nationally, if required.

The Subcommittee on Commercial/Industrial Conservation of the Conservation Committee has identified the Northern Energy Corporation in Cambridge, Massachusetts as the most attractive organization to act as contractor. Further, the subcommittee notes that interest in pilot programs has been expressed by energy decision-makers in Massachusetts and Connecticut.

III. Retrofit of Existing Commercial and Industrial Buildings

One pervasive problem for business interests is the cost of heating and cooling industrial and commercial buildings. Thus building energy conservation is one of the most comprehensive approaches available to benefit all businesses. In New England, a large segment of the building stock is comprised of existing structures. With a replacement rate of approximately 2% a year, the mix will continue to be predominantly existing structures for a number of years, making it essential to address the problems of retrofitting older buildings.

Energy conservation programs addressing existing buildings should be given equal emphasis as programs for new buildings, including government research efforts, the development of performance standards, and financial incentive programs. Current and past government programs focus attention on new buildings. Federal research efforts predominantly address energy conserving technology that is most easily applied to new construction. Similarly, major federal government initiatives are under way in the development and implementation of standards for new construction.

The current emphasis on new construction is misdirected for two reasons: first, the problem of improving the existing building inventory is more complex and difficult than the problem of constructing better new buildings; and second, the rate of replacement of the New England building stock is such that buildings constructed under today's and future standards will represent a small percentage of the region's building stock over the near term (25 years), and will consume even a smaller percentage of the energy used in buildings.

Therefore, Congress should allocate at least one half of federal research resources in building energy conservation to research on the problems of existing structures. Standards are needed for the upgrading of existing buildings, as are programs to address cost-effective improvements in the energy efficiency of such structures.

The importance of such programs to New England is evident. The region's building stock is being replaced at a lower rate than the national replacement rate. Additionally, due to the colder climate, energy consumption in buildings is a more significant portion of the cost of doing business in the region. Finally, as newly constructed facilities become relatively more attractive than existing facilities, the probability of businesses relocating outside of New England increases. The retrofit and increased energy efficiency of all buildings is important to the overall reduction of the nation's energy needs, and should be a major part of any conservation program.

RESIDENTIAL ENERGY PACKAGE

INTRODUCTION

The residential sector has been identified by all six committees of the New England Energy Congress as an area in which immediate and extensive public and private sector action is needed. During the Energy Congress's first six months of deliberations, the committees identified the energy characteristics of the sector and formulated a variety of recommendations aimed at reducing the consumption of fossil fuels in the existing and future housing stock. In general, the committees concluded that an aggressive approach to residential energy problems is justified on the basis of a substantial fuel savings potential, a need to alleviate the impact of escalating energy prices on residential consumers and, equally important, the wealth of employment opportunities associated with energy conservation investments.

This report represents the combined efforts of a number of Energy Congress delegates to synthesize, and in some cases, to elaborate on existing committee recommendations. The goal has been a comprehensive, integrated residential energy package which incorporates both conservation and solar applications. We have attempted to address the specific needs of all income levels and housing types within the overall objective of presenting policy-makers with proposals which collectively can achieve a substantial reduction in fuel consumption. Because this report represents to a large degree a synthesis of the six committees' residential findings, extensive documentation has been omitted. For a more thorough analysis of many of the issues presented, the reader is referred to the individual committee reports as referenced in appropriate sections of this package.

RECOMMENDATIONS

In support of the above discussion concerning residential energy conservation needs and opportunities, the following measures are suggested.

I. Homeowner Subsidy Provisions

1) *Expand the present Internal Revenue Service (IRS) tax credit provisions to include:*

   a) *Eligibility: any homeowner*

   b) *Systems: parts and labor from a well-publicized, comprehensive list of home improvements of demonstrable utility in reducing the existing use of non-*

renewable fuels for space heating and hot water: insulation, storm windows, weatherstripping, active solar, passive solar, wood stoves, replacement of boilers and furnaces, etc.

c) *Terms: refundable credit for 30% of first $4000, 20% of next $8000. Maximum credit of $2800 for all above provisions.*

2) *Expand the solar and conservation loan programs in the National Energy Act (NEA):*

a) *Eligibility: households with incomes up to $25,000*

b) *Systems: per above*

c) *Terms: subsidized loans at 7.5% or the best available government interest rate, up to $8000 per family unit.*

II. Weatherization Program Improvements

3) *Amend the Energy Conservation and Production Act (ECPA) to authorize labor as an allowable expenditure.*

4) *Supplemental Comprehensive Employment and Training Act (CETA) labor: continue implementation of the program at the local level by Community Action Agencies (CAA). CAAs may utilize private contractors or undertake weatherization activities directly. Where a private contractor is used, CAAs should encourage use of CETA labor by contractors and the hiring of workers previously trained in weatherization activities under the CETA program. In CAA-run programs, CETA labor should be used only as supplemental labor, whose utilization will be determined by the number of slots available, skills required, and other administrative considerations. CAAs will be encouraged to hire such CETA workers as may be reasonably expected to be permanently hired by private sector employers after their training program is completed.*

5) *Remove the restrictions of a $100 ceiling on making incidental repairs to a dwelling unit which are necessary to make installation of weatherization materials effective.*

6) *Amend the ECPA to increase maximum expenditure per dwelling unit to $1920, with maximum permissible expenditures in the following categories:*
$800 - labor
$800 - materials
$320 - administration and related expenses
Within these categories, local program operators are given maximum flexibility to determine the optimal expenditures and appropriate mix of weatherization measures.

7) *Coordinate Housing and Urban Development (HUD) rehabilitation funds to be used in conjunction with federal weatherization programs.*

8) *Increase the authorization level for the weatherization program from $200 million to $960 million annually (constant 1978 dollars) with a goal of weatherizing 500,000 low-income owner-occupied homes nationally per year (30,000 in New England) so that all such homes are weatherized by 1988.*

9) *Establish a separate program to weatherize rental units.*

10) *Amend the ECPA to establish that the primary purpose of the weatherization program is to lower fuel bills paid by low-income persons, and establish a standard of optimal weatherization to carry out this purpose.*

11) *Amend the National Energy Conservation Policy Act (NECPA) to require documentation of savings achieved for dollars spent through the weatherization program.*

III. Tenant Provisions

12) *Establish a program through the state energy offices/public utility commissions to address the needs of tenant-occupied buildings providing for:*

   a) *An expanded utility-audit program to cover multi-family units, with the cost of the audits going into the commercial rate base;*

   b) *Mandatory retrofit requirements for multi-family units; if the requirements are not met, the building owner would be disallowed from deducting the property taxes on that building from his or her federal income tax;*

   c) *Write-off of retrofit costs, amortized over 3 years;*

   d) *A loan program for owners of multi-family unit buildings, with below market interest rates, to provide the front-end money for retrofit; such a program would be established in the State Energy Management Plan (SEMP).*

IV. Consumer Protection

13) *Require that all states develop a mandatory licensing program for installers of weatherization materials, alternative energy equipment, and fossil fuel heating systems with the following provisions:*

   a) *That the licensing boards have adequate consumer and industry representation,*

   b) *That the licensing boards establish a mechanism to air and investigate consumer grievances,*

   c) *That the licensing boards establish the goal of increasing rather than decreasing industry competition.*

14) *Require an appropriate national standards board to develop standard performance testing methods for weatherization materials, alternative energy equipment, and fossil fuel heating systems.*

15) *Amend the Federal Trade Commission Act to include affirmative disclosure (truth in advertising) in advertising for energy products with the following provisions:*

   a) *That an energy product must be labeled to indicate whether it has been tested and what its performance level is,*

   b) *That advertisements for an energy product include whether or not it has been tested, and what its performance level is,*

   c) *That false and misleading statements, specifically with regard to the amount of energy savings that can be realized by using a certain energy product, be prohibited.*

V. Zoning and Land Use Provision

16) *The federal government should encourage, through the application of available fiscal instruments (e.g. revenue sharing) all states to:*

   a) *Require their municipalities and counties to revise zoning and subdivision regulations to incorporate passive design concepts (e.g. street layout, lot orientation, size, shading, landscaping, etc.), and to permit variances to such regulations based upon energy conservation considerations,*

   b) *Enact solar access and solar easement statutes,*

c) *Where absent, enact solar property tax incentives which include an allowance for the cost of easements.*

VI. Demonstration Programs

17) *Establish a competitive design program which provides for state administration of federal grants to individuals and builders, with emphasis on public information and public access.*

Market Demonstration/Competition

A) *Persons Eligible: Any individuals, partnerships or corporations residing in participating states.*

B) *Systems Eligible: Implementation of designs for new housing or for retrofits that minimize reliance on fossil fuels in a comprehensive, economical and practical fashion. Specific criteria would vary by state, but dederal guidelines would encourage design features such as use of renewable regional resources and/or ability to minimize peak-load problems and/or durability and easy maintenance and/or food production capabilities.*

C) *Terms: HUD would distribute $100 million to participating states and set overall program objectives. States would empanel official juries, empowered to make competitive awards to cover both design and construction costs. Per HUD guidelines, these juries would represent distinct user groups, including builders, contractors, architects and consumers. Juries could receive additional state or private monies. Grant amounts: New houses — Single Family $50,000; Two Family $75,000; Three-plus Family $100,000. Existing houses — $10,000; $12,500; $15,000.*

18) *Promote technical demonstrations of residential applications of such developing systems as photovoltaics, wind systems, and district heating, within existing DOE programs.*

VII. Other

19) *Require all lending institutions to consider operating and maintenance (O & M) costs in addition to principal, interest, taxes and insurance (PITI) in evaluating the debt service capability of prospective buyers under all federal housing programs, e.g. FHA, FMHA, Section 8, etc.*

20) *Urge state and federal government, through their respective regulatory authority, to encourage lending institutions to expedite the processing of loans for investment in energy efficient structures; such structures may use new and innovative designs.*

21) *Continue and expand the existing HUD passive design competition with special emphasis on, and incentives for, region-specific designs used by builders of residential housing.*

22) *Provide incentives to encourage the professional education of builders, contractors and architects in passive design concepts, and to include such concepts in the professional examination process.*

VIII. Needed Studies

1) *Congress should study the regional impacts of energy policies; an understanding of how policies affect consumers is essential to the development of equitable energy programs. Further, the elasticity of energy prices must be taken into consideration in such policy decisions.*

2) *An indepth analysis of the housing stock characteristics in New England is needed, broken out by the income level of the occupants. It is important to know these characteristics in order to develop legislation addressing the most critical needs of the residential sector.*

3) *Congress should require HUD and DOE to study the economic and institutional feasibility of weatherizing private rental units without passing the cost on to low-income tenants. They should also be required to study community scale solar heating systems, and, if feasible, to set up a demonstration program.*

4) *A study of the weatherization program should be undertaken to determine the most effective and efficient working relationship between the Department of Labor, Community Services Administration and the Department of Energy in managing and funding weatherization programs.*

5) *Building Energy Performance Standards (BEPS) should be thoroughly re-examined before setting standards, including a review of: thermal performance, passive solar applications, and behavioral aspects relating to control of the total heating system.*

6) *Congress should commission an analysis of residential usages of electricity and of the potential for reducing those usages, with an eye toward legislative action.*

OVERVIEW AND RATIONALE

The largest source of energy savings in New England, perhaps 75% of the region's potential, lies in improving the efficiency of its buildings, equipment, machinery, and appliances. As a result of an aging infrastructure and low replacement rate, fuel savings in New England's residential, commercial and industrial sectors represents a virtually untapped opportunity to reduce the region's extreme dependence on imported fossil fuels. In addition, these efficiency-related measures present no serious behavioral impediments or lifestyle changes. Improved energy efficiency and its attendant savings are achievable through an effective combination of financial incentives, regulatory modifications, and public education.

In addition to reduced fossil fuel consumption, a second major advantage of efficiency-related conservation policies is the economic, especially employment, spinoffs they create. Whereas most energy production investments are distinctly capital intensive, energy conservation investments offer enormous opportunities for reducing unemployment and underemployment in the New England region. For example, the recent New England Energy Policy Alternatives (NEEPA) study by the Massachusetts Energy Office concludes that a comprehensive energy conservation effort, utilizing existing national programs and two-year payback investment, would increase direct employment in New England by 44,496 jobs annually. Furthermore, by reducing the volume of energy consumed and the outflow of dollars from the region, disposable income would be increased and recycled to stimulate local economic activity. The NEEPA study estimates that a conservation effort would save approximately $1.4 billion dollars per year in fuel costs by 1985 and that reinvestment of these savings in the region would create 50,000 jobs per year. Numerous related studies, summarized in the Jobs Subcommittee report of the Alternatives Committee, corroborate these findings. (See pages 184 .)

The discussion and package of recommendations presented in this report represents an attempt to realize a portion of this impressive array of energy savings and economic benefits for the New England region through implementation of a comprehensive residential conservation package. Three basic concerns guided this group in preparing these proposals.

First, we recognize that the 4 million housing units in the region comprise a wide diversity of conditions and needs. Policies appropriate to older owner-occupied single family units may be of little relevance or consequence to renters in new multi-family units. In formulating our recommendations, we attempt to account for these variations.

Second, the group believes that conservation must be broadly interpreted to fully exploit all types of potential fossil fuel savings in the region. Our recommendations, therefore, relate to both conventional conservation techniques (e.g. insulation, weatherstripping, caulking) as well as complementary proven and cost effective technologies such as passive solar design which are capable of further increasing the level of energy savings.

Third, the proposed recommendations in many cases build upon existing federal and state energy policies. The group recognizes the many advantages of utilizing existing statutes and regulations: they have survived the test of political feasibility; appropriations, where necessary, have been authorized and/or expended; and the necessary administrative machinery is in place. Whenever possible our recommendations focus on reorientation or modification of these existing statutes and regulations without additional appropriations. Thus, substantial emphasis is devoted to such items as the types of solar demonstrations to be funded, the interpretation of which solar equipment qualifies within the existing tax incentive legislation, and the regulations that govern the expenditure of DOE weatherization monies.

In the following section, we begin with a profile of the New England housing stock and estimate the potential savings attainable under a series of conservation scenarios. This is followed by a review of existing federal programs effecting residential energy conservation and the extent to which these programs are likely to achieve potential savings. From this discussion, we have identified the major shortcomings of existing programs and have presented a list of recommendations aimed at enhancing the federal, state and local government, and private sector actions in residential energy consumption.

Housing Stock Profile and Savings Potential[1]

Energy use in the residential sector comprises twenty-nine percent of the total use in New England compared with twenty percent of the total use in the United States. The reason for the proportionally larger residential consumption in New England lies in the heavy heating demand for the region. In fact, seventy-five percent of the energy used in the residential sector is for heating homes. Oil is the primary fuel used for this purpose, heating over seventy percent of all New England households with gas and electricity contributing in much smaller quantities (22 and 4 percent respectively).

Table 1 presents the characteristics of the New England housing stock as estimated by the REFORM model, owned by the New England Regional Commission. This estimation is based upon the 1970 census data and recently observed construction and population trends. The housing stock is disaggregated by age, type of fuel used, and housing type; housing types include single family detached homes, single family attached homes (consisting of 3 units), multi-family low rise residences (10 units), multi-family high rise residences (60 units), and mobile homes. (The numbers shown in the table are number of *units* rather than numbers of buildings.) One should notice the following characteristics: first, the heavy use of oil to heat homes; second, the growing number of electrically heated homes, particularly in multi-family dwellings; and third, the advanced age of the housing stock.

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[1]The model developed for this analysis has been titled the New England Energy Congress/New England Regional Commission/Massachusetts Audubon Society Housing Stock Profile (NEEC/NERCOM/MAS). See also the Demand Committee Report on page 206.

Table 1
Projected 1978 New England Housing Inventory
(1000 Units)

Category		SFD	SFA	MFLR	MFHR	MOBILE	
1965-1978	E	198	97	53	21	25	
1965-1978	D	271	173	69	112	73	
1965-1978	M	79	53	21	27	9	
1940-1965	D	586	145	73	0	0	
1940-1965	M	179	45	26	0	0	
Pre 1940 Unins	D	576	315	99	0	0	
Pre 1940 Unins	M	163	95	35	0	0	
Pre 1940 Ins	D	200	123	43	0	0	
Pre 1940 Ins	M	58	36	14	0	0	
Total		2310	1082	433	160	107	4092

Code For All Tables

INS - insulated
E - electrically heated
D - distillate oil heated
M - methane gas heated
F - fossil fuel heated
UNINS - uninsulated

SFD - single family detached house
SFA - single family attached house
MFLR - multi-family low rise residence
MFHR - multi-family high rise residence
MOBILE - mobile home

Source: Residential Energy Forecasting Model (REFORM), New England Energy Management Information System (NEEMIS).

Viewing this table the question to be asked is, "How adaptable is the New England housing stock to conservation measures and retrofit to renewable fuels (e.g. solar, wood)?" Although no quantitative studies have been undertaken with regard to retrofit potential, a study has been done on the conservation potential of the housing stock, both by weatherizing homes and by improving heating system efficiencies. No hard data exists on the actual weatherization characteristics of the housing stock. However, information gathered from energy auditors, building contractors and insulation installers throughout the region has led to the formation of the model shown in Table 2 where the numbers shown represent an average within each category. In addition, average heating system efficiencies are estimated to be 50 percent for oil, 60 percent for gas, and 95 percent for electric. (The lower efficiency of oil as compared with gas was assumed because on the average oil-heated systems tend to be older than gas-heated systems, and therefore in worse repair).

Once the current characteristics of the New England housing stock were modeled, they were used in the REFORM computer program mentioned earlier to yield an estimate of the annual space heating consumption of the region. Four weatherization programs were then developed, referred to as Options 1 through 4. These programs assumed that each building owner invested a sum of money (which increased with each option) into the weatherization methods which had the most return on their investment. For example, for single family detached dwellings, Option 1 assumed an investment of $250, Option 2 of $500, option 3 of $750, and Option 4 of $1000.[1] The levels of investment assumed for each housing type are shown in Table 3 (here the investment is per building, not per unit). Another program was also developed, the Ideal Case, which assumed that levels of weatherization were brought up to optimal standards. Options 1 through 4 and the

[1]For an "average" house an investment for both materials and labor of $250 will buy storm windows and weatherstripping, $500 will buy ceiling insulation, and $1000 will buy wall insulation.

Table 2
Estimates of New England Housing Stock Characteristics

Category	Walls	Ceiling	Ground Floor	% Storm Windows	% Storm Doors	% Weather-Stripping
Single Family Detached, Single Family Attached, and Multi-Family Low-Rise Housing						
Post-1965						
Electric	R-7	R-15	R-0	60*	60	30
Fossil	R-7	R-12	R-0	45*	50	25
1940-1965	R-3	R-7	R-0	65	65	25
Pre 1940						
Ins. (20%)	R-11	R-9	R-0	70	70	25
Unins. (80%)	R-0	R-0	R-0	70	70	25
Multi-Family High-Rise Housing						
Electric	R-4	R-7	—	30*	70	25
Fossil	R-0	R-3	—	20*	70	20
Mobile Homes						
Electric	R-7	R-11	80*	80	80	
Fossil	R-7	R-11	R-11	70*	50	30

* Adjusted for thermopane windows

Source: Massachusetts Audubon Society, February 1979.

Table 3
Capital Investment For the Four Improved Weatherization Programs

Weatherization Program	Type of Housing SFD	SFA	MFLR	MFHR	MOBILE
Option 1	$ 250	$ 500	$1,500	$ 5,000	$125
Option 2	500	1,000	3,000	10,000	250
Option 3	750	1,500	4,500	15,000	375
Option 4	1,000	2,000	6,000	20,000	500

Source: Massachusetts Audubon Society, September, 1978.

Ideal Case were then run through the REFORM program; Table 4 shows the calculated fuel consumption for the current case and each of the improved cases, the percent fuel savings characteristic of each of the improved weatherization cases, and the cost of each of the improved cases. From the table, one can see that by weatherizing maximally, more than 50 percent of all energy consumed for heat may be saved.

A similar analysis was performed for heating system efficiencies. Three options were chosen. Option 1 assumed that each home that does not have an annual heating system service contract started a maintenance program, costing an estimated $30 annually; the average efficiencies of gas and oil-heated systems were thus estimated to rise to 62.5 and 52.5 percent respectively. Option 3 assumed that all oil-heated homes were retrofitted with new burners and boilers and all gas-heated

Table 4

Estimated 1978 New England Space Heating Fuel Demand
Alternative Weatherization Cases

	Electricity		Distillate		Natural Gas		Total	Total Cost	% Savings	Annual Dollar
	KWH (10^9)	BTU (10^{12})	Gals. (10^9)	BTU (10^{12})	Cu.Ft. (10^9)	BTU (10^{12})	BTU (10^{12})	Dollars (10^6)	over Base Case	Fuel Savings (10^6)
NEEC Base	8.5	29	4.1	561	132	132	722	—	—	—
Option 1	8.0	27	3.7	503	118	118	648	900	10	270
Option 2	7.3	25	3.4	458	107	107	590	1600	18	500
Option 3	6.8	23	3.1	419	97	97	539	2400	25	700
Option 4	5.7	19	2.9	389	91	91	499	3600	31	880
Ideal	5.2	17	1.9	257	59	59	333	7500	54	1510

Source: Massachusetts Audubon Society, February, 1979.

homes with stack dampers and pilotless ignition systems, with a resultant rise in average efficiencies to 80 percent for both oil and gas-heated homes; these efficiency estimates are considered to be an upper limit to what can be achieved in New England. Finally, Option 2 assumed that only half of all present homes were retrofitted to Option 3 standards with the resultant average efficiencies of 70 percent for gas and 65 percent for oil. Table 5 displays the fuel consumption, the percentage savings, and the cost for each of these options. One should note that by improving heating system efficiencies to their fullest over one third fuel savings may be achieved.

Table 6 shows the results of combining both the weatherization and heating system efficiency options. The total fuel consumption is the first figure shown, and the percent savings is shown below it in italic type. As one can see, the *total* fuel consumption is less than that for each option alone, and a maximum savings of more than 70 percent may be realized.

The numbers shown are merely estimates and by no means attempt to accurately portray the savings potential in the residential sector. They do point out, however, the tremendous potential in that sector.

Current Energy Programs

Since the oil embargo of 1973 and the ensuing dramatic increases in the price of energy, the federal government has enacted a number of programs which address residential energy issues. These include: 1) the Low Income Weatherization Program (1976); 2) the Energy Policy and Conservation Act of 1975; 3) the Energy Conservation and Production Act of 1976; and 4) the National Energy Act of 1978.

The federal weatherization program formally began in January 1975, when the Congress authorized the Community Services Administration (CSA) to operate the Emergency Energy Conservation Services Program to lessen the effects of rising energy prices on low-income individuals and families and to reduce energy consumption.[1] In August, 1976, Congress authorized the Department of Energy (DOE) to establish a supplementary home weatherization program.[2] Corollary to these programs is the Special Crisis Intervention Program, enacted for one year in 1976

[1]Community Services Act of 1974 (P.L. 93-644)Section 222(a) (12) (42 U.S.C. 2809). Under the Act, the Director of CSA was authorized to provide financial and other assistance for programs and activities including an energy conservation and education program, the winterization of old and substandard dwellings, emergency loans and grants, emergency fuel, research for alternative fuel supplies, alternative transportation designed to save fuel, and programs for legal and technical assistance relating to energy.

[2]The Energy Conservation and Production Act (47 U.S.C. 6861 (b)). The DOE weatherization program was recently amended by Section 231 of National Energy Production and Conservation Act (PL-95-1751).

Table 5

Estimated 1978 New England Space Heating Fuel Demand
Alternative Heating System Efficiency Cases

	Electricity		Distillate		Natural Gas		Total	Total Cost	% Savings	Annual Dollar
	KWH (10^9)	BTU (10^{12})	Gals. (10^9)	BTU (10^{12})	Cu.Ft. (10^9)	BTU (10^{12})	BTU (10^{12})	Dollars (10^6)	over Base Case	Fuel Savings (10^6)
NEEC Base	8.5	29	4.1	561	132	132	722	—	—	—
Option 1	8.5	29	3.9	505	127	127	661	50 (annually)	8	120
Option 2	8.5	29	3.2	403	113	113	545	2400	24	520
Option 3	8.5	29	2.6	322	99	99	450	4900	38	860

NEEC Base Efficiency: Gas - 60%; Oil - 50%

Option 1 Efficiency: Gas - 62.5%; Oil - 52.5%. (It was assumed that the remaining homes that do not have an annual heating system service contract, approximately half of all homes, started an annual maintenance program.)

Option 2 Efficiency: Gas - 70%; Oil - 65%. (It was assumed that half of all existing homes were retrofitted to Option 3 standards.)

Option 3 Efficiency: Gas - 80%; Oil - 80%. (It was assumed that all oil-heated homes were retrofitted with a new boiler and burner at a cost of $1,850, and all gas-heated homes were retrofitted with stack dampers and a pilotless ignition system at a cost of $350. These efficiencies are considered uppermost estimates. Some may consider them to be too high.)

Source: Massachusetts Audubon Society, February, 1979.

and reenacted in 1977. Designed to provide emergency fuel assistance to low-income consumers, the future of the Special Crisis Intervention Program is uncertain.

In FY 1978, Congress appropriated $65 million each to DOE and CSA to carry out weatherization activities. Weatherization projects, whether CSA or DOE funded, have been operated principally by Community Action Agencies (CAA) which administer local programs. Their efforts have been to weatherize low-income owner-occupied homes, with DOE providing $300 worth of materials (such as weatherstripping, storm windows, insulation, etc.), and with CAAs assembling work crews (primarily through CETA labor) and overseeing the weatherization operations.

For FY 1979, Congress has appropriated $200 million for weatherization to DOE. The amount, if any, that CSA will receive in FY 1979 and 1980 for its weatherization program is presently unresolved, but the President has proposed that the program be discontinued and administered entirely by DOE.[1]

The Energy Policy and Conservation Act of 1975 (EPCA) requires each state to develop and implement state energy conservation plans, aimed at reducing energy needs by at least 5% of the state's projected 1980 demand. Programs include mandatory thermal and lighting standards for public buildings, car and vanpool incentives, right-turn-on-red, and energy procurement policies.

The Energy Conservation and Production Act (ECPA) followed in 1976, amending the previous energy legislation and providing money for the implementation of supplemental state energy conservation plans. These plans must include public education programs, procedures for energy audits for buildings and industrial plants, and intergovernmental coordination.

It was not until 1978 that Congress passed the National Energy Act (NEA), the first attempt to establish a comprehensive national energy policy. The NEA is composed of five acts, each designed

[1]Congress placed CSA's FY 1979 appropriations under a continuing resolution. However, OMB has indicated it will seek a recession of the CSA's FY 1979 weatherization funding. In his FY 1980 budget, the President proposes to discontinue CSA's weatherization activities.

Table 6

Estimated 1978 New England Space Heating Demand
Combining Alternative Weatherization and Heating System Efficiency Cases

Alternative Heating Systems Cases	Alternative Weatherization Cases				
	Option 1	Option 2	Option 3	Option 4	Ideal
Option 1	594[1] / 18%[2]	540 / 25%	494 / 32%	458 / 36%	305 / 58%
Option 2	490 / 32%	446 / 38%	407 / 44%	377 / 48%	251 / 65%
Option 3	404 / 44%	368 / 49%	336 / 54%	311 / 57%	207 / 71%

[1] Total Energy Consumption (BTUs × 10^{12})

[2] % Savings over Base Case

Source: Massachusetts Audubon Society, February, 1979

to address specific concerns (taxes, conservation, gas, coal, and electric rates). The provisions directly impacting the residential sector, are, for the most part, contained in the tax and conservation acts.

The Energy Tax Act of 1978 provides for income tax credits for conservation home improvements and for the installation of renewable energy source systems (solar/wind). Conservation credits can be claimed on 15% of the first $2,000 spent, for a total credit not to exceed $300. Items eligible for the credit are limited to: insulation, storm windows and doors, caulking and weatherstripping, furnace replacement burners, electrical furnace ignition systems, automatic clock thermostats, and meters displaying the cost of energy usage.

In addition, credits can be taken for solar/wind systems; 30% of the first $2,000, and 20% of the next $8,000, for a total credit of up to $2,200. Renewable energy source property includes solar collectors, rockbeds, heat exchangers, geothermal equipment, and wind energy conversion systems.

Major provisions for solar and conservation grants and loans are contained in the National Energy Conservation Policy Act of 1978 (NECPA). Loan programs are established for home improvements with energy conservation measures for families below the median income level ($14,958), at interest rates to be set between 7 and 12%. Homeowners at all income levels are eligible for loans of up to $8,000 (also at rates ranging from 7 to 12%) for the purchase and installation of solar heating and cooling equipment.

NECPA also established a utility conservation program for residences, requiring utilities to offer energy audits to their residential customers that would identify appropriate energy conservation and solar energy measures and estimate their likely costs and savings. Utilities will be required to offer to arrange for the installation and financing of any such measures.

Market Penetration[1]

With the exception of the four year old weatherization program, the recently enacted National Energy Act represents the federal government's first major commitment to subsidizing residential energy conservation. At this juncture, therefore, estimates of market penetration must be based on informal speculation plus the limited amount of empirical evidence available from the low-income weatherization program.

In general, we may assume the following rank order of effectiveness among the seven major types of government subsidies:[2]

1) Grant
2) Rebate
3) Tax credit
4) Tax deduction
5) Below Market Interest Rate (BMIR) subsidy
6) Loan Guarantee
7) Insuring Capital Availability for Loans

Assuming all else constant, property owners seem to value most the time span between the expenditure on conservation or solar investments and the recovery of that expenditure. In the case of a grant, that time span equals zero; for a rebate, usually a few months; for a tax credit or deduction, up to a year; and for the various loan incentives, probably several years.

To this order of priority, a second generalization should be added. RUPI, Inc.[3] concludes that for a solar space or hot water heating investment, 30-40 percent of cost is the threshold necessary to achieve a significant market response. It may safely be assumed that this figure is somewhat less for conservation measures given the lower degree of uncertainty associated with such expenditures. The effect of this on the rank order of incentives is likely to be an accentuation of the grant/rebate/credit advantage. A 30 percent cost coverage under any loan program is far less obvious and attractive to the consumer than an identical subsidy available through either a grant, rebate or tax credit subsidy.

Under current NEA provisions, all forms of incentives except the rebate and tax deduction are offered in some form. Given current levels of subsidy for low-income households, we may extrapolate past performance to estimate the annual impact in New England. Between 1975 and 1977, approximately 30,000 homes were weatherized, or about 10,000/year[4], with costs for materials averaging $233/unit. In 1976, there were approximately 700,000 low income households using the Census' definition. If 75 percent are in need of weatherization, then approximately 525,000 units should be included within the program. DOE has $200 million available nationally for FY 1980 and 1981. Assuming each unit is allocated $800 (the current limit) and New England receives 10 percent of the national total, then about 25,000 units will be weatherized annually. Of course, if the region receives more than 10 percent of the total and/or less is expended per unit, more units

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[1]See the Direct Solar Subcommittee Report of the Economic Development through Alternative Sources of Energy Comittee

[2]RUPI, Inc., "Federal Incentives for Solar Homes: An Assessment of Program Options," November, 1977.

[3]*Ibid.* p. III-1

[4]Written communication from Larry Kerpelman, Abt Associates, January 19, 1979. The figures for weatherization achievements, needs and costs in this section are taken from this source.

will be weatherized. In any case, under current program levels, weatherization of the complete low-income housing stock will take at least 10, and probably more than 15 years to weatherize.

The effect of the NEA tax credits and loan incentives is even less certain. RUPI[1] estimates that for solar hot water heating, a 30/20 tax credit (roughly equivalent to the existing provision) will induce an additional 80,900 units over four years in addition to a projected baseline figure of 178,000 units. New England's portion of the total 240,800 units, assuming the region's share is proportional to its share of national households, will total about 13,500. If half of the region's 2.3 million single family units are feasibly retrofitted for solar hot water, this will amount to only 1.2 percent of the housing stock by 1982.

For the conservation incentives of 15% of the first $2000 (up to $300 total), an equally low level of market penetration is likely to occur. By penetration in this case, we mean the expenditure of $1000-$2000/unit across the entire housing stock, a range which approximates an optimal level of expenditure for a single family unit in the region.[2] For a household which spends $1500 on conservation, $225 is reimbursable via the tax credit, a figure unlikely to induce a significant increment to the no-incentive case. If New England's share of the projected total of $1 billion cost[3] for all tax incentives were dedicated exclusively to conservation, then 37,333 units/year (.056 x $1 billion/$1500) could receive near optimal funding. If 1.15 million, or half of the 2.3 million existing single family units, are in need of weatherization, then the current tax incentive program could reach a mere 3.2 percent/year. If we allow for the other loan subsidies and guarantees of the NEA and assume no major labor or materials obstacles to implementation, 5 percent per annum may be a plausible program goal. In light of recent experience, however, a projection of this magnitude must be considered optimistic.

Program Deficiencies

Experience with existing federal energy programs and the estimated market penetration of the newly enacted conservation and solar provisions indicate that significant potential energy savings in the residential sector are not being realized. To achieve the energy savings outlined in the NEEC/NERCOM/MAS Housing Stock Profile, modification and expansion of current programs are necessary. Improvements in the Low Income Weatherization Program, expansion of the National Energy Act provisions, and measures which address conservation in tenant-occupied dwellings are enumerated below.

I. Weatherization Programs[4]

The most significant problem affecting the viability of the federal weatherization program in New England and the country is the lack of a certain and stable labor force. The present situation is so precarious that unless immediate corrective measures are taken the program will come to a virtual halt.

Community Action Agencies have mainly been required to rely upon CETA labor to carry out their weatherization activities. However, such labor provides too few slots for weatherization personnel, too little training for the majority of workers, too little pay for those workers who are

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[1]RUPI, *Op. Cit.*, Table III-7.

[2]For estimates within this range see Kerpelman, *Op. Cit.*; Harvard University, Department of City and Regional Planning, *Energy Conservation in Maine: Weatherization Improvements to the Existing Housing Stock*, Cambridge, June, 1977.

[3]Sara Glazer, "Fact Sheet: National Energy Act," Environmental Study Conference, Washington, D.C., November, 1978, p.2.

[4]See the Weatherization Program Report of the Conservation Committee

skilled, too brief a work assignment to enable workers to gain experience, and far too much uncertainty as to future funding levels. Of these problems, the most crucial concerns the actual availability of CETA labor. Without labor, federal weatherization goals simply cannot be met.

Unless Congress acts to ensure that additional labor is available to perform weatherization activities, the present situation will continue to erode. CSA's weatherization regulations have a waiver provision which permits its weatherization funds to be used for labor. However, these funds may not be available since the Administration presently proposes to discontinue the CSA weatherization program. DOE will not be of any assistance in solving this problem. Although EPCA states that financial assistance under the program is to be used for the purchase of weatherization materials "to the maximum extent practicable," DOE officials do not regard this language as permitting expenditures of any EPCA weatherization funds on labor.[1]

The second major problem area undermining the effectiveness of the weatherization program deals with the lack of flexibility. Although DOE has amended its regulations recently and NECPA will provide additional assistance, restrictions severe enough to prevent effective weatherization still exist. Major restrictions include limitations placed on expenditures and activities per unit, current levels of funding, and involvement in major housing rehabilitation.

Limitations are set for the maximum amount allowed to perform repairs($100). Most homes eligible for weatherization are also in need of substantial rehabilitation before basic infiltration measures can be undertaken.[2] The 1975 census figures show that one-half of all homes in New England were built before 1940 and many are in need of repair. The low-income population is 30% more likely to live in these structures than people with higher incomes; this suggests that three-fourths of all low-income people in the region live in such substandard housing.

The primary purpose of the weatherization program should be, quite simply, to lower the fuel bills of low-income people. This goal will not be achieved if the program continues at its present funding level and retains artificial spending levels. If this program is, as has been claimed, a serious attempt at conservation for the low-income constituency, optimum weatherization measures must be undertaken. This can only be accomplished by increasing current funding levels, dropping artificial limitations on eligible activities, and giving more autonomy to local administering agencies.

II. Tax Credits

The NEEC/NERCOM/MAS model estimated the energy savings potential of the New England housing stock, and outlined various weatherization measures to be implemented. Energy conservation expenditures included $250 for storm windows and weatherstripping, $500 for ceiling insulation only, $1,000 for wall insulation only, or a combination of improvements to achieve the optimal level of weatherization.

In addition to weatherization improvements, the NEEC/NERCOM/MAS analysis examined heating system efficiencies, and recommended improvements ranging from a $30 annual maintenance program, to $350 for retrofit of gas systems (stack dampers and a pilotless ignition system), and $1,850 for retrofit of oil systems with a new boiler and burner. This last improvement, which is estimated to have significant savings, is not included within the qualifying improvements eligible for the conservation tax credits. Given the number of oil-fired residences in the region, the NEA should be expanded to cover such equipment.

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[1]See 42 F.R. 27899 (June 1, 1977); 43 F.R. 34493 (August 4, 1978); 44 F.R. 31 (January 2, 1979).

[2]New England Community Action Program Directors Association (NECAPDA), *Weatherizing New England* (February 1, 1979).

While the new tax credits are a first step towards stimulating conservation improvements, studies show that two-thirds of the people who received tax credits for insulation would have made the investment without the credit.[1] The savings of the $300 credit is not adequate to encourage a significant number of additional homeowners to make an investment in energy conservation materials.

For solar applications, it is estimated that to achieve effective market stimulation, 30 to 40 percent of the initial cost of the system needs to be provided. As mentioned in the market penetration study, grants and rebates are more effective measures for market stimulation because of the immediacy of reimbursement. The present NEA provisions for loans (at 7 to 12% interest rates), and tax credits (up to $2,200) do not begin to meet the up-front capital requirements of solar systems. Furthermore, President Carter's budget requests include no provisions for the solar loan programs.

Passive solar designs, which also play an important role in saving energy, are not eligible for tax credits under present NEA provisions. In addition, there is no provision requiring the incorporation of passive design concepts into zoning and land-use planning to induce the consideration of street layout, lot orientation and size, shading, solar access, easement, and other elements which collectively comprise the passive design concept.

Terms and provisions of the utility conservation program are to be determined by the appropriate state regulatory agency. The agency will establish which utilities are required to participate and which additional fuel suppliers may offer conservation services on a voluntary basis. However, without further, more definitive guidelines from the federal government, the program may waiver. State provisions may lead to inconsistencies from state to state, and non-integrated services may inhibit the most economic and effective measures available to customers. Therefore, the federal government should re-examine the program and possibly devise more specific guidelines for the states to follow.

III. Tenant Provisions

The current energy programs and tax credits totally ignore the need to apply weatherization and solar adaptations to tenant-occupied dwellings. According to the NEEC/NERCOM/MAS Housing Stock Profile (an estimation based upon 1970 census figures), there are approximately 400,000 multi-family low-and high-rise buildings in New England, many in substantial need of weatherization. Such units account for a large fraction of heating consumption, and to date, there has been very little effort made to improve them. The federal government must take stringent measures to address this problem because improvements are simply not getting done.

The problems of retrofitting multi-family units are complex but not insurmountable. First, the cost of retrofitting an apartment building is much higher than a single family unit. There are presently no financial incentives available to assist a landlord in making solar and weatherization improvements.

Second, motivation varies according to who pays the heating bills. If the tenant pays, measures such as lowering the thermostat and weatherstripping windows and doors may be taken. But tenants generally will not make a major expenditure for insulation or storm windows, because they will not be residing in the apartment long enough to recover their costs.

If the landlord pays the heating costs, she or he may realize a savings on heating bills, but also may tend to pass along the cost of retrofit to the tenant. Also, the tenant is less motivated to practice such measures as lowering the heating level of the apartment, negating some of the landlord's savings.

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[1]*President Carter's Energy Proposal: A Perspective*, Congressional Budget Office, June 1977.

Ideally, the problem could be solved by educating landlords as to the desirability of retrofitting, and devising an equitable way of sharing the cost among both landlords and tenants. However, to achieve any significant savings in heating fuel, it appears necessary to establish a mandatory retrofit requirement for the tenant-occupied dwellings. A precedent for such a mandatory requirement exists in both California and Minnesota, where deadlines have been established for the reduction of air infiltration and the improvement of thermal efficiencies in residential rental properties. Mandatory programs run the risk of forcing the landlord to abandon a marginal dwelling and thereby reducing the already short supply of low-income housing. Coupled with adequate financial incentives, however, such a program could significantly reduce energy consumption in multi-family residences.

REGULATORY AND INSTITUTIONAL PROCESSES COMMITTEE

DELEGATES

Shirley Bergert
Staff Attorney, Connecticut Legal Services, Rockville, CT—low income

Robert W. Bishop
Secretary and Counsel, Northeast Utilities Service Company, Berlin, CT—utilities

Richard A. Bleakney
Vice President for Operations, Boston Gas Company, Boston, MA—utilities

J. Willcox Brown
Natural Resources Consultant, Dunbarton, NH—unaffiliated

Lynn Elaine Browne (Committee Chair)
Assistant Vice President and Economist, Federal Reserve Bank of Boston, Boston, MA—finance

Miriam B. Butterworth
Chairwoman, Connecticut Public Utilities Control Authority, Hartford, CT—government

Mark R. Dyen
New England Regional Facilitator, Massachusetts Fair Share, Boston, MA—consumers

Joseph S. Fitzpatrick
Director, Massachusetts Energy Office, Boston, MA—government

Ian Goodman
Coordinator, Boston Clamshell Intervention Task Force, Boston, MA—environmentalists

Malcolm J. Grant
Consultant, Resource Management Systems, Hope Valley, RI—R&D

Charles S. Isenberg
Executive Vice President, Independent Connecticut Petroleum Association, Hartford, CT—small business

John J. Lee
Business Manager (retired), Pipefitters Union, Local 276, Brockton, MA—labor

Paul F. Levy
Former Chairman, Department of Public Utilities, Boston, MA—government

C. Frederick Lowell (Committee Vice Chair)
Senior Department Staff Member, Regional Energy System Group, Mitre Corp., Bedford, MA—R&D

Rosalyn Oakes
Board member, Vermont Public Service Board, Montpelier, VT—government

Cheryl Ring
Public Policy Researcher, Maine Audubon Society, Falmouth, ME—environmentalists

Evelyn R. Rubin
Assistant Director, Cambridge Economic Opportunity Committee, Cambridge, MA—low income
Patricia Maria Smith
Executive Director, Power Facilities Evaluation Council, Hartford, CT—consumers
Arnold R. Wallenstein
Legal Counsel, Northeast Solar Energy Center, Cambridge, MA—R&D
Lee R. Whitaker
Senior Planner, Rhode Island Statewide Planning Program, Providence, RI—government

RESOURCE CONSULTANTS

Robert A. Beaudry
Sales Manager, City Coal and Oil Company, Nashua, NH
Dr. Dominique P. Casavant
Professor, Physics Department, St. Michael's College, Winooski, VT
Jean L. Hennessey
President, Women and Foundations/Corporate Philanthropy, Hanover, NH
David W. Sampson
President, New England Gas Association, Boston, MA
Carl C. Patrick
Manager, Facilities Planning, Wyman-Gordon Company, North Grafton, MA
Jack Wark
Public Information Director, Northeast Public Power Assoc., Wellesley, MA

STAFF RESEARCHER

Edward Kaynor

EXECUTIVE SUMMARY

The Regulatory and Institutional Process Committee was charged with developing concrete proposals for reducing regulatory and institutional barriers to energy conservation and energy development. The committee has placed particular stress on the concepts represented by the term "institutional" and "process". This has resulted in a set of recommendations focused more on altering perceptions about energy and changing the way in which decisions are made than on improving individual regulations.

The committee has attempted to achieve consensus recommendations. Therefore, the recommendations in this report should not be viewed necessarily as a set of ideal recommendations for changing regulatory or institutional processes as they impact on energy problems. Rather, they are an amalgam of recommendations which could be agreed upon.

The committee spent considerable time discussing and researching some topics which it did not finally act upon. Failure to act upon them can be attributed to a realization that other committees of the Energy Congress were studying and making recommendations on certain topics, that suggested options for action would provide Congress with little more than reiteration of known opinion, or that opportunities for consensus were limited.

Committee Themes

There have been five broad themes evident in committee deliberations. These themes are as follows:

1) *A sense of the committee favoring use of incentives rather than control through regulation.* While recognizing the appropriateness of regulation in certain circumstances, the committee has generally favored increasing public understanding and awareness and giving incentives which would lead to improvement in the energy planning, production, or consumption process rather than dictating changes through regulatory control or prohibitions.

2) *A sense of the committee favoring maximum opportunity to participate in energy policy deliberations or action decisions.* The committee has recognized the desirablility of obtaining better representation in energy policy deliberations by those impacted but inadequately endowed with the means to represent themselves.

3) *A sense of the committee favoring regional solutions to regional problems.*

4) *A sense of the committee favoring benchmark planning in energy.* All-or-nothing-at-all planning for a given date in the future invites unnecessary risk because of the heavy burden of uncertainty which attends all forecasting. Such risk can be reduced by a) planning in short-term stages with well-defined benchmark assessment points, b) continually monitoring the correspondence between expectation and actuality, and c) developing contingency plans for implementation in case expectations are not realized. The flexibility offered by benchmark planning can be even more effective if planners constantly seek means for shortening the lead time between the planning of energy facilities and their actual construction.

5) *A sense of the committee favoring economic viability as a criterion of action.* The committee believes that the present system of regulatory controls and the present existence of monopolistic elements in control of energy production are both impediments to a true evaluation of the economic viability of many energy-related policies and actions. The committee's deliberations have therefore tended to emphasize the need to permit new or revised energy technologies or systems to prove themselves in a climate as free as possible of artificial regulatory constraints or monopolistic control. The committee also recognized the validity of social goals which may exist independently of economic criteria.

Key Recommendations

Reflecting these themes, the following are key recommendations of the Regulatory and Institutional Processes Committee.

1) *There should be established for New England a public Energy Awareness Council, politically uncommitted and representing a cross-section of energy-related interests dedicated to improving interaction in order to increase public awareness of energy tradeoffs and options.*

2) *There sould be established in each New England state an office of low income consumers council and a committee to fund intervention by experts on behalf of low income energy consumers.*

3) *Opportunities for viable alternative energy technologies to compete with institutionally established traditional energy sources should be enhanced. To this end, Congress should encourage actual appropriations of authorized funds, and agencies of the federal*

government should liberally interpret eligibility for grants, tax credits, demonstration funds, and other incentives for energy conservation and renewable technologies under terms of the Energy Act of 1978 and the Energy Conservation Act of 1978.

4) *The New England states, through the Public Utility Regulatory Policies Act of 1978 or by independent action should reduce existing regulatory barriers to development of cogeneration, small scale hydropower, and other forms of decentralized electric power production and distribution where economically justified and to an extent consistent with environmental goals.*

5) *The need for new energy facilities and their siting should take place in the context of regional and state energy plans. Establishment of a periodic review and reassessment process should be an integral part of such plans.*

6) *The New England states should actively encourage or provide for interstate cooperation to improve utility regulatory capability on a region-wide basis.*

Reasons for Recommendations

The committee's report forcuses on public awareness as a critical need because little will be done to improve New England's energy situation unless New England's people willingly do the things needed to improve that situation. The committee believes that implementation of its public awareness proposal will serve to increase comprehension of energy issues and options, and that a public armed with such comprehension will choose options wisely. The committee also believes that better representation of low income constituencies in the energy planning and decision-making process is a necessary component of such public awareness.

However, aware citizens cannot, purely on their own initiative, do all that should be done. The regulatory/institutional climate is not sufficiently flexible or motivation-inducing. Therefore, the committee also recommends other measures to encourage the public to decide wisely and act to improve New England's energy situation. In addition to making the public aware, the committee recommends increased incentives to develop promising new and innovative energy technologies, and it recommends reduction in regulatory barriers to development of such technologies.

The committee has placed heavy stress on the reduction of regulatory barriers to decentralized sources in keeping with its view that economic and social factors free of any bias induced by constraining regulations will operate to produce optimum energy-related choices and actions by a fully aware public. Yet the committee also recognizes the relative irreversibility of energy investments already made in a highly regulated system. Any major shifts in the direction of actions so far taken to meet the region's energy needs will necessarily have to be accomplished slowly and by degrees. The committee therefore recommends a comprehensive study of the probable consequences of changing the present highly centralized energy production and consumption system into a more decentralized system which would be a likely consequence of policies which encourage use of new and promising technologies.

The committee recommends a general effort to regionalize energy-problem solutions, and it has stressed in particular a regional planning approach to the siting of new energy production facilities. The committee believes that New England has special attributes as a region where energy problems cannot be dealt with at the individual, local or even state level without debilitating sacrifices of inter-connectedness and mutual stake.

As regards the recommendations of the New England Energy Congress as a whole, the committee supports current plans to aggressively *seek means for implementing the recommendations of the Energy Congress,* and it believes that a means should be found for *constantly monitoring New England's progress* toward meeting its energy goals with the possibility

of developing a set of contingency actions which could be taken to meet any deficiencies in goal attainment.

DETAILED FINDINGS AND RECOMMENDATIONS

Following is a more detained discussion of the findings and recommendations of the Regulatory and Institutional Processes Committee.

Statement on the Role of Regulation

As a general principle, the Regulatory and Institutional Processes Committee favors the achievement of energy conservation and production objectives through expanded public awareness of the energy situation and the use of incentives rather than through direct regulation of public activities. The committee recognizes that there are situations in which direct regulation is appropriate and that under some circumstances, as for example, where there are natural monopolies, it is essential. However, where there is a choice of alternatives, the committee feels that an initial opportunity should be given to those methods which emphasize incentives and public education, with resort to regulation only if the former prove ineffective.

Public Understanding as a Factor Encouraging Energy Problem Solutions

The Regulatory and Institutional Processes Committee felt that a key, probably essential, element in achieving substantial increases in either conservation or energy production is widespread public cooperation. Such cooperation is most likely to be realized if the public fully comprehends the energy tradeoffs required to achieve their goals. If the public fails to recognize or accept such things as the need for higher energy prices or mileage restrictions or higher taxes to subsidize energy research, little will be accomplished. Laws which have not met the test of public understanding or support may be passed, but they are likely to be honored in the breach more than in the observance, or even repealed when their impact is fully felt. At the same time, the development of new energy technologies, particularly small scale approaches, will not achieve the hoped for goals if the public at large is not aware of their availability and potential benefits.

One of the reasons for these problems is lack of comprehension. The public, on the whole, is not well informed and only vaguely comprehends the energy problem, and what information they do possess is often overlayed with distrust. This is not because the issues have not been studied, but rather because much of the work done is of a fairly technical nature or, where an attempt has been made to reach the public, the information source is perceived to be motivated primarily by self-interest.

Thus, the committee viewed public comprehension, understanding, and awareness of energy facts, forecasts, and options as the cornerstone of concerted public action to deal with New England's energy crisis. Technical aspects of energy programs can be imparted to the public at large through existing governmental outreach agencies but full public understanding of energy issues and options calls for something more: an institutional means for *interaction* of varying interests, public debate, and issue deliberations.

Both financial incentives and full public knowledge can result in similar outcomes: more concerted public action to solve energy problems. But in a choice between the two, the Regulatory and Institutional Processes Committee would tend to favor public awareness because it leaves the proof of desirability of any energy improvement to the individual's own *educated* evaluation and does not cloud the true economics of the enterprise with government-sponsored incentives or regulations. This concept of awareness goes far beyond present notions of outreach as exemplified by the DOE-funded outreach program in each state.

One difference between present energy outreach programs and the "public awareness" proposal made here is the specification of an agency free of governmental policy obligations. Such freedom is considered necessary to assure the public that facts dispensed by an agency are unbiased. Whether data disseminated by any agency can be truly objective is less to the point of this proposal than that an attempt to be objective is made and the public *perceives* such facts to be objective. Another difference is that present outreach programs focus on dispensing practical knowledge on how to go about obtaining or installing insulation and renewable energy source systems, while this "public awareness" report envisions wide-ranging debates, multiple-interest group discussion, and many other techniques for more clearly defining the issues so that people will become well enough informed to make choices based on state-of-the-art comprehension, and not simply on the basis of advice or consultation from a technically specialized outreach agency.

Specific recommendations of this subcommittee include the following:

1) *Creation of a Public Awareness Council made up of:*
   a) *A host organization: a regional nonprofit or academic institution,*
   b) *A program manager with professional staff advised by*
   c) *An advisory board representing varied regional interests and administratively responsible for*
   d) *Working panels of consensus-seeking and fact-seeking representatives of energy production and consumption, the environment, business, industry, commerce, and government whose work would be communicated through*
   e) *Regional interest representatives.*
2) *The output of this Council would be:*
   a) *Energy data*
   b) *Informed choices and an articulation of regional energy needs*
   c) *The establishment of better communications between various interest groups within the region, and*
   d) *The establishment of a focal point for debate on regional energy issues.*

Equitable Representation of Public Interests in Energy Deliberations

Adequate recognition of low income interests is critically needed because insufficient financial resources reduce the energy problem-solution options available to such groups. In essence, solutions to an "energy crisis" pose a financial crisis for low income groups more so than for any other element of the public at large, and this committee therefore has adopted the position that special steps should be taken to assure adequate representation of low income groups in energy planning and implementation deliberations.

The report of the Low Income Intervention Subcommittee, approved by the full committee, elaborates upon this problem and suggests creation in each New England state of two institutional mechanisms to provide adequate representation of low income interests before state commissions and agencies. These two recommended mechanisms are:

1) *Six state low-income consumer councils and*
2) *Six state funding committees empowered to make grants for low income intervention in public hearings relating to energy production and consumption.*

Incentives to Encourage Conservation and Alternative Sources

This portion of the Regulatory and Institutional Processes Committee Report is contained in the Solar Subcommittee's Report: "A Proposal for Energy Conservation and Solar Energy Subsidy". This report focuses on direct financial incentives to the solar industry to give it parity with the currently subsidized, conventional energy industry (oil, gas, nuclear) and to help create conditions for a mass market in alternative energy sources, also reducing solar's current price disadvantage. The report recommends federal follow-through on those provisions of the Federal Energy Tax Act of 1978 and Energy Conservation Act of 1978 which provide a system of subsidies, guarantees, and standards designed to give residential, commercial, and industrial consumers confidence in use of solar energy systems and to lower net costs to such consumers for purchase of such systems. The impact would be double-barreled and spiraling because consumer confidence and lower costs would encourage the solar industry to invest in greater production capacity and improved technology, thus lowering prices through mass production and further reducing costs to consumers. An additional incentive to the solar industry would be provided by the governmental programs mandating solar equipment installations in governmental facilities which should help to demonstrate the feasibility of solar energy systems and which will more heavily subsidize research and development in photovoltaics.

The "Solar" report recommends speedy appropriation of authorized funds, and rapid administrative implementation of the following programs contained in the Energy Tax Act and Energy Conservation Policy Act of 1978:

1) *Eligibility for income tax credits for residential conservation and renewable energy equipment.*
2) *Warranties and product standards applicable to such eligible equipment.*
3) *Loan guarantees and federal insurance applicable to such equipment and to equipment not covered by other federal subsidy programs.*
4) *Low income and urban programs.*
5) *Accelerated depreciation, tax deferral, special investment tax credits, and loan guarantees applicable to commercial and industrial conservation equipment and renewable energy systems.*
6) *Federal demonstrations programs in federal buildings, schools, hospitals, and local public buildings.*
7) *Minimum solar requirements in federal housing.*
8) *Federal facilities photovoltaics program.*

The report also urges federal action to include passive systems in eligibility for these programs and to use other incentives (such as refundable tax credits) to encourage participation in the renewable energy program by those whose tax liability would not normally be sufficient for them to take advantage of the program.

Reduction of Regulatory Barriers to Decentralized Energy Sources

This aspect of the Regulatory and Institutional Processes Committee report is dealt with in the reports of the Decentralized Sources Subcommittee entitled "Consolidated Reports on Small Scale Power Production." These reports focus on issues involved in reducing institutional and regulatory barriers to the development of small-scale power facilities in order to permit these to demonstrate their merits in a climate as free as possible of regulatory constraints. The committee recommends federal follow-through on those aspects of the Public Utility Regulatory Policies Act of 1978 which

would reduce regulatory barriers to development of decentralized sources consistent with environmental and safety standards.

The small scale power report does not contain a list of specific recommendations. Rather, it identifies the advantages, disadvantages, regulatory implications, and obstacles to development of decentralized sources. It then suggests three scenarios which might be used to guide policy in the development of these sources, and it highlights important findings of the recent report of the Massachusetts Governor's Commission on Cogeneration.

As regards forms of diffuse energy sources, many can obviously be used most efficiently on a decentralized basis. Local wood and solar sources, for example, are capable of producing heat building by building. Conversion of such heat into electric energy for wide distribution could be accomplished, but only with a loss of efficiency.

However, the committee has focused its attention on the problems and opportunities associated with use of electric energy on a decentralized basis. In use of electricity, the case for decentralization is less clear. The subcommittee report calls attention to many disadvantages as well as advantages of decentralized electric power generation.

The Public Utility Regulatory Policies Act grants authority to the Federal Energy Regulatory Commission to order interconnection between existing electric utilities and potential small power producers; and it mandates consideration of standby rates, time of day rates, interruptible service, sale and purchase of excess power, and other load management options. These provisions of the Act appear to require investigation of the economy, efficiency, and reliability of bringing many small electric power producers into the existing grid. Such a study in New England would have to take into account the fact that "the existing grid" is, in fact, a highly complex New England-wide interconnected system with computerized dispatch of power and the long-range regional capacity and capability planning necessitated by system demand expectations. Such an existing system may absorb decentralized power easily and efficiently where the power is reliable and dispatchable, and the Regulatory and Institutional Processes Committee has recognized this fact in its general support of decentralized sources. However, the full impact in terms of the net balance of total benefits and costs of absorbing many such power sources and of dealing with varying degrees of power reliability cannot be predicted without much more systematic investigation than has been undertaken to date.

Therefore the Regulatory and Institutional Process Committee recommends that an objective, scientific study by undertaken by a qualified, impartial agency of all of the ramifications of welding many small decentralized sources of electric power into the existing centralized grid operated by NEPOOL and its affiliates in New England. Such a study should begin by attempting to identify the impacts of decentralized power production on NEPOOL and of NEPOOL on the decentralized sources. It should then evaluate the benefits, costs, and policy implications of either adding additional centralized capacity or additional decentralized sources in the future. Such an evaluation should deal with questions of social policy as well as with questions of economy, efficiency, and reliability in a systematic manner.

The Need for and Siting of New Energy Facilities

Many of the recommendations of the New England Energy Congress require the siting of energy facilities in New England. The Congress' support for alternative renewable energy sources implies the location in the region of such facilities as wood fired electric generation stations, solid waste disposal steam and electric generation plants, tidal and hydroelectric power facilities and bio-mass/methane gas production plants. While most of these facilities will be relatively small in size, many sites will be required if these alternatives are to become an important source of energy in New England; experience suggests that even for these facilities the siting process will not be problem free. In addition, the Supply Committee foresees the need for at least one nuclear, or

possibly coal, plant beyond those presently under construction, and, if conservation or alternative energy production objectives are not achieved, more such plants will have to be built. Thus, the siting process is central to the achievement of Energy Congress objectives.

Regulatory processes must be fair, complete, and responsive to the needs which they were designed to serve. It is clear that in most states siting procedures do not satisfy these criteria nor are they efficient by any meaning which can be given that term. Participants in siting deliberations claim that the process is too time consuming, that there are too many agencies involved, that a decision once made is not adhered to, that alternative sites are not thoroughly evaluated, that there is insufficient consideration of whether a facility is needed or not.

Policy development and the regulatory mechanism to accomplish that policy must be, and must be perceived to be, fair (such that disperate points of view can be expressed, analyzed and incorporated according to their merits), responsible (so that once a decision is made it will be respected and followed because of faith in the process), and certain (a decision must be the end product, and that decision must be reached on a timely basis, and be a final decision such that necessary steps can be taken promptly to implement it). Institutional processes must also be made supportive if the desired societal goals are to be realized.

To make the siting process fairer and more responsive to New England's needs the Regulatory and Institutional Processes Committee has developed the following set of principles.

1) *Primary responsibility for the planning and implementation of energy facility siting should rest at the interstate regional and state levels rather than with the Federal government.* The Federal government should encourage sound facility management by means of financial incentives and the establishment of broad siting guidelines; however, the actual planning and carrying out of facility siting decisions are regional and state responsibilities. (Reasons: a) environmental impacts are site-specific and cannot be adequately assessed by monitoring generic check lists; b) balancing socio-economic and environmental impacts with need can best be done in the area where they are most likely to occur; c) state agencies are more likely to consider and be aware of potential conflicting uses of a given site within the state.)

2) *Planning to meet New England's energy needs should be done regionally.* There should be a *regional energy plan* and a regional *planning process.* Because the New England states have many common interests and because the siting decisions made by one state can have implications for the entire region, the six states should establish a mechanism whereby they can work together to identify New England's future energy requirements and to formulate strategies for meeting these needs.

3) *Each New England state should have a state energy siting plan adapting the overall regional plan to the state's specific needs.* The state plans would focus more on how the policy directions developed at the regional level can best be implemented in the individual states.

4) *The regional and state energy plans should be reviewed on a regular basis—perhaps every two years—to assess progress in achieving the stated objectives and to evaluate the objectives themselves.* The primary purpose of these reviews is to allow the states time in which to take corrective action if it appears that conservation and fuel mix objectives will not be met. Such action may take the form of additional incentives for the achievement of the objectives or the development of less economically or environmentally attractive energy options.

5) *The siting process itself should begin with the determination of the need for the facility.* Need should be evaluated in the context of the state energy plan. Thus, to the extent possible, issues involving future energy demand and the contribution of different energy sources should be addressed before the question of the specific site. This should not be seen as precluding site banking.

6) *The determination of need, as distinct from the issue of site, can take place on a generic basis for small energy facilities.* If construction of a small facility is consistent with the energy plan, as the plan projects the contribution of that energy source, then an individual determination of need should not be required. (An exception to this would be an energy producer constructing many small facilities which in the aggregate are quite significant.)

7) *The determination of need should not be simply another step in the facility siting process.* Rather it should be an explicit and thorough treatment of concerns already present in and contributing to dissatisfaction with the energy facility siting process. The regional and state energy plans upon which the determination of need is based should be of sufficiently high quality and should command sufficiently broad support that there will be little public and official sympathy with those who attempt to reopen the question of need once a decision has been made.

8) *The views of local areas likely to be directly impacted by the energy facility should receive appropriate weight in the siting decisions.* These views should be solicited broadly and in public hearings. They should be considered sufficiently early in the process that they can be fully taken into account when the first major siting decisions are made (i.e. well before the construction authorization stage).

9) *If these principles are to be put into practice, the states' siting capabilities must be strengthened and incentives for regional cooperation developed.* To these ends the Regulatory and Institutional Processes Committee supports the concept of the State Energy Management and Planning Act of 1978 (SEMP). However, the development of better siting procedures should not be dependent on or limited by SEMP or other federal funding. (It should be recognized that one way in which states can increase their analytic capabilities is through regional cooperation and the pooling of resources.)

Regional Regulatory Capability

Many of the regional need and siting problems indicated in the Regulatory and Institutional Processes Committee's principles discussed in the preceding section were highlighted in early Committee deliberations on the regional regulatory capability of the six New England states.

While no subcommittee on this topic was organized, the existence of the New England Power Pool as a regionwide power planning and dispatching organization, the existence of utilities with interstate franchises, the problems of transporting LNG and radioactive materials interstate, the problems of siting, and many other regional energy problems all call for greater cooperation between the New England states to enhance regional regulation. The existence of the New England Regional Regulatory Assistance Program of the New England Conference of Public Utilities Commissioners, Inc. can do much to assure regional regulatory cooperation in the handling of interstate energy problems.

The Regulatory and Institutional Processes Committee supports the work of the New England Conference of Public Utilities Commissioners, Inc., and does not support the recent recommendations of the Office of Management and Budget to greatly reduce the funds authorized for Public Utility Commissions by the Public Utility Regulatory Policies Act of 1978. Although the present interstate programs of the New England Conference are adequately funded, future work of the Conference to improve interstate regulatory capability could be jeopardized if it cannot obtain assistance from state utility regulatory agencies to investigate those aspects of PURPA which relate to interstate regulatory problems.

Uniform Taxation of Utilities

The Regulatory and Institutional Processes Committee deliberated at length on two related aspects of utility taxation: the use of tax reserves for expansion by investor-owned utilities and the disequilibrium in tax policy which permits municipals and cooperatives to receive favored tax treatment. The Subcommittee on Uniform Taxation of Utilities produced an issue background report on utility taxation. This report is included in the detailed subcommittee reports which follow, but the committee as a whole did not reach consensus on the topics.

The issues raised in the subcommittee's report are still very much alive in Congress and among state regulatory agencies. Those responsible for implementation of the recommendations of this Energy Congress would be well advised to follow closely the development of these issues at the state and federal levels of government.

SUBCOMMITTEE REPORTS

The following reports of subcommittees of the Regulatory and Institutional Processes Committee are an integral part of the committee's report. These subcommittee reports contain important details not specified in the preceeding sections. Among written materials not reproduced for this report are two background papers on foreign tax credits and decontrol of oil prices, available on request.

Proposal for Energy Conservation and Solar Energy Subsidy

I. Federal Government Energy Development Spending Policies

Research and development has established the potential ability of solar and other alternative energy technologies to make a significant contribution to New England's production of energy. However, current construction and installation costs of alternative systems are high relative to established systems using oil, coal, gas, and nuclear-derived energy sources. These higher costs are due, in large part at least, to the fact that solar and alternative technologies do not compete on an equal basis with conventional systems which have been, and are, heavily subsidized by the federal government.[1] In order for costs of alternative renewable systems to achieve economic parity with established systems either: (1) federal subsidy of conventional sources could be decreased (thus permitting "true" cost to dictate choices of an energy system) or (2) federal subsidy of renewable sources could be increased.

Elimination of all governmental subsidies might be an effective strategy. However, for the near term, reduction of existing federal subsidies and other incentives currently used to stimulate traditional fossil fuel and nuclear resources is considered to be politically unattractive and unlikely to occur until depletion of such sources more closely approaches actual exhaustion.

For alternative, renewable systems to gain a significant foothold among near-term energy options, therefore, this committee firmly believes that costs of such systems must be reduced by mass marketing and commercialization of existing and developing solar and other renewable technologies. A first step toward such cost reduction should be increased federal subsidy to give such technologies an opportunity to compete with our traditional, subsidized energy production and consumption system.

The following recommendations provide details for application of federal incentives to stimulate competitive manufacture, installation, and use of solar and other alternative energy

[1]For an estimate of the magnitude of federal incentives given to conventional sources, see Battelle Pacific Northwest Laboratories, *An Analysis of Federal Incentives Used to Stimulate Energy Production*, Report to DOE, March, 1978.

systems. Many of these recommendations have been accepted by Congress and appear in the Energy Tax Act and the Energy Conservation Act of 1978.

This committee recommends that Congress pursue the budgetary and administrative realization of its recently enacted legislation. Specifically, the committee recommends as follows:

1. That administrative agencies of the federal government be urged to make liberal determinations of eligibility for federal energy conservation and alternative energy incentive programs including (but not limited to) installation of passive solar systems;
2. That budgetary appropriations be made adequate to cover authorized amounts contained in energy-related legislation, and
3. That current federal energy legislation be amended to provide direct grants, loans, and/or refundable tax credits where tax liability is insufficient to make tax credits effective as incentives to conserve energy or install renewable energy systems.

II. Solar Subsidy Package

The following packages of solar industry and market subsidies are focused on the residential, commercial/industrial, and governmental sectors which will have the greatest impact on expanding the use of solar energy with the least cost to government and least regulatory burden. The incentives will also apply to energy conservation devices as the structure must be energy efficient and well-insulated in order for a solar energy system to be cost effective.

A. *Residential Sector*

1. Income tax credit for energy conservation and alternate energy equipment.
2. Minimum warranty requirements for equipment eligible for the income tax credit.
3. Minimum collector and system product standards for equipment eligible for the tax credit.
4. Certification of these products or systems to the standards.
5. Federal backup of insurance or warranties given by manufacturers to consumers.
6. Federal loan guarantees for banks loaning money for such equipment.
7. Low income and urban programs.
8. Inclusion of passive design systems and on-site constructed systems for eligibility for tax credits and inclusion within warranties and system standards.

B. *Governmental Sector*

1. Schools, hospitals, local public building energy conservation and solar energy retrofit program.
2. Federal solar heating and cooling demonstrations program.
3. Minimum solar requirements for federally funded housing construction and rehabilitation.
4. Federal facilities photovoltaic program.
5. Utilities program.

C. *Commercial/Industrial Sector*

1. Accelerated depreciation for energy conservation equipment and solar energy systems.

2. Federal loan guarantees to banks lending money to commercial/industrial establishments.
3. Bonus depreciation.
4. Special investment tax credit.
5. Deferral of taxes used to purchase major commercial or industrial systems.
6. Tax free alternate energy equipment banks.
7. Inclusion of passive design systems and on-site construction within eligibility requirements.

III. Elaboration Of Solar Package

A. Residential Sector Incentive Package

This package of subsidies for the solar industry and market focuses on providing an income tax credit to homeowners to purchase energy conservation, solar and other alternate energy equipment. It is important that passively designed systems and systems constructed on-site are included within the definition of eligible systems.

As the quid pro quo for receiving this solar income tax credit, the equipment eligible for the credit must meet minimum product standards for design, output, reliability, and cost-effectiveness, and the system must be certified by an independent testing laboratory to meet these standards. Eligible systems must also provide a warranty on system components that will meet these standards for at least five years, and the warranty will provide that the systems will be repaired without cost for the duration of the warranty.

To further increase consumer confidence that systems eligible for the federal tax credit will perform as warranted, and that the warranties will be honored, the federal government should provide an insurance program for the solar industry to guaranty that all warranties on solar equipment will be met even if the company should go out of business or drop its solar equipment line.

Additional residential sector incentives would include federal guarantees of loans to homeowners to buy solar equipment at subsidized interest rates. This would help alleviate the high front-end cost barrier to homeowners for purchasing solar systems by ensuring that low cost credit to purchase the systems is available, and this would also remove hesitation bankers might have about loaning money for such systems. Moreover, the federal government can subsidize the interest costs for these systems by paying the bank the difference between the lower consumer interest rate and the higher commercial rate. Precedents for this type of federal government secondary financing guarantees are found in the activity of FHA, FHMA and GNMA, and they have been shown to be effective and low cost interventions. These programs are basically adopted within Section 141-167 of Title I HR-8444, the National Energy Act, and should be promptly administered.

There must also be a series of incentives focused on introducing use of energy conservation and alternate energy sources in the low income and urban market. Installation of energy conservation equipment would be the first priority in this sector, because it is energy and cost efficient, and is a necessary first step before any solar energy equipment could be installed. The low income weatherization program of the Community Services Administration and the Department of Energy to install energy conservation improvements can later be used as a potential vehicle to retrofit urban low income dwellings with passive or active solar devices. Tenant and other local community organizations can also be used to retrofit solar energy systems in urban areas with

substantial governmental assistance and funding. These programs, along with installation and maintenance training efforts, would provide a number of urban unemployed the skills to compete for the jobs that will be created by the incipient solar market, while rehabilitating many new living units in currently uninhabited inner city buildings.

A refundable tax credit for low income individuals can provide a financial incentive to install energy conservation and alternate energy devices. The refundable feature would give money back to people who did not have sufficient income tax liability to take advantage of a regular income tax credit, and give them sufficient supplementary funds to make energy conservation or solar energy purchases. Low interest, long term loans guaranteed by the federal government or made directly by federal agencies to low income people should also be implemented for this sector.

It is believed that this residential sector package will provide effective financial incentives to homeowners to purchase such systems, and will develop consumer confidence in these systems as they will be warranteed and meet minimum design and reliability standards. They will aid the solar industry itself by guaranteeing that all warranties will be carried out, and ensuring that only high quality products will be put on the market.

Finally, it is suggested that this incentive package will be effective, yet will cost the government relatively little money as it would not require significant appropriations. This is because much of the subsidy comes from tax credits and federal loan or warranty guarantees. This fits into current trends of fiscal responsibility by government and minimum federal intervention in the industry.

B. Governmental Sector Incentive Package

A program encouraging retrofit of energy conservation and solar energy equipment in schools, hospitals and state and local public buildings will not only achieve the objective of insuring the maximum number of installations in these types of buildings, but will provide a great market stimulus to the solar industry, as well as providing an example by government for the public and private industry in general to install such systems. The schools, hospitals and local public buildings program could be patterned after Title I of HR-8444, the National Energy Act, Sections 301-323, which provides $900 million over three years for energy audits and actual retrofit of energy conservation and solar energy equipment.

Another important governmental sector program would be to convert a substantial number of federal buildings and facilities to use solar heating and cooling equipment such as is found in Title I, HR-8444, of the National Energy Act, Sections 721-752. This program would provide $100 million over three years to demonstrate solar heating and cooling in federal buildings, require a life cycle cost analysis of all federal buildings, and require minimum percentages of buildings owned by each federal agency to be retrofitted yearly, with all federal buildings to be retrofitted by January 1, 1990. The money for retrofit would be included in the budgets of each requesting federal agency.

In addition, it should be required that all publicly funded housing construction or rehabilitation funded through federal agencies include as the quid pro quo for receiving the federal money a minimum number of units to be heated, cooled or supplied with hot water from solar units. There are many tens of thousands of units of low and moderate income housing rehabilitated yearly with federal money, and this can be an effective method of implementing a federal policy of subsidizing alternate energy resources within a residential context, particularly in urban and low income areas. This will also provide a tremendous demonstration as well as market stimulation device.

The governmental sector series of subsidies should include a program for purchase

and utilization of photovoltaic energy devices in federal facilities, as included in Title I of HR-8444, Sections 761-769, authorizing $98 million over three years for the procurement of photovoltaic systems to be used by federal agencies. This, of course, would be a significant incentive to the photovoltaic industry to develop mass production techniques (and thereby bring costs down) and would also give photovoltaics a massive real life test of their reliability and ability to supply electric energy for essential uses.

Finally, a utilities program could be implemented to have public utility companies offer to install energy conservation and solar energy devices in customers' homes, and allow them to pay back through the utilities' periodic billing systems. This would alleviate the high initial cost problem, and relieve consumers from being concerned about selecting and installing equipment, maintenance, enforcing warranties, or finding financing. This would utilize the utilities' expertise in the energy area and established relations with every energy user, and would stimulate the mass production of equipment, reducing costs. This program is similar to the utility residential energy conservation program in Title I of the National Energy Act.

C. Commercial/Industrial Sector Incentive Package

This package would provide incentives to commercial and industrial establishments to install solar energy and energy conservation devices, somewhat similar to the package of incentives for the residential sector. Initially, the federal government would guarantee loans made by banking and other private lending institutions for the purchase and installation of energy conservation and solar energy systems, with the interest charges subsidized by the federal government. This will help not only to overcome the initial capital high cost problem, but will also help to make available credit to purchase and install such systems, credit that might not otherwise have been offered by conservative lenders in a tight credit market. Again, the systems purchased through such federal financial guarantees should meet minimum product system standards and should offer minimum warranties, although they would differ somewhat from the residential standards and warranty requirements. Moreover, a federal warranty guarantee program as was suggested for the residential sector would be available for a period of time to assure the buyers of this equipment that the warranties will be implemented.

In addition, these business organizations can take advantage of a number of traditional financial incentives given by the federal government to business and industry primarily through the tax code. These focused incentives would include accelerated depreciation of solar and energy conservation systems; increased investment tax credits for purchase of solar energy and energy conservation systems; modification of the class life asset depreciation range system to favor depreciation times for solar energy equipment; and provision for solar energy development bonds which would be tax free and would be similar to industrial development or air pollution control facilities bonding which also receive tax free treatment within the Internal Revenue Code.

This series of subsidies, including loan guarantees to make credit more available and tax benefits to induce commercial and industrial establishments to purchase and install solar energy equipment, can open up a large new market for the solar energy industry and make substantial gains in promoting the widespread use and development of alternate energy equipment in the industrial and commercial sector.

Again, it must be cautioned that it is essential that passively designed equipment and on-site constructed systems must be eligible for these subsidies.

The foregoing incentives concentrate on the residential, governmental and commercial/industrial sectors where it is felt that an impact can be made in the shortest time with a moderate amount of federal subsidy. These programs are suggested as a result of the analysis in Section I of the federal patterns of spending and energy subsidies which indicate that if this country

really wants an alternate energy industry, it must take decisive and forthright steps to provide the incentives necessary to create that industry in the minimum period of time. Because the alternate energy industry is, in fact, competing against oil, coal, natural gas and nuclear power industries, which are extremely heavily subsidized by the federal government, the federal subsidies will have to be effective and powerful enough to meet this stiff but subsidized competition. It is possible, however, that subsidies may be removed from all non-renewable and nuclear sources and that they be allowed to compete on an equal basis with unsubsidized alternate energy sources. However, this seems politically and practically unfeasible, as it would be extremely difficult to divorce these major nonrenewable energy industries from their historical and extremely profitable federal energy subsidies.

There are a number of other possible subsidies which have not been mentioned here, partly because they are not as powerful as the ones mentioned above, and partly because they apply primarily to state level action and cannot easily be implemented on the federal level, where the decisions of the New England Congressional Delegation will be most effective, and where they have the best opportunity to take action. Many of these possible state-level incentives are contained in A.R. Wallenstein, *Barriers and Incentives to Solar Energy Development: An Analysis of Legal-Institutional Processes in the Northeast*, Northern Energy Corporation, Northeast Solar Energy Center, December, 1978.

Consolidated Reports on Small Scale Power Production

I. Factors in an Economic Evaluation of Decentralized Power Production

1) Decentralized energy sources must be analyzed in relation to the existing centralized system.

2) The use of decentralized sources of electric power offer the following possible advantages:

   a) Reduced reserve requirements for central system generation

   b) Reduced transmission losses

   c) Reduced fuel costs in some cases such as hydro and wind

   d) Reduced construction costs (although not necessarily per unit of output)

   e) Reduced lead-time between planning and construction

   f) Cushioned impact of major facility outage.

3) The use of decentralized sources of electric power may result in the following possible disadvantages:

   a) Reduced economies of scale

   b) Additional cost of protective devices

   c) Cost of additional transmission facilities where wheeling is not possible or permitted

   d) Central station capacity reduction advantages not realizable where backup or standby power is needed

   e) Service reliability reduced by impact of variable power output

   f) Reduced revenue available to cover installed central system fixed costs.

4) From a purely economic standpoint, many of these factors apply equally to all forms of

energy conservation as well as to decentralized energy production. The problems of unplanned reduction in demand or of unplanned increases in supply may both be a price which society must pay for conserving or decentralizing. The point to be emphasized is that a policy of decentralization and/or conservation may require certain sacrifices in efficiency or economy over the near term, given the existence of the present centralized system in New England but that, over the long term, many economic advantages might be realized if efforts are made to meld decentralized sources efficiently into the existing grid.

II. Factors for Consideration in an Evalauation of Regulatory Needs

1) Decentralized energy sources may require the development of new administrative and legal proceedings to address government regulation, price setting, and economic and personal liability doctrines.

2) In those instances where small scale power is utilized instead of utility-generated power, utility fixed costs in the short run must still be covered over a smaller amount of energy output. (In the long run, of course, utilities would adapt by adding new capacity at a slower rate.)

3) Long range planning must coherently address the contribution of decentralized power and the attendant need for construction of backup/standby equipment.

4) The problem of allocating costs to utility customers will be made more complex if some of those customers feed power back into the system on an irregular basis. The question of who should pay for resulting short-term overcapacity is only one of these problems.

5) Lengthy and complex administrative requirements for cost/price determinations (which presently do not acknowledge small scale power producers) will be required.

6) Extensive and complex legal proceedings for various licenses and permits to construct and operate facilities may be required because of the great diversity of types of decentralized power production.

7) Installation of some types of small power production facilities may be in opposition to other social policies such as reducing oil dependence. Regulators may be required to choose between policies which are mutually contradictory.

III. Small Scale Power Production Utilization Scenarios

A. Scenario 1—Minimization of Cost to Consumer

1) Purchase power only when less expensive than all other available sources. It would be required that power be purchased on a hierarchical cost basis. Energy cost comparisons must include appropriate allocation for costs of the facility, including depreciation, and necessary transmission and wheeling costs.

2) It may be impossible to specify true costs in a highly regulated or subsidized system, but minimization of costs to consumers requires an effort to account for all costs over both short and long terms.

3) Adoption of this scenario would be most appropriate where a power pool exists to accurately assess costs of alternate sources of generation. The difficulty, of course, is with cost fluctuations as major units go on and off line. (Obviously this assumes that power pool cost assessment assumptions and calculations are appropriate and accurate.)

B. Scenario 2—Minimization of Oil Dependence

1) The crucial issue is the development of political and financial incentives to promote nonpetroleum based small scale power production, or to use petroleum-based power only where the addition of small power facilities would increase efficiency. At present, nonpetroleum based generation, other than at existing hydroelectric facilities, would likely be more expensive than utility generated power. To the extent that this is true, financial incentives are needed because of the higher costs and somewhat speculative operating characteristics and operating life of new types of nonpetroleum energy sources. Political incentives are needed to adopt a regulatory climate which would foster the development of nonpetroleum based sources and to convince the public, where higher-cost alternatives are advocated, that they should pay more for power than they would otherwise have to, in order to realize the goal of decreasing oil dependence.

2) Recognizing that cost will always be of regulatory concern to some degree, it may be appropriate to put some type of ceiling price on small scale power, establish a ratio between small scale costs and alternative source costs, or adopt some other pricing mechanism so that completely uneconomic generation will not be uncritically subsidized through rates.

3) As an alternative, small scale power production utilizing petroleum or petroleum derivatives could be prohibited thereby forcing anyone desiring to put in a decentralized facility to use a nonpetroleum energy source.

C. Scenario 3—Maximization of Decentralized Sources of Energy

1) This scenario requires a positive, clear and comprehensive articulation of the desirability of decentralized energy sources. This can be accomplished again through political and financial incentives.

2) An important adjunct is the allocation of any additional transmission and/or wheeling costs among appropriate customers.

3) A direct incentive would be to allow decentralized sources to transmit and sell power to ultimate retail consumers at whatever costs and under whatever conditions might be negotiated between the cogenerator and the consumer.

4) Regulatory processes would have to be simplified and streamlined. State or federal agencies are in a much better position to assess environmental effects and carry out ongoing monitoring activities. Licensing, permitting and financing regulations of the many amorphous acronymic agencies of federal and state government would be a major administrative and economic hindrance.

5) The rights of access and sale given to decentralized sources must be as equally binding on municipal systems as on private or public utility systems, including the right to allocate increased costs. Some administrative process for price regulation would have to be developed to insure that there is a reasonable relationship between the cost to consumers of decentralized power and the cost of production of that power.

Implicit in all these scenarios is a determination of what characteristics of a small scale producer will be chosen to distinguish it from a utility facility as necessary so that incentive and disincentive programs have the desired effect. It is likely that the optimum strategy (which coincidentally may be the one most likely to be approved) would be seen as a marriage of all three scenarios—the maximization of decentralization to the extent it can yield lower energy costs while reducing oil dependence.

IV. Cogeneration Issues Prominent in Report of Massachusetts Governor's Commission on Cogeneration

1) According to this report, cogeneration can provide 1,700 MW in replaced electric generating capacity in New England. However, since capacity to meet increased demand must be built in advance, utilities and regulators alike are reluctant to depend on uncertain prospects for increased cogenerated power. Therefore, if some utility does in fact come on line rapidly while utility expansion occurs at a rate deemed adequate without cogeneration, short-term overcapacity is certain. Furthermore, policies to date have treated cogenerated power as unreliable, and utility expansion plans assume 100% back-up for cogenerating customers. Such a policy is tantamount to ignoring cogenerated capacity altogether.

2) Since most cogeneration in New England requires use of oil, any delay in utility non-oil capacity expansion caused by increased cogeneration will save expansion capital but increase (or at least not reduce) New England's oil consumption.

3) Because, historically, expansion has decreased average costs per KW of electricity produced, a policy of advocating stagnation to avoid costs of expansion does not appear to make sense (or is at least economically unorthodox). But marginal costs are now so high that each expansion increases average costs and depreciation of old capacity cannot produce revenue sufficient to fund expansion. Since cogeneration is produced at historical costs, it tends to be economically sound for utilities to replace new construction plans with anticipated cogenerated power, provided the cogenerated power is firm and can be used on peak.

4) Fuel saved by itself is almost never enough to amortize capital installation of a cogenerating system but:

   a) Dispersed generation reduces transmission losses,

   b) A large number of small plants are generally more reliable than the same capacity in one large plant, and

   c) Cogenerated power can replace new centralized power and thus eliminate capital costs for the central utility.

5) Because of this uncertainty of utility rates, cogenerators are reluctant to make the necessary capital outlay. This tendency would rob New England of an important source of interim power, and therefore appears to justify financial incentives such as those contained in the National Energy Act. There should also be state-by-state encouragement plans which would help potential cogenerators over the planning uncertainties.

6) The economics of cogeneration is heavily dependent on power planning decisions. Inappropriate definitions of need or incorrect estimates of workability of new technologies can make real savings appear to be potential losses, or vice versa.

7) Except for the possibility of near-term overcapacity, every impact of increased cogeneration on existing utilities could or should be either neutral or beneficial given proper cogeneration incentives and regulations.

8) A workable cogeneration system must include time-of-day metering and the resultant incentive to produce cogenerated power on peak and to use back-up utility power only at off-peak intervals.

9) The Public Utility Regulatory Policies Act of 1978 allows FERC to order interconnection, purchases, and sales for any cogenerator with excess power to be sold at wholesale to an interstate-connected grid.

10) However, an important residue (in New England especially) of potential cogenerators may wish to sell at retail by contract. This would require important policy decisions by state regulators.

11) The Report also deals with other legal changes which could encourage cogeneration including:

    a) Amendment of Federal Power Act Sections 824 a (b) and 824 (b) to clarify right of cogenerator to interconnect,

    b) Amendment of the NEPOOL Agreement, Section 1.2 which excludes participation in NEPOOL by cogenerators, and Section 10.1 which disqualifies use of cogenerated power as part of a participant's capability responsibility,

    c) Amendment of Mass. G. L. Chapter 164A, Section 3 which appears to limit NEPOOL purchases to purchases from generating units producing 25 MW or more,

    d) Amendment of Mass. G. L. Chapter 164, Sections 1, 2, and 3 to indicate if cogenerators may be called "electric companies,"

    e) Amendment of Mass. G. L. Chapter 164, Section 92 to mandate backup power at a fair price,

    f) Amendment of Mass. G. L. Chapter 164, Section 94A to include availability of cogenerated power in rate cases, and to enforce DPU Order 18810 requiring utilities to consider all possible sources for peaking,

    g) Encourage DPU to indirectly require acceptance of excess cogenerated power and utility interconnection through liberal interpretation of Mass. G. L. 164, Section 94G and Order 18810,

    h) Encourage basic policy change at the state level to amend traditional monopoly-franchise approach by permitting limited competition where the public interest (defined to include conservation and cost-effectiveness) warrants it, and

    i) Make appropriate changes in Siting Council and SEC regulations.

12) Since states have general control of sales at retail, present federal legislation will have limited impact on retail sales.

13) FERC may order interconnection where sale is at wholesale and grid is interstate.

14) States may indirectly require interconnection through siting, fuel adjustment regulations, and load management regulations.

15) The Report recommends mandatory purchase of excess cogenerated power by utilities where such power is reliable and more economical than conventional sources.

16) The Report does not deal with the possibility that cogenerators may be willing to sell excess at a *loss* because any market is better than none where it would be uneconomical for the cogenerator to shut down. This would imply mandatory purchase by the utility at a reasonable *price* even if not economical to the cogenerator.

17) The Report deals with many other problems including air pollution (which is responsible for a major share of the high capital cost attributed to cogenerated power), regulation of

construction as limited by building codes, siting powers, SEC jurisdictional problems, franchise-monopoly implications, and precise economic elaboration.

18) The Report deals with Massachusetts almost exclusively although it cites Connecticut PUCA Dockets 770319 and 770320 which direct HELCO and CL&P to design rates for purchase of excess cogenerated power, and New Hampshire's Chapter 362:5 allowing PUCA to exempt cogenerators from rate and service regulations applicable to utilities.

19) The Report does not deal with cogeneration in central plants with district heating.

Proposal for a New England Council for Energy Awareness

I. Introduction

The energy crisis has caused widespread concern among people from all sectors and has given rise to a special and probably unique set of problems. Because energy affects our economic, political, business, social and environmental institutions, ramifications of energy usage have wide ranging impacts throughout our society. Various interest groups have examined various aspects of the problem, i.e., technical, institutional, economic, environmental, sociological and political. These examinations have been conducted by individuals representative of industry, government, environmental, public interest and academic organizations. It is reasonable to expect that almost every facet of the problem has been addressed by one group or another. It is also reasonable to expect that solutions to the energy problem involve participation by virtually every segment of our society, e.g., financial, consumer, legal, academic, business, industrial, technological and public interest groups.

The federal government is presently attempting to lessen future adversities by stimulating the development and commercialization of new energy technologies, energy conservation, and intelligent energy planning before problems become acute. It is evident that the *development* of technologies and strategies may be easier to achieve than their *acceptance* and their *utilization*.

The solution to today's energy problem obviously does not lie *solely* in technological innovation and development. In the past, most of the federal government's successful experience in technology development has been in cases where the government was not only the developer but the user. The users of future solutions to today's energy problem are the members of the pluralistic society in which we live. Thus the viability of any solution rests not only upon its technological but also its environmental, institutional, political, sociological and economic "realities". These "realities" are not well known to the general public. In addition, the establishment of what is "reality" is prone to subjective decision and data inaccuracies. These "realities" also have regional characteristics.

New England is a region with specific characteristics. It has a high dependence on oil and it has high energy prices. It has no developed indigenous fossil fuel supplies. In the event of an embargo, New England could be forced into a crisis situation with unforeseen environmental consequences. It has a strong tradition of political independence and participation. It is highly urbanized and industrialized, but also contains scenic areas of unsurpassed beauty which are of key recreational importance to not only its own urban centers but also those of its populous neighbors, New York and New Jersey. New England contains many of the most prestigious universities and academic institutions in the nation, and is home base for many leading special interest groups.

New England's unique set of energy problems and opportunities has been recognized and a variety of organizations have been addressing various aspects of the problem. While these activities are evidence of a desire to solve the regional energy problem, they are not individually an adequate means of achieving a solution.

One way to expedite a solution is to create an informed public (businesses, environmental organizations, "public interest" groups, utilities, etc.) such that intelligent choices may be expressed. The identification of consensus and divergence among these groups should be more easily identified. What is needed then is an organization which can increase the public awareness and focus the concerns within the region.

II. Objectives

It is proposed that there be established within New England a Council for Energy Awareness. The Council should possess the following *characteristics*:

1) Be realistic and workable, serving a useful function for both the public and private sectors;

2) Be interactive with the public and private sectors and include all regional interests, especially those which do not have formal responsibility for energy policy formulation.

The *goal* of the Council should be to develop and communicate energy alternatives. In pursuit of this goal, the Council should accomplish the following general *tasks*:

1) Identify the present New England situation (Where We Are),

2) Identify alternative New England energy futures (Where We Want to Go),

3) Identify possible strategies for effecting needed change (How We Get There), and

4) Communicate the results of these tasks.

III. Structure

In order to achieve the objectives outlined in Section II, it is proposed that a New England Council for Energy Awareness be established. The Council should be structured in a manner similar to that shown in Figure 1 with the following element functions.

A. Host Organization

It is proposed that a Council be established under the auspices of a regional non-profit or academic institution.

Function

The Host Organization would be responsible for fiscal, contractual and administrative arrangements necessary for the conduct of the Council.

B. Operations

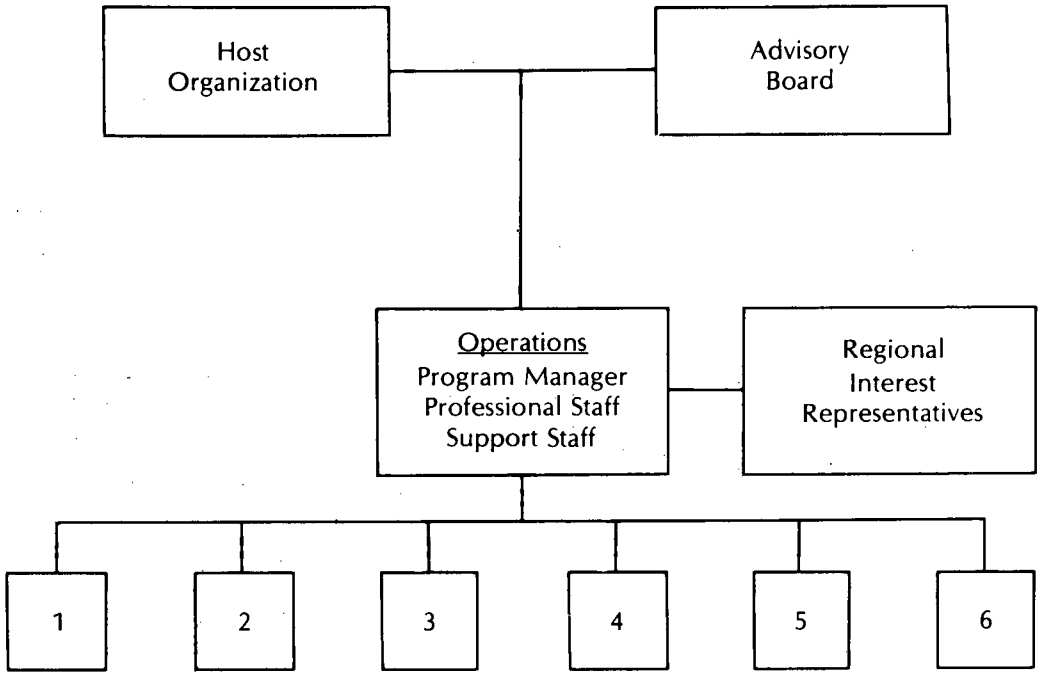
The Council would be under the overall direction of a program manager, who should be assisted by professional and support staff. The staff should be chosen such that it would possess a cross-section of technical, environmental, institutional and economic skills with out-reach experience in the region.

Function

The program manager would oversee the selection of topics, nominate and oversee the working panels, select the panel chairmen, hire and manage any required consultants, coordinate activities with appropriate private and public sector organizations, and prepare necessary administrative and directive materials such that

Figure 1

Council Structure



day-to-day council business is handled in an organized and business-like manner. The staff should support the program manager in the accomplishment of these tasks.

C. Advisory Board

Policy guidance and direction of the Council would be provided by an Advisory Board. The board would consist of representation such that a balanced viewpoint of the various interests of the region would be provided.

Function

The Advisory Board would provide guidance for the activities of the Council. It should approve topics selected for consideration, the membership of work panels, and outputs of the Council. It should assure the appropriate means for providing both private and public interactions with the Council.

D. Regional Interest Representatives

The Regional Interest Representatives would be a group of key persons who should be representatives of the various interests and states within the region. It is proposed that they be constituted from the present delegates to the New England Energy Congress. They would include environmental interests, the energy industry, the business sector, labor, public interests and others.

Function

The Regional Interest Representatives would review working panel outputs, would deliberate in order to develop consensus from divergence and would then direct operations staff to produce a sense-of-the-meeting paper outlining areas of agreement and divergence for public awareness.

E. Working Panels

Each Working Panel would have a chairman. Representatives of labor, environmental, financial, consumer, governmental, university, industrial and commercial interests would be recruited as panelists so that each panel possessed expertise on its subject matter and represented all significant regional viewpoints. It is suggested that panel members be nominated by present delegates to the New England Energy Congress. Panels would be assisted by Council staff.

Function

Working Panels would identify the assumptions of each interest group; assemble the most up-to-date data; analyze such data for completeness, accuracy and bias; synthesize the data into a readable form; and seek agreement and recommendations. These Work Panels would then focus and communicate results including areas of consensus and divergence.

IV. Process

There are currently great differences of opinion and levels of awareness among the various New England interest groups. In order to narrow these differences and increase public awareness, it is necessary to understand their basis. Among the elements contributing to divisiveness between groups are: (1) different fundamental values, (2) different data bases, (3) different visions of the future consequences of today's energy choices, and (4) different self-interests and interpersonal conflicts.

The Council outlined in this proposal attempts to increase the level of public awareness and to ameliorate this divisiveness through the operation of a carefully defined process.

The process itself would: (1) identify issues of broad regional concern; (2) establish Work Panels whose work can be understood and accepted by regional interests; (3) develop interactions between Council members which would hopefully be carried on beyond the Council process itself; and (4) develop interactions between the Council and the private and public sectors. The following is an example of how the Council might operate on a given issue:

1) The program manager and staff oversee the issue selection process and nominate Working Panel members.

2) The Advisory Board after receiving input from the program manager, staff and regional interest representatives, approves the issues to be addressed by the Working Panels.

3) The Advisory Board after receiving input from the program manager, staff and Council, approves the Work Panel members.

4) The Working Panel will then meet and produce draft recommendations with assistance of the staff. They will:

    a) Draw on existing data and expertise, and assemble and analyze relevant data for accuracy, completeness and bias.

b) If needed, they will collect additional data, either internally or by contract with approval of the program manager. With board approval, the Working Panels may further refine or expand their general scope of work.

c) They will deliberate and identify areas of consensus and divergence for public awareness.

d) They would seek public input through public hearings or other means as they deem appropriate.

e) They will report to the project Advisory manager and Board for review.

5) The report will be submitted to the Regional Interest Representatives by the program manager and staff.

6) The Regional Interest Representatives will meet to review the report of the Working Panel and, with staff assistance, produce a "sense of the meeting" paper on the report.

7) The "sense-of-the-meeting" paper will then be sent to the Advisory Board.

8) The Advisory Board will advise on a course of dissemination for the Working Panel's report. The Advisory Board will also determine the appropriate methods for maximizing awareness of final recommendations.

V. Products

Products of the proposed Council would range from those that are highly visible to those that are truly of an amorphic nature. Products would include:

1) Energy data from which informed, intelligent decisions may be made.

2) Articulation of a series of regional needs which might be used as one of the guides to establish priorities.

3) The establishment of better interactive communications between various interest groups within the region.

4) The establishment of a focal point for debate of regional issues by responsible and representative organizations within the New England community.

5) The sharing of information by bringing together regional representatives and organizations.

6) The sensitizing of regional participants to other regional viewpoints.

Proposal For Development Of Funding For Low-Income Intervenors

I. Introduction

The public utility regulatory process involves an adversary proceeding in which the regulating agency balances the interests of the utility companies against those of the various classes of consumers.

Current administrative practices in public utility regulation fail adequately to protect the interests of the low-income residential utility consumer since no state has an institution with

sufficient expertise in the field of utility regulation which is devoted solely to the representation of such consumer interests. In nearly all cases where there is an office of consumer counsel (or its equivalent) that office is charged with representation of all consumer classes — industrial, commercial and residential. Often, interests of these classes will conflict and the low-income residential consumers' interests will be ignored or compromised. The regulatory agency's staff are also in the position of being unable adequately to represent each discrete interest and therefore are forced to ignore or aggregate interests. Thus, the regulating agency cannot define and protect the interests of the consumers without the routine intervention of knowledgeable and representative consumers of all classes to balance the case presentation of the utility companies.

While commercial and industrial consumers can pass increased costs of utility service on to the consumers of their products or service, residential consumers have no such option. However, middle and upper income residential consumers have the income flexibility to expend resources to react to rate increases by conserving (e.g. weatherizing, purchasing timers to take advantage of time-of-day rate structures, etc.) and could conceivably pool resources to advocate for their interests. Low income residential consumers lack the resources to react to increases by conserving, and they lack the resources to advocate on their behalf before regulatory agencies. An effective affirmative or defensive presentation in a utility case can require considerable financial outlay where experts and/or studies may be necessary such as in generic rate structure cases or rate increase cases. Additionally, while all other consumers have the flexibility to maintain utility service where rates increase (though they may suffer economic harm or inconvenience), low-income consumers are exposed to potential life-threatening harm where rates increase beyond what those consumers can pay.

As a method to begin dealing with these problems, we propose development of advance funding drawn from federal and/or state sources and a minimal percentage of gross revenues of regulated utilities for intervenors acting on behalf of low income consumers.

II. Funded Entities

Funding of two separate entities is proposed. Federal legislation creating this program could allow states to choose between the two proposed entities, mandate development of only one entity, or mandate development of both. The proposed entities are described below.

A. *An Office of Low-income Consumer Counsel.*[1]

The existence of such an office would help guarantee continuity and competent representation of low-income interests in energy matters. Such an office would not necessarily overlap an existing office of consumer counsel (or equivalent). It would represent exclusively low-income residential consumers whose interests may conflict with the interests of consumers generally, or, where there is no conflict, the low-income counsel could choose to join with the consumer counsel in the burden of preparation and presentation of a case, or decide not to participate at all, conserving minimal resources for cases of greater importance to low-income consumers. Additionally, the low-income consumer counsel's office should be funded to handle all energy related matters, not just regulated utilities, which would allow for representation of low-income consumers, for example, to obtain oil and bottled gas, to obtain increases in weatherization programs, to obtain increases in available subsidies for energy bills, or to intervene on a federal level.

The low-income consumer counsel needs to be independent to avoid being compromised. Therefore, wherever such an office may be physically located or through

[1]If only one entity is chosen for funding, it is our recommendation that it be an "Office of Low-income Consumer Council" which will allow for development of expertise and provide continuity of representation.

whatever agency its funding may be handled, it alone should determine its budget expenditures (within federal and state law) and its positions and activities. Hiring of the counsel should be by appointment of the governor for a fixed term, with removal between terms only permitted for cause. Limiting the ability of those outside of the low-income consumer counsel to make budget expenditure determinations or to remove counsel severely limits potential interference, political or otherwise, with the activities of the counsel.

B. *A committee in each state, created to distribute funds to intervenors who represent low-income consumer interests in whole or in part, and whose presence would contribute to a full and fair consideration of the issues.*

Often, individuals and groups outside those normally intervening have taken on an issue which has not received adequate consideration previously and which should be presented. Lack of resources could prevent such an individual or group from putting on an effective case.

III. Funding Sources

The proposed funding sources for both entities include monies appropriated on the federal and state levels, private contributions and a minimal percentage of gross revenues of regulated utilities. Receipt of federal funds would be contingent upon state by state development of a program and funding mechanism for low-income intervenors consistent with the enabling federal legislation. Federal funding levels could be determined by the number of low-income persons in the state, balanced by the impact of the potential loss of service.[1] Grant administration and development of federal regulations would be handled through the Department of Energy (DOE) which presently has similar responsibilities with federal money granted to states to establish or expand electric utility consumer counsel offices under Section 205 of the Energy Conservation and Production Act of 1976. Significant freedom would be allowed within which each state could experiment in its program so long as the broad parameters of the federal legislation were met.

Funding would be somewhat different for the low-income consumer counsel's office and for other funded groups:

A. The low-income consumer counsel's office would receive funds by the same method as the state commission or regulating agency and some federal funds.

B. A statewide funding committee would be responsible for making grants to applicant organizations other than the office of low-income consumer counsel. This committee would need at least $100,000 annually for funding of low-income intervention. Such funds could be obtained by a combination of federal funds, state funds, and/or a minimal percentage of gross revenues of the regulated utilities, and it would be empowered to receive funds from other sources including private contributions. The committee would consist of at least the following individuals (or his/her designee where a state agency is involved):

1. The head of the agency regulating activities of the utilities;
2. The head of the agency or sub-agency responsible for activities concerning consumer protection;
3. The head of the agency or sub-agency administering federal welfare programs such as Aid to Families with Dependent Children;

[1]Thus, states with colder climates, where a loss of utilities can be life-threatening, would receive a large grant. The administering federal agency would determine by regulation what formula would be employed to effectuate the balance.

4. A representative, appointed for a fixed term by the governor, of an organization which has consumer rights as one of its primary concerns; and

5. A representative, appointed for a fixed term by the governor, of an organization which is primarily concerned with the needs and rights of low-income consumers.

To the extent that an individual or group funded through the committee receives funds derived from a percentage of gross revenues of regulated utilities, its use of this funding would be restricted to activities involving regulation.

In determining which applicant organizations to fund, the committee would set its own criteria. However, the committee could only fund activities designed to present a low-income perspective or meet a low-income consumer need, and additionally would be bound to consider at least the following:

1. Whether activities proposed by the applicant would be likely to contribute to a full and fair consideration of the issues to be covered;

2. The chance for impact on low-income residential consumers of utility service;

3. Whether any impact of the proposed activities is likely to have state-wide or local impact;

4. The importance of the issues around which activities are proposed;

5. The availability of alternative or supplemental funding for the proposed activities;

6. Whether or not the proposed activities are duplicative of other activities which have been or will be carried out; and

7. The "track record" or the applicant group or individual.

IV. Timing of Funding

Any office of low-income consumer counsel would need to be funded at a minimum per fiscal year to provide continuity of representation. Any funding left from one year should remain in the office's budget to avoid encouraging the office to engage in unnecessary activities or activities of limited value just to expend the balance of the budget. Such flexibility in the budget would allow the office to cope effectively with periods of relative inactivity and periods of great activity, which do not necessarily occur in times coinciding with the funding years.

Funding or funding guarantees of applicant organizations must be available before activity is required. Several insoluble problems arise if it is not available until after activity occurs:

A. It may be impossible to hire experts and conduct studies which are important to effective case presentation without at least a funding guarantee which will cover any fee;

B. If an attorney is involved, she/he may not ethically hire experts and make fee payment contingent on the outcome of the case or on the potential receipt of money which is contingent on that attorney's case presentation.

As in the case of the funding of the office of low-income consumer counsel, any funding left from one year should remain in the committee's budget for fund disbursement in the future for the same reasons as stated above.

V. Summary

Low-income residential consumers are in the unique position of lacking the income

flexibility to effectively deal with increasing utility costs or to represent their special needs. As a result their position often receives less than adequate consideration. Therefore, federal legislation must be developed which encourages the state by state development of independent offices of low-income consumer counsel and/or a funding mechanism for other groups representing low-income interests, and provides federal funding for this purpose. Receipt of federal funds would be contingent upon each state devising a program within the broad parameters of the federal legislation with supplemental funding becoming available through state appropriation and/or a minimal percentage of gross revenues of regulated utilities. All funding or funding guarantees must be provided in advance to permit development of the most effective case possible. In this way, the position of low-income residential consumers, the most vulnerable segment of utility consumers, would receive consideration necessary to avoid potential tragedy.

Federal Taxation of Electric Utilities: An Issue Background Paper

I. Background

Utilities (like other corporations) are mandated by Congress to collect, through rates charged, amounts sufficient to cover corporate tax liability at the corporate income tax rate of 48%. Because of the 10% investment tax credit and accelerated depreciation, the major portion of these taxes are never paid by utilities which are expanding capital plant almost continuously to serve expanding markets for electric energy. It is estimated that approximatelyt $3.1 billion was collected for federal income taxes in 1976 by investor-owned utilities, but only $542 million was paid in federal taxes that year.[1] The unpaid balance is usually kept in reserve and used per se or as collateral to fund capital expansion.

Whether or not tax reserves become appreciable amounts depends somewhat on state regulatory policy. Section 167-(1) of the 1969 Internal Revenue Code permits state regulation to exclude all of the benefits from capital base upon which ratepayers pay a return under accelerated depreciation. However, under Section 46-(f) of the 1971 Code covering normalization for the investment tax credit, companies are given 2 options: (1) to allow a return on the unamortized ITC benefits or (2) allow both full use of ITC funds by companies and claims for a depreciation allowance on the entire value of an asset purchased only partially with ITC funds.

Generally, New England states attempt to adjust their ratemaking calculations to account for deferred or excused taxes in the tax reserves of the companies they regulate. Connecticut, New Hampshire, Maine, and Vermont are considered "flow-through" states. Massachusetts and Rhode Island policies are not known. However, Massachusetts appears to permit normalizing in certain circumstances. In a presentation on deferred taxes in June 1978, Gene Gaber of the University of Vermont tried to show that tax reserves are dramatically higher in normalizing jurisdictions. He contrasts "normalizing companies" such as AT&T, Central Telephone and Utilities, and Boston Edison whose deferred taxes as a percentage of invested capital were 11.9, 15.5, and 11.0 respectively with "flow-through" companies like Niagara Mohawk, Northeast Utilities, and Public Service of New Hampshire, whose like percentages were 1.9, 2.4, and 4.7 respectively.

The California Commission advocates a usage tax rate of .0004 per KWH to replace the present 48% income tax on regulated utilities. A bill, H.R. 8897, was filed by Congressman Stark in the First Session of the 95th Congress incorporating the California recommendation. Many state PUC's support the California position, and the number supporting appears to be growing. However, many states oppose this position, as does the National Association of Regulatory Utility Commissioners.

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[1]Edison Electric Institute as quoted in Batinovich testimony before House Ways and Means Committee, 3/8/78.

A delegate has suggested that the mere change from income to usage taxation is too shallow a focus; that electric utility management in general is a problem of wider concern. The delegate suggest that equal regulatory treatment of all utilities giving electric service should be the goal of tax reform.

This delegate therefore suggests consideration by this committee of an additional proposal to exempt the interest on utility bonds and the dividends on utility stock from taxation to make investor-owned utilities more comparable to municipal electrics and cooperatives in terms of their treatment under tax law.

II. Major Points For and Against H.R. 8897

PRO	CON
1. Removal of present limitations on regulatory procedures through income tax law would return to states their full powers and duties to regulate consistent with optimum service to utility users, especially as regards the power of regulators to limit capital expansion in a period when such limits are called for by energy conservation policy.	1. A change from income to usage taxation would increase regulatory power and responsibility at the state level. Whether this is good or bad depends on one's view of the qualifications of regulators and the adequacy of their regulatory procedures.
2. Taxation would be simplified by a usage tax.	2. Greater simplicity should be achieved by degrees. To revolutionize a taxing system at one stroke is to invite equity suits and inadequate coordination of tax policy.
3. Public credibility would be enhanced by removal of a confusing tax system used for purposes other than revenue collection alone.	3. Public credibility is not an issue because the public is unaware of the tax issue.
4. A tax on use would discourage non-essential use in conformance with national conservation policy.	4. Conservation benefits of a usage tax are not significantly different from present tax policy. As bills go up, incremental conservation will occur regardless of the factors causing electric bills to rise.
5. Incentives for capital formation are not only inappropriate in a period of moderating demand, utilities are a special case in the private sector. Because they are regulated they serve, in effect, as tax collectors. Present law permits collection of taxes which are not in fact passed on to the government. They are collected under "false pretenses".	5. Investor-owned utilities are not inherently different from other private corporations as regards their needs to cover debt for capital costs. Congressional intent through AD and ITC was to improve capital formation throughout the private sector. At least *some* capital expansion will be required even in a period of moderating growth in demand. The burden of taxes on all corporations is unclear, and a substantial amount is paid by consumers.
6. In states where regulation is lax, IRS rules encourage utilities to exacerbate these "false	6. Without reserve accounts, income would have to be raised to provide equivalent

PRO	CON
pretenses" by "normalizing" instead of "flowing through" tax benefits to ratepayers (who make the tax payments). This is probably illegal on fifth amendment grounds.	coverage. This would reduce any benefits to ratepayers. It is alleged by both sides that regulators who wish to "flow-through" benefits to ratepayers do so notwithstanding IRS rules. Lax regulation is a separate issue.
7. A tax at the rate of 20¢ for 500 KWH would not be a heavy burden on electricity users. Yet it would provide IRS with revenue at least equal to revenue from the present "phantom" tax.	7. Several advantages of the income tax as a taxing mode have been elaborated. Corporate tax deferrals and exemptions as currently authorized reduce cost of capital and ultimately, therefore, cost of electricity to consumers.

III. Tax Exempt Bonds and Stock

PRO	CON
1. Municipals and coops now enjoy tax exempt status. This gives ratepayers served by such utilities an unfair advantage over ratepayers served by investor-owned and taxed utilities.	1. Ratepayers served by investor-owned utilities enjoy the progressive management innovations which publicly-managed utilities have difficulty adopting because decisions are often based on political factors remote from "good" management considerations.
2. Making investor-owned utility bonds and stock tax exempt would lower cost of electricity to consumers.	2. The cost of electricity would be reduced only at the expense of higher cost for something else since revenue "lost" through tax exemption would have to be replaced by other taxes.
3. A special subsidy for electricity users is justified by the substantial universality of electric usage. It is now a "necessity".	3. One might say that automotive use is also substantially universal. Would an automaker be less qualified for exempt status?
4. If private and public utilities are treated more uniformly under tax law, the process of regulation will be easier and more equitable.	4. To open up a Pandora's Box of legal questions about private rights to tax-exempt status seems a heavy price to pay for easier regulation of utilities.
5. Rates to ratepayers would be lower, and, since electricity is used universally, the proportionate benefit to the poor would be greater than to the well-off.	5. Lower rates would not encourage conservation.
6. Any stimulus to expansion of investor-owned utilities would not in fact result in unwarranted expansion because expansion is regulated in any case.	6. The stimulus to expansion would in fact result in expansion where regulation is lax.

ENERGY ECONOMICS AND FINANCING COMMITTEE

DELEGATES

Elmer B. Anderson (Chair, Cost/Benefit Subcommittee)
Manager, Planning Department, Algonquin Gas Transmission Co., Boston, MA—utilities

Roger F. Aubin (Committee Chair)
Director of Conservation, Governor's Council on Energy, Concord, NH—government

Ernest Bing
Counselor/Supervisor, Foster Grandparents, Inc., Providence, RI—low income

Charlene Block
International Representative, United Auto Workers, Region 9A, West Hartford, CT—labor

Donald B. Craft
Vice President and Director, Wyatt Incorporated, New Haven, CT—industry and manufacturing

Alan Davis
Director, Public Affairs, Boston Edison Company, Boston MA—utilities

Ralph F. Davis
Director of Energy, Community Renewal Team of Greater Hartford, Hartford, CT—low income

David S. Dayton
President, Technical Development Corporation, Boston, MA—small business

Kenneth E. Frazee (Chair, Government Policies Subcommittee)
Investment Officer, Phoenix Mutual Life, Hartford, CT— finance

Paul Gionfriddo
State Legislator, Connecticut General Assembly, Hartford, CT—government

Kevin R. Guernier
Principal Planning Analyst, Office of Policy and Management, Energy Division, Hartford, CT—government

John M. Joseph
Director, Maine Office of Energy Resources, Augusta, ME—government

Glenn Kumekawa
Executive Director, CONEG Policy Research Center, Inc., Providence, RI—government

Mindy Sue Lubber
Staff Researcher, Massachusetts Public Interest Research Group, Boston, MA—consumers

Abbie Page
Member of Technical Staff, The Mitre Corporation, Bedford, MA—R&D

Bill Painter
Director, Conservation Society of Southern Vermont, Townsend, VT—environmentalists
Nicholas Scobbo, Jr. (Committee Vice Chair)
Financial Analyst, National Consumer Law Center, Boston, MA—consumers
David K. Smith
Consultant, Central Vermont Public Service, Rutland, VT—utilities

RESOURCE CONSULTANTS

Walter Wadyka
Economist, Office of Policy and Management, Hartford, CT
Thomas A. Weber
Director, Financial and Business Affairs, Regis College, Weston, MA
Jeri Justice
Director, Special Seminars, Phillips University, Enid, OK

STAFF RESEARCHER

David Kathan

EXECUTIVE SUMMARY

In viewing our final recommendations, the reader should bear in mind that the Energy Economics and Financing Committee placed major emphasis on the achievement of complete consensus agreement within the committee on all recommendations. The desired result of this consensus requirement was realistic and workable recommendations. The consensus requirement created relative efficiency in the committee's deliberations by having subcommittees initially consider proposals on a consensus basis. Therefore, the committee as a whole was able to spend more time reviewing and discussing proposals with wider agreement.

In our opinion this self-imposed consensus requirement increases the probability of these recommendations' eventual realization. Since these recommendations have already passed this test of consensus, they should be legislated and implemented with relative ease by the appropriate legislative and administrative bodies.

In one further note, the reader should be aware that each subcommittee considered the problems of low-income individuals in their separate deliberations. This emphasis is evident in the committee's final recommendations.

The immediacy of New England's reliance on imported oil was the focal point of the committee's initial meetings. Although there was disagreement concerning the desirability of continued oil use, the committee attained consensus on one central point: New England's major energy problem is its overwhelming dependence on imported oil. Dependence on imported energy sources that are uncertain in price and quantity (1978-1979 Iranian oil strikes) creates a serious security problem for New England. All efforts need to be taken to decrease this dependence, but we felt that the region will continue to consume large amounts of imported oil in the near future. Two major factors in this decision were: 1) the large disruptions that would result from a sudden shift from oil use, due to the large capital investment in the existing oil distribution system; and 2) the fact that the relative cost of oil will remain competitive with other heating fuels as oil prices rise.

Nevertheless, additional large-scale energy projects will be necessitated by additional demand. It was mainly around the financing of these projects that the subcommittees could not attain consensus. Therefore, no recommendations were made in this area. The reader should bear in mind that this lack of recommendations is due to a lack of consensus rather than a failure of consideration. In addition, alternative energy sources, that are at advanced stages of development, will displace future oil consumption where these sources meet the standard set of financial criteria. These criteria include adequate rates of return and relative resistance to adverse impacts which could disturb the financial viability of the energy project.

The instability and uncertainty of future oil supplies and prices causes projections of energy use past 1985 to be both broadly speculative and of limited usefulness in projecting the financial needs of the New England energy sector. Forecasts that continue past this date are less germane to decision-making.

As a result of the assumption of minimal change in the region's dependence on imported oil and the committee's consensus requirement, the committee did not directly address the region's oil dependence. Instead, major emphasis was placed on the financing and development of indigenous resources that could provide energy to the region before 1985.

Throughout the deliberations of the committee, consensus was achieved on a number of low-income topics. The inevitable increase in energy prices will have adverse effects on this sector of the population. The extent of this impact, however, is difficult to forcast. The lack of New England specific data on both the structure of low-income energy use and the past adjustments of low-income individuals to price increases creates serious deficiencies in accurate analysis and prediction. The committee feels that an indepth study of New England low-income energy consumption characteristics should be conducted by the General Accounting Office (GAO). The current use of massive low-income energy relief programs was determined to be inefficient and ineffective. Given the problems with existing programs and the lack of data on the impacts of future energy price increases, the committee proposed changes in the specific present institutions that place low-income persons at a relative disadvantage (i.e., energy-inefficient public housing and non-refundable energy tax credits).

New England's dependence on imported oil can be reduced through the development of alternative energy resources. This reduction can be achieved in a number of manners. We feel generally that the development of indigenous resources (e.g. wood and tidal) may well mitigate the economic and scarcity problems involved with the use of imported oil. Alternative forms of fossil fuels (e.g. coal gasification) should be developed because of their inter-substitutability with oil and gas. The committee expressed concern for the development of alternative sources as evident in several of the committee's recommendations. The committee does not want to forestall the potential contribution of any new and innovative energy resource, but the committee wants to emphasize that these resources must be economically viable.

Financing of energy conservation was given a high priority by the committee. Many energy conservation measures are cost effective. These measures can provide significant savings in regional energy expenditures. At the present time, however, there are insufficient incentives and a lack of widespread knowledge of energy conservation benefits. The committee addressed these two major difficulties with existing energy conservation measures. The provision of accelerated amortization, the rapid write-off of an energy conservation investment over five years, to the region's industrial and commercial businesses lowers the effective capital investment cost of retrofit energy conservation measures. Energy conservation information has not been directed specifically towards financial institutions. This has hampered the residential application of energy conservation. The committee recommends that financial institutions be the recipients of information on existing, successful energy conservation bank programs.

The committee would like to emphasize their rationale for their proposed level of funding to various energy areas. The provision of funds and incentives for the development of all indigenous

energy resources would be fiscally irresponsible and inflationary. Consideration must be given to the energy resources and the potential research areas which indicate cost-effectiveness.

The Energy Economics and Financing Committee was charged with the responsibility of developing concrete, realistic recommendations to address New England's energy situation. To achieve this goal with meaningful results, the committee chose to view these problems through the organization of three subcommittees: Financing Mechanisms, Government Policies, and Cost/Benefit.

Each subcommittee was given a directive by the full committee to study its area of concern and develop specific recommendations for full committee review.

Since May 20, the committee and its subcommittees have met several times each month. A broad spectrum of economic and financial topics relating to New England's energy situation were discussed and assessed within the three subcommittees. Reports and position papers were drafted to address this situation and the energy problems in the New England region. After these initial investigations, the subcommittees drafted recommendations within their jurisdictions. The majority of the committee's work in the first half of the Energy Congress effort was the review and discussion of these recommendations. Since the Energy Congress Convention in early December, the committee has revised and strengthened its recommendations and documentation.

The process of proposal review took place at both the full committee and subcommittee level. The committee based its decisions on a consensus system. It utilized the subcommittee reports as the basis for discussion. Straw polls were conducted in order to arrive at the sense of the committee. At times, some recommendations would not be considered further, while at other times, a recommendation would be accepted outright. Although the committee was unable to reach consensus on a number of issues, the discussion of the proposals provided an insight into the complexities of energy decision-making.

This final report of the committee includes all proposals that have gained full committee support through this process. Other proposals that have failed to gain full support are included if there has been sufficient support among members (i.e., more than 2/3 of the members favored inclusion), but these proposals are not given the status of committee findings and recommendations.

CONSENSUS RECOMMENDATIONS

The final committee recommendations are listed below in priority order:

1) *Require that life-cycle cost analysis on buildings' energy systems be conducted on new, federally financed multi-family housing projects.*

2) *Congress should direct the GAO to study energy cost problems of persons of less than median income with the goal of developing recommendations to alleviate negative impacts.*

3) *Emphasize increased DOE support for research, development and demonstration of wood and peat as viable energy sources.*

4) *Investment tax credits and accelerated amortization be extended to industrial and commercial businesses that install alternative energy or conservation equipment for retrofit applications. Accelerated amortization is defined as the rapid write-off of an investment over a five-year period.*

5) *Tax credits established in the National Energy Act for the residential sector to encourage the use of non-conventional energy sources and energy conservation equipment should*

be refundable (i.e., provide incentives to individuals whose tax liability is lower than the credit amount).

6) *Emphasize continued DOE funding of research on coal technologies, e.g. conversion and cleaning. These research and development efforts should include solvent refined coal, fluidized-bed combustion, coal liquefaction, and coal gasification.*

7) *Solar training programs and courses need to be set up for city planners, architects, labor unions, etc. Classes and workshops should also be aimed at educating the general public so they can construct and install active and passive solar systems.*

8) *State utility regulatory agencies should consider rates based upon the cost of service of back-up energy for users of renewable energy sources at the same proceedings and following the same timetable suggested by the National Energy Act for utility rate reform.*

9) *Federal and state governments should provide information to lending institutions regarding successful bank programs for financing energy conservation projects.*

10) *The proposed legislation that established a State Energy Management Plan to coordinate the development of state energy programs should provide a level of funding which is at least equal to current levels for these programs.*

11) *The New England Congressional Delegation should support the development of the Cobscook Bay Tidal Project in eastern Maine if it is proven economically feasible using life-cycle costing techniques. This life-cycle cost analysis should account for the inevitable increases in the real cost of electricity in the future.*

12) *We recommend that DOE investigate and identify other non-profit groups who have not been covered under present incentives for the usage of conservation measures and alternative energy to non-profit groups.*

Non-Consensus Proposals

1) *The FERC should be directed to use rolled-in pricing in cost-of-service rate setting procedures in cases involving LNG.*

2) *Low-income families should be assisted in coping with rising energy costs through a direct rebate program based on an objective formula.*

3) *Increased amounts of money need to be diverted from the Highway Trust Fund into the financing of public transportation systems, especially bus and light rail.*

4) *The Small Business Energy Loan Act of 1978 should be interpreted, or amended, to provide loans to solar equipment leasing companies.*

5) *Congress should avoid laws which would restrict horizontal investment within the energy industry.*

DISCUSSION OF RECOMMENDATIONS

1) *Emphasize continued DOE funding of research on coal technologies, e.g. conversion and cleaning. These research and development efforts should include solvent refined coal, fluidized-bed combustion, coal liquefaction, and coal gasification.*

Creation of a synthetic fuels industry based on our nation's abundant coal resource is essential to offset the scarcity and cost of imported oil.

Maximizing DOE funding of research on coal technologies will shorten the lead time for the commercialization of conversion processes. These processes will greatly reduce the environmental problems which would result from the direct burning of that coal.

Conversion of coal to high-BTU pipeline quality gas is an efficient way to utilize coal. It is efficient because this gas, which is interchangeable with natural gas, can be delivered through existing pipeline and distribution systems. Moreover, this high-BTU gas can be utilized in the New England region to offset reliance on imported fuels.

Research and development funds spent on direct combustion of coal with stackgas clean-up and the use of sulfur-removing fluidized-bed combustion systems will make the pollution control methods more feasible. Solvent-refined coal may offer a viable alternative for pollution control. Commensurate funds are required for research on the disposal of the residual by-products of these pollution control technologies, i.e. ash, sludge.

Research funding is also necessary to develop efficient and environmentally acceptable processes for the conversion of coal to liquid fuels which can be used as transportation fuel.

The end result of these research and development efforts will be the efficient and environmentally sound utilization of the nation's largest energy resource, coal.

2) *Emphasize increased DOE support for research, development, and demonstration of wood and peat as viable energy sources.*

The availability of wood in the New England states (especially the Northern Tier) could be the basis of providing a significant portion of the regional energy mix. Without government support for research, development, and demonstration, this renewable, indigenous source of energy might not be fully utilized. For example, over 75% of the land mass of Maine, Vermont and New Hampshire is commercial forest land and appears to have the potential of supplying the development of large-scale electric generation, home heating and other uses in both the long and short run.[1] It is the sense of the committee that, in order to aid in the capital formation necessary for the development of this industry, DOE's research activity and expenditures must be increased.

Wood as an energy source has, unfortunately for New England, been largely ignored by the federal government. Research that has been funded has focused mostly on large scale applications that may or may not prove to be very useful to New England.

The increased federal research recommended by the committee should be aimed primarily at small scale, rather than large scale, applications. Firstly, wood is a dispersed resource that lends itself to use in a number of small scattered facilities, as opposed to a few large centralized ones. Second, it seems more efficient and economical to use wood on a small scale. Third, in the case of wood-fired electric generating facilities, it seems more likely that uses can be found for the steam byproduct of smaller plants (less than 10 MW) than the steam produced by larger plants.

Techniques for stimulating regeneration of desired tree species and increased production per acre should be examined. Methods for developing short-rotation silvaculture should be examined, along with the possible environmental, social, and economic consequences thereof.

Emphasis needs to be placed on the development of wood energy systems for use at the residential, commercial, and small industrial level. Pelletization and gasification

[1]USDA Forest Service Resource Bulletins NE-26, NE-36, NE-43, NE-46.

hold particular promise for these applications and should be encouraged. Better transportation and delivery systems for wood chips and pellets need to be developed. Reliable mechanisms for moving chips and pellets from storage bins to combustion units need to be devised.

The question of air quality impacts from widespread use of wood energy requires further study, particularly as it relates to urban areas. In addition, means of disposing of or reusing ash residue should be explored.

Due to the abundant reserves of peat in the region, peat emerges as a possible alternative source of energy. In a region that is primarily dependent on oil and is coal deficient, it would be highly desirable to look at peat resources which are abundant. The economics and the state of the art of peat energy development are quite well-known in Ireland and in the Soviet Union. In these countries peat energy is utilized to fuel electric generating facilities, heat homes and industry; it is cheaper than imported petroleum. The New England region could benefit from peat as an energy resource. In Maine alone, the reserves are estimated to be 21 quadrillion BTUs. However, as is the case with wood, government funding is needed. Research and development should serve as the catalyst for infusing the necessary capital.

3) *The New England Congressional Delegation should support the development of the Cobscook Bay Tidal Project in eastern Maine if it is proven economically feasible using life-cycle costing techniques. This life-cycle analysis should account for the inevitable increases in the real cost of electricity in the future.*

The Passamaquoddy and Cobscook tidal projects have already undergone comprehensive study and investigation dating back to 1930 and are undergoing further research at the present time by the Army Corps of Engineers. The project could provide as much as 500 MW of capacity to the region. Tidal power, a form of renewable energy, fits the objectives of the National Energy Plan in that regard. The project could serve as an important demonstration of the feasibility of tidal power in the United States.

To determine whether this project is economic, a detailed life-cycle cost analysis will have to be made. This analysis, however, should not contain the limiting assumption that fuel costs will remain constant in the future. It is unrealistic to believe that the cost of capital operations, and more specifically, the cost of fuels, will remain constant in the future. The experience of the past several years should highlight the extent of variation that fuel prices can take.

We should give consideration to a capital-intensive renewable energy project such as the Cobscook Bay tidal project.

4) *State utility regulatory agencies in considering utility rate structures should include rates based upon the cost of service of back-up energy for users of renewable energy sources at the same proceedings and following the same timetable suggested by the National Energy Act for utility rate reform.*

Those customers utilizing renewable forms of energy for heating and other functions present potential problems to utilities and their customers. Two potential problems that may arise are negative impacts on load factors and the charges of discrimination or unequal distribution of total costs among ratepayers. On the other hand, solar users and renewable energy supporters have advocated that solar energy actually lowers the total amount of generating capacity needed by a utility, and thereby reduces the nation's reliance on non-renewable energy sources. The initial conclusions of two recent articles by Feldman, et al., and Davitian et al. support this view. They suggest that proper design of a back-up auxilliary system and the implementation of

alternative rate forms (e.g. time-of-day pricing and interruptible rates) enhances the economic benefits of solar energy for both the utility and the customer.[1]

Actual system-monitoring studies and economic models of the interactions in the solar/utility interface are sparse. Nevertheless, the few studies that have analyzed the potential impacts of solar energy on utilities conclude that the use of solar energy is an economic form of energy for all parties in several areas of the country.[2] This economical nature is, however, highly dependent on several factors. Indeed, the Office of Technology Assessment's solar report states that "the results are so sensitive to local conditions that each utility must make its own analysis of costs."[3] Specifically, the variables that generated the most variation were: "1) the regional cost of equipment, the available financing, and the local cost of fuels; 2) local climatic conditions; 3) the type of solar equipment installed; and 4) the number of buildings in a utility service area equipped with solar energy devices."[4] Another significant factor is the load characteristics of a local electric utility.

Indepth monitoring experiments and actual operating experience will provide the final determination of solar/utility economics. An example of a study of this type is one being conducted by A.D. Little. A.D. Little has been actively monitoring solar installations in a variety of locations within the EPRI-sponsored Residential Solar Heating and Cooling Project.[5] Also, in conjunction with their monitoring activity they have developed a computer model that analyzes the economics of the systems. This computer model is available for use by member utilities. Therefore, careful analysis of the impacts of solar energy on a utility is crucial for proper cost-of-service rate-setting.

The committee wishes to emphasize that the thrust of this recommendation is not to alter a state commission's mandate in setting fair and reasonable rates, but to urge commissions and utilities to study the problems on a meaningful and timely basis.

The best mechanism for rate hearings of this type are the procedures suggested in the Public Utilities Regulatory Policies Act of 1978. This act contains provisions that urge state commissions to consider such rates and allows the Department of Energy to intervene in proceedings, along with citizen intervenors, to argue on behalf of such structures.[6] The Act incorporates a timetable for the scheduling of such hearings. It is at these hearings and within this required timetable that the committee strongly urges the New England state utility commissioners to address the issue of rates based on the cost of providing "back-up." The resultant rates for renewable energy use would thereby be addressed on a timely basis. In addition, this procedure would highlight the potential coupling of the various rate reform proposals with solar energy rates.

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[1]Stephen L. Feldman and Bruce Anderson, "Financial Incentives for the Adoption of Solar Energy Design: Peak-Load Pricing of Back-Up Systems," *Solar Energy* Vol. 17, p. 339; and R. Davitian, R.N. Bright, and W. Marcuse, *Utility Load Management and Solar Energy: Study Background and Preliminary Market Potential* Analysis, Brookhaven Natl. Lab.

[2]Office of Technology Assessment, *Application of Solar Technology to Today's Energy Needs*, June 1978, p. 153, and The Aerospace Corp., *Solar Heating and Cooling of Buildings (SHACOB) Requirements Definition and Impact Analysis* Final Report, for the Electric Power Research Institute, EPRI ER-808, June 1978.

[3]OTA, p. 151.

[4]In the Matter of *Proposed Increased Rates and Charges Contained in Tariff Revisions Filed by Public Service Co. of Colorado*, Decision No. 87460 (Colo. Public Util. Comm'n., Oct. 21, 1975).

[59]*Home Builders Ass'n of Metropolitan Denver v. Public Service Co. of Colo.*, Decision No. 89573 (Colo. Public Util. Comm'n., Oct. 26, 1976).

[6]Title I of H.R. 4018, The Public Utility Regulatory Policies Act of 1978

5) *Require that life-cycle cost analysis on buildings' energy systems be conducted on new, federally financed multi-family housing projects.*

The National Energy Act of 1978 requires that life-cycle cost analysis be applied to all existing federal buildings for purposes of retrofit and to any new federal construction.[1] In addition, several states such as Massachusetts have legislation that requires state and local governments to consider using alternative energy systems, including solar and wind, in the design of new state funded construction. Connecticut is amending existing life-cycle cost legislation to accomplish a similar goal. To date, however, no legislation has been enacted that requires that life-cycle cost analysis be conducted on federally financed multi-family housing projects.

Past experience with the energy efficiency of public, multi-family housing has been dismal. Prior to 1950, there were no construction standards for residential energy conservation, and those that were enacted at that time were ineffective. It was not until 1973 that the standards were adequately toughened.[2] Since existing public, multi-family housing was built predominantely in the immediate post-war period, the result is widespread energy inefficiency in these projects.

Current funding mechanisms often encourage the installation of the lowest initial cost heating systems and ignore the higher operating costs that are subsequently passed on to residents. Electric resistance heat is a good example. New England's public housing stock is 22% electrically heated;[3] the total New England housing stock is 12.1% electrically heated. Many new multi-family units with electric heat are currently being constructed in the region, even though they result in higher lifetime costs. A major reason for this practice is Congress' emphasis on maximizing the total number of units built with the money appropriated. Therefore, HUD and the local Public Housing Authorities have constructed units that require a minimum initial investment which often results in meeting only minimum conservation standards.

A life-cycle cost analysis of space heating, cooling, and hot water equipment that considered all available conventional and alternative energy systems would identify the total costs of those different energy systems in these facilities. Moreover, it would help alleviate the economic burden that is currently being placed on consumers with the least ability to meet those costs. Steven Ferrey has put the problem into perspective:

> Because of their limited access to quality housing low income persons residing in federally-assisted housing are in a position of greater dependence upon conscientious fulfillment of the federal regulatory role in residential energy conservation than are other segments of the population. For local housing authorities, which must operate under limitations upon per unit cost, there is no incentive to provide greater thermal integrity to dwellings than required by minimum federal standards.[4]

We feel that HUD and the local housing authorities have to be more conscientious in their energy conservation role in the future. These analyses would also serve as models for the private sector in selecting the most appropriate system for use in local and specific conditions. This, in turn, would lead to increased consumer awareness of the trade-offs of initial versus life-cycle costs of energy systems.

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[1]Title V, Part 3 of H.R. 5037, The National Energy Conservation Policy Act of 1978.

[2]Steven Ferrey, "The Ghosts of Cold November: An Examination of HUD's Energy Conservation Policy for the Poor", *Clearinghouse Review*, May 1977, p. 2.

[3]Communication with Glenn Rogers, Region I HUD, January 30, 1979.

[4]Ferrey, p. 2.

One final comment needs to be expressed concerning the implementation of this recommendation. Although there is HUD support for this recommendation, several HUD officials have expressed concern over who will do the actual analysis. With the limited staff available at HUD offices and at the local housing authorities, proper analysis might not be undertaken.

If this recommendation is enacted, careful attention must be given to ensuring that adequate personnel and resources are made available to perform quality analyses. The present ineffectiveness of the life-cycle costing in Massachusetts and Connecticut stem from a lack of consideration for these implementation measures.

6) *Investment tax credits and accelerated amortization should be extended to industrial and commercial businesses that install alternative energy or conservation equipment. Accelerated amortization is defined as the write-off of an investment over a five year period.*

The intent of this proposal is to encourage energy conservation in the commercial/industrial sector by stimulating capital spending on energy saving measures and renewable energy resources. The concept of investing capital to more efficiently utilize resources is not new. In fact, when "cheap energy" abounded many of the increases in productivity were accomplished through investment in energy consuming machinery. Efficient use of energy was not as important as it is today because of its low cost. With the current trend of higher energy costs and the ultimate exhaustion of nonrenewable energy sources, efforts to increase capital investment in more efficient processes is essential. This is especially true for those processes which convert primary fuels to provide space heating and cooling and for processing energy for business and industrial needs. These efforts will not only decrease growing demands on limited energy resources, but will also improve the economic viability of business and industry in regions such as New England which have a heavy preponderance of older facilities.

Investment in alternate energy and conservation equipment can take many forms. Installation of solar or wind energy systems for heating, cooling, or generation of electricity; conversion or replacement of existing boilers that use oil or gas with more efficient units or with those that utilize alternate fuels; and the insulation of building to reduce heating and cooling requirements are just a few of the many options available.

Unfortunately, widespread investment in energy and conservation will require the commitment of substantial amounts of capital, and lack of capital resources and/or long payback periods could restrict investment decisions. Most businessmen generally look for a fifteen percent return on investment in their product lines, but they typically demand a return on thirty percent or more on discretionary investment, including those on energy saving equipment.[1] The double incentive of the investment tax credit and accelerated amortization will make energy saving equipment investments more attractive, and will result in higher energy savings.

Although conversion of older equipment using oil and gas to alternate sources is encouraged in the National Energy Act, the substitution of more efficient oil and gas units, when such conversion is not appropriate, must also be encouraged. This conversion should be limited, however, to those installations which show at least a 10 year payback when energy savings are compared to the investment.

7) *Federal and state governments should provide information to lending institutions regarding successful bank programs for financing energy conservation projects.*

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[1]Business Week article cited in Steven Schneider's "Common-sense about Energy, Part II", *Working Papers* March/April 1978, p. 50; this tendency is also documented in G. N. Hatsopoulos, et al, "Capital Investment to Save Energy" *Harvard Business Review*, March/April 1978, p. 111.

The experience of a number of innovative banking institutions indicates that conservation programs can be greatly enhanced when special discounts and conservation education for homeowners are combined in a concerted marketing effort. The government should encourage lending institutions to expand this effort and to explore and develop other possibilities for increasing consumer interest in conservation investments. Government sponsored educational programs that outline some of the initiatives that have proven successful would increase lending institution participation.

Examples of the successful bank energy conservation programs are instructive. For instance, some lenders have offered lower down payments and reduced interest rates on mortgages for the purchase or refinancing of homes meeting certain energy efficiency standards. Others have developed coordinated marketing strategies with utilities, insulation contractors, and hardware outlets, thereby providing the consumer with "one stop shopping" that includes financing. The provision of direct line of credit to conservation and solar contractors and the development of common financing packages with forms geared to particular kinds and sizes of energy projects is another approach. Some are thinking of working with large employers to develop financing packages for conservation/solar options for their employees, perhaps including payroll deduction plans and other mechanisms designed to reduce administrative costs to the lender.

Probably the most successful energy conservation program by a financial institution is the program conducted by Seattle Trust and Savings Bank. Their success results from their incorporation of the various essential characteristics of successful energy conservation programs into a single aggressive program. [1]

8) *Tax credits established in the National Energy Act for the residential sector to encourage the use of non-conventional energy sources and energy conservation equipment should be refundable as well as retroactive to April 20, 1977.*

The Energy Economics and Financing Committee is highly satisfied that the final version of the National Energy Act includes substantial programs of tax credits for the purchase of energy conservation, solar, and wind energy.[2] However, we believe that the credits as passed would be further improved if they could be made refundable, and thus available to home-owning low-income families. Therefore, we recommend that legislation so amending the credits be enacted during the 96th Congress.

Under the version of the legislation originally passed by the Senate, both the conservation and solar credits would have been refundable; that is, home-owners with little or no taxable income and who therefore pay little or no tax would still have received the credit in the form of a cash disbursement from the treasury. This would have insured that such low income persons were not disadvantaged by what, in lieu of such provision, constitutes a regressive tax program. The importance of rendering the credits refundable is based in part on the desirability of making these tax incentives available to retired families who have low and/or fixed incomes, a substantial portion of which incomes are nontaxable (e.g., Social Security income). In addition, such retired families are apt to be occupying older housing stock which is either uninsulated or not insulated to current standards, and are therefore very much in need of activities within the scope of the conservation credit. The limited financial resources of such families constitutes a constraint on such activities, and in addition many families in this category may not take advantage of low income weatherization programs. We therefore believe that it is important that the tax credit should operate to provide these citizens with an incentive at least equal to that accorded more affluent homeowners.

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[1]Further information about this program is available in *Innovative Financing Banks and Energy Conservation*, prepared for DOE, May 1978, Contract No. EY-76-C-03-1201.

[2]PL 95-619, The National Energy Conservation Policy Act of 1978.

At the same time, however, the refundable nature of the credit could create possible abuse. Affluent homeowners, whose tax liability is small enough, would be eligible to take advantage of the refund. Since this recommendation benefits low and fixed income homeowners, the use of the credit by affluent taxpayers would be detrimental to the intent of the committee. Therefore, there should be a statutory income limit on the refundable credit.

9) *The proposed legislation that established a State Energy Management Plan to coordinate the development of state energy programs should provide a level of funding which is at least equal to current levels for these programs.*

The proposed State Energy Management Plan (SEMP) legislation would coordinate existing federal programs that provide funds to state energy offices, and allow the states more flexibility in planning and conducting timely and relevant energy programs. While this legislation is in itself an acknowledgement of the important role that the states must play in any national energy program, the committee is concerned that present funding levels will not be adequate to provide the necessary resources.

The committee agrees with the appropriation levels developed by the National Governors Association SEMP Task Force, which call for $120 million in FY 1979, $140 million in FY 1980, and $160 million in FY 1981-83. This level of funding would allow the states to continue many of their successful conservation programs and establish the new programs required by the act. Without this support it seems inevitable that many state conservation programs would have to be eliminated in order to concentrate on new responsibilities.

10) *Solar training programs and courses need to be set up for city planners, architects, labor unions, etc. such as the training course, "Solar Heating and Cooling of Residential Buildings: Sizing, Installation, and Operation of Systems", U.S. Dept. of Commerce, Oct. 1977. Programs are needed for labor unions on solar job opportunities. Courses should be designed to train and update workers on solar technology. State and local officials should be made aware of the merits of solar technologies and encouraged to use them. Classes and workshops should also be aimed at educating the general public so they can construct and install active and passive solar systems.*

There are a number of educational activities that are needed to increase knowledge about solar technologies. Educational workshops aimed at the general public as well as specific special interest groups, who would be responsible for the design, installation, or maintenance of solar heating and cooling systems, must be initiated to promote and encourage this energy source. The residential, commercial, and industrial sectors are the specific markets where this activity should be directed. State and local officials, including city planners, when instituting a new project or evaluating an old one, should consider solar as an alternative. Project planners, architects, engineers as well as the investors in new or remodeled facilities must become aware of the advantages and limitations of solar technology so that it may be compared with conventional systems.

In anticipation of increasing market demand for solar systems, and in order not to deter acceptance, consideration must also be given to educating and training both professional and tradesman in its application. Information must not only be provided on solar hardware, but programs must be developed to demonstrate how conventional skills apply to solar technologies. It is anticipated that the skills required for solar installations would be similar to those traditional construction skills now required for the installation of conventional systems. Workers would thus only need simple retraining or training in special applications in most instances. Such training should not only include

installing solar devices, but consider the problems associated with retrofitting existing structures, conducting energy audits, and implementing conservation and weatherization measures. These activities are often essential to the operation of a solar heating or cooling system. In addition to the training and retraining programs, community energy programs should be set up that would generate jobs by hiring and training the unemployed.

The training course, "Solar Heating and Cooling of Residential Buildings: Sizing, Installation, and Operation of Systems", conducted by the Dept. of Commerce provides a more indepth investigation of solar. This course acquaints the participant with many of the technical and economic considerations concerning solar energy. A course of this type is invaluable for public officials and individuals who need extensive knowledge about solar technologies.

11) *We recommend that DOE investigate and identify other non-profit groups who have not been covered under present incentives for the usage of conservation measures and alternative energy to non-profit groups.*

Due to Congress' reliance on tax-related devices to provide incentives for the installation of energy conservation measures and renewable energy systems, non-profit institutions are at a relative disadvantage. Section 501(c)(3) of the Internal Revenue Code exempts non-profit groups from income taxation. As a result of this tax-exempt status, however, these non-profit institutions do not nave the same incentive to purchase energy-saving technologies. Although these technologies would lower their increasing fuel costs, non-profit institutions do not have the working capital available to undertake high initial cost, energy-saving expenditures.

The National Energy Act attempts to alleviate this problem by providing for a three phase program of energy audits and matching grants.[1] Specifically, schools and hospitals qualify for initial preliminary energy audits. If there is an evident potential for energy savings, the qualifying building would receive technical assistance audits. After these audits have determined the need for energy saving technologies, a program of 50% federal funds—50% state or private sources would be provided. This 50-50 split provides needed funds, but also provides an inducement for the institution to participate fully because of the significant expenditure of its own funds.

Nevertheless, there are non-profit institutions who do not benefit from these federal programs. These institutions include churches, museums, veteran's halls, granges, and other non-profit groups who own their own facilities. The federal government should identify and investigate the existence and the extent of the energy needs of these institutions. If the energy needs of these institutions are serious enough, possible action similar to those provided for schools and hospitals could be undertaken.

12) *Congress should direct the GAO to study energy cost problems of persons of less than median income with the goal of developing recommendations to alleviate negative impacts.*

The energy costs for persons of less than median income who live in the New England region present problems which may cause deterioration in their living standards to unacceptable levels. These potential negative impacts on the quality of life demand meaningful action on the part of the government. It is the position of this committee that there exists no reliable body of data from which the Congress can base a sound judgement as to whether remedial action in necessary. What exists at the present time are general figures and conclusions for the entire United States, not New England

[1]Title I of PL 95-618, The Energy Tax Act of 1978.

specific data. Separate analysis is essential on New England because of its adverse climate and its greater dependence on petroleum. The combination of the long heating season and relatively expensive energy necessitates a large expenditure on heating bills. These expenditures are regressive for the part of the population below the median income. With this in mind, the committee strongly suggests that the GAO be directed to compile and develop recommendations sufficient to alleviate any negative impacts.

Throughout our deliberations, questions of energy cost impacts have frequently surfaced. The lack of reliable data precluded more specific recommendations and it is for this reason we request the Congress to direct the GAO to perform the required task.

OTHER PROPOSALS DISCUSSED

The following topics received considerable attention from the committee, but specific courses of action were not taken.

1) Creation of a central clearing house for coordinating and expediting the approval process for energy projects.

2) Authorization for states and/or local governments to use bonding authority and provide loan guarantees for energy projects.

3) Establishment of a no-return on equity, government-sponsored finance agency.

4) Avoidance of laws which restrict voluntary movement of capital within the energy industry.

5) Efforts be made to achieve uniform legislation in New England to deal with industrial development or revenue bonds.

6) Direct DOE and IRS to develop legislation that would encourage the financing of new energy projects.

7) Environmental regulations affecting an energy project should be specified in advance.

8) Property tax exemption on energy related equipment be legislated at state and local levels.

9) Small solar companies be provided with access to and assistance in obtaining capital for investment.

10) Subsidies for R & D of renewable energy sources be equitable to those provided for R & D of non-renewable sources.

11) Subsidization of renewable energy production facilities which are in the national interest.

12) Direct the use of rolled in pricing and an all-events tariff in the investment in a coal gasification plant.

13) Recommend to DOI a timetable for lease sales and environmental input to accelerate offshore development.

14) Recommend that Congress price natural gas and new oil at prices that fully recognize the replacement cost of these sources.

15) Reinstitution of the percentage depletion allowance for tertiary recovery, shale oil, heavy oils, and tar sands.

16) Empower municipal governments to use tax-exempt bonds to assist citizens in utilizing conservation and solar energy.

17) Extend existing financial incentives for solar to solar leasing companies.

18) Institution of a gas-guzzler tax for all the New England states.

19) Development of financing packages for conservation/solar projects for federal, state, and local government employees.

FINANCING MECHANISMS REPORT

I. Introduction

The Financing Mechanisms Subcommittee of the Energy Economics and Financing Committee was charged with the responsibility of investigating New England's energy financing situation. The end result of this investigation is the report that follows.

This report is designed to provide an overview of the financing problems of future energy supplies. The report is divided into three sections, which correspond to the three major energy-user sectors: large-scale, community-scale, and consumer-scale. Within each of these sections, the report reviews for each sector the types of energy technologies included, the financing mechanisms available for these technologies, and the current and potential problems involved in such financing.

Since this report is meant to be an overview of energy financing, a detailed analysis and description of utility industry financing is not included. Nor does this report contain detailed analyses of large energy projects, e.g. nuclear power.

One point needs to be emphasized concerning the project financing discussed in this report. All projects that are candidates for financing need to be economically feasible, i.e., provide an adequate and stable rate of return, before they will be financed. This condition is a prerequisite for all financial institution review and consideration. Although this report places major emphasis on alternative energy technologies and their attendant problems, these technologies will be financed by private means only when they achieve economic viability.

II. Large-Scale Projects

The committee suggests that the great bulk of the dollar requirements for large energy project financing in New England will be for projects in excess of $10MM per project. The traditional private sector financing arrangements are geared toward this type of project.

Within the private sector, the sources of funds for equity investments and loans are very large in number and diverse as to interest in alternative types of financing. The primary sources of financing from the private sector are:

1) Wall Street — This represents the traditional source of funds from the sale of equity and public bond issues by investment banking firms.

2) Institutional lenders — This is the largest and most diversified source of large scale financing and primarily includes loans from banks, insurance companies, and pension funds.

3) Non-institutional lenders — This includes commercial finance companies, large industrial corporations, and wealthy individuals.

4) Foreign investors — These investors would usually be individuals, corporations, banks or governments.

The primary factors determining which type of financing is most appropriate for a particular project, and which financial source to use are: 1) the amount of financing needed, 2) the time frame of repayment, and 3) the rate of return of the project. For example, short maturities do not interest insurance companies, but are ideal for banks. On the other hand, investments with long maturities and fixed returns are of more interest to pension funds and insurance companies than they are to banks.

The projected private sector demand for capital funds to finance energy projects in the next ten to twenty years is enormous. Nevertheless, the most extensive recent research insists that the financial markets have the capability to raise the needed funds. Bankers Trust Co. completed a study in 1978 which makes this very point:

> Since the time of the oil embargo and the subsequent rededication of U.S. efforts to the development of domestic energy supplies, the energy industries have substantially expanded their share of the credit and capital markets.
>
> Although the change has been noteworthy, we have been living with it now for several years, and the capital markets appear to have taken it in stride.
>
> Since the energy industries' call on the capital markets is not projected to show any significant increase during the next 5 years, the bank concludes that no energy-induced capital shortage will occur.[1]

The situation in terms of capital availability in New England may be better than that in more rapidly growing areas, since the New England economy is relatively mature, with minimal influx of new industries. An additional reason for the relative stability of the demand for capital is the relatively small population growth predicted until 2000.[2] Within the nationwide competition for available funds, New England's demand for capital funds should be smaller than other regions.

Public sector financial sources include financing made available by federal, state, and local governments together with their various agencies. Today, the bulk of this financing has been largely in the form of municipal bond financing and industrial revenue bonds. This form of financing will in all likelihood be used primarily for community energy projects, however, and not for large-scale energy projects. This topic will be addressed in more depth in the second section of this report.

The financing of large scale projects is based on institutional arrangements which have developed over a span of many decades. The traditional demand and supply forces have accomplished a reasonable allocation of funds. Until recently, the intensity of the economic needs for projects produced a financial viability on the demand side. This intensity further made possible an adequate rate of return on the supply side. The lender could expect a timely repayment program. The stockholder or equity investor could expect both regular dividends based on earnings and capital appreciation based on the growth of the economy and other favorable factors. Proponents of large scale projects could lay their plans, acquire necessary permits, and finance their construction requirements with a high degree of certainty.

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[1]Enough capital available for energy to 1983, The Oil and Gas Journal, May 22, 1978, p. 3

[2]The population of the region has grown at a less rapid rate than has the country as a whole since 1970. New England has had a 3.3% growth rate, the U.S. has had a 6.4% increase. The projected increase for the region and the U.S. until 2000 will be respectively, 17.82%-.72% compounded annual increase; 20.13%—.80% compounded annual increase. U.S. Bureau of the Census. *Current Population Reports. Population Estimates and Projections, Annual Estimates of the Population of States.* Series p-25, No. 727, July 1978, *Current Population Reports, Projections of the Population of the United States, 1977 to 2000*, July 1977; and report of the Demand Committee, New England Energy Congress.

In recent years, large scale energy projects have come under increased regulation and regulatory review. These regulations have been created as a result of energy shortages (e.g., the 1973-74 oil embargo and the 1977 winter freeze-generated shortages), energy price increases, and intensified environmental and consumer-related concern. The "ground rules," which in the past permitted a stable assessment of project viability, have been changing rapidly. Legislative and administrative standards, divergent interpretations of rulings, and the bureaucratic infighting between the agencies with jurisdiction over a project have led to a regulatory climate which has negative implications for financing. These regulatory effects have created adjustment difficulties for the financial markets involved. In response to this instability, the financial markets have requested ironclad legislation to protect their investments. This legislation, which would be in effect at the date of the loan issuance, would not allow subsequent legal or regulatory action to alter the firmness of the financial commitments of a project. This type of assurance, however, might not be politically feasible, given the extent of public interest and opposition to many large-scale projects, especially nuclear power plants.

The effects of regulation on an energy project are, nevertheless, only part of the various risks involved in the financing of these projects. According to Lee and Healey in a 1977 *Public Utilities Fortnightly* article, there are three areas of risk in financing large-scale energy projects: 1) risk of noncompletion of the project; 2) risk of insufficient project revenues; and 3) risks of revocation of pass-through mechanisms or institution of uneconomical pricing structures by a regulatory authority. The first two risks are common to all large energy projects, and the third risk is peculiar to regulated industries.[1] The various problems that the large energy projects have faced in the past decade can be placed into this framework. These risks can be substantially decreased, but not completely eliminated. Efforts need to be directed at reducing the potentially adverse results of regulatory fluctuations, and thereby decreasing the financial risks. Several solutions have been offered to accomplish this reduction: all-events full cost-of-service tariffs, consumer surcharges, and cost indexing.[2] Although these potential solutions should be investigated, the committee was unable to agree on implementation of these solutions.

Demands for energy financing will come from the replacement and expansion of electric generating capacity, but the magnitude of these demands will be less than in previous years. The recent, smaller-than-expected electricity demand growth has decreased electric generating capacity needs. Nevertheless, this area needs special attention. Presently, the private sector utilities must pay nearly twice as much for capital funds as those in the public sector, i.e. municipals and cooperatives. This lower capital cost is a result of both access to federal monies at low interest rates and the ability to offer tax-free bonds. There has been a trend to make public monies available at low interest rates to private industry through the device of municipal or state bond sales with a reallocation of the funds to industry. Interest costs to industry may thereby be reduced by at least 40% without change to the debt maturity schedule. The use of these bonds should be investigated as a potential source of capital. The effects of such a large increase in demand for these funds, and the possible implications of such use should also be delineated in this investigation.

There is a very substantial investment in energy distribution systems in New England. Over the years, New England has developed a mature and relatively efficient system for distributing:

1) Liquid hydrocarbons, including gasoline, home heating oil and residual oil;

2) Electricity generated from nuclear plants, hydroelectric plants and plants fueled by solid or liquid hydrocarbons;

3) Natural Gas;

4) Coal.

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[1]Charles H. Lee, Jr and Thomas J. Healey, "Project Financing of Large-Scale Energy Programs," *Public Utilities Fortnightly*, April 14, 1977, p. 19.

[2]Ibid, p. 21.

Naturally, there is concern over whether the financing needs of these distribution systems can be met in the future. Due to the quality and flexibility of existing highway systems and the seasonal need for certain hydrocarbon products, the only major potential changes in the distribution pattern which appear to require financing follow.

1) Pipelines and other Oil Facilities

At the present time, the vast majority of liquid hydrocarbon products are received from tankers and barges at various terminals and distributed by trucks to end users. In the future, the growth of product pipelines throughout New England could be the most efficient method of distribution, however, this assumes that the Colonial Pipeline can be and will be extended to New England. This pipeline is presently being substantially expanded from a throughput standpoint. However, the expansion has terminated in Virginia, due to opposition from the Philadelphia area refiners. Some groups, including Massport, are studying the use of an offshore facility for large product tankers including additional terminal facilities; however, the extension of the Colonial Pipeline would probably make this project uneconomical. Limited discussions with major terminal operators favor extension of the Colonial Pipeline as the most efficient means to serve the region rather than further development of the waterborne transportation system. In the event crude oil is discovered in the Atlantic Ocean, it is quite possible that refineries and related processing plants will be built in New England. This would create a need to finance such plants as well as pipeline systems to distribute the product on the most economical basis.

2) Electric Distribution

The electric distribution system is well established with the existing transmission lines and interconnections with grids in other regions. As a result, it is unlikely that there would be any significant distribution changes unless New England becomes a major net exporter of electricity. New England could only become a net exporter if large numbers of electric generating plants were built along the Atlantic Ocean, as some people have suggested. Electricity demand growth together with the need to replace obsolete plants will require financing. This financing should be possible within the existing financial market structure, assuming the projects are financially and economically viable. Some small utilities in New England are experiencing bond rating problems today as a result of unrealistic rate structures as well as outmoded generating plants. In the future some sort of governmental assistance may be needed to assist these companies in obtaining from the private capital market the funds necessary for expansion.

3) Terminals

At the present time, it is almost impossible to obtain the necessary permits to build new terminals for refined products or liquified natural gas. Many people have suggested that additional terminal space is required in New England for emergency storage to prevent consumer shortages due to prolonged adverse weather. Independent studies by various terminal operators indicate that there is ample storage to meet existing needs. In the event that one or more levels of government feel that emergency storage is required, a government guaranty of that will cover loans for the construction of terminals, financing of the product, and a guaranteed rate of return to the private operators who might be willing to build, supply, and operate the terminals will undoubtably be required.

4) Coal

Today New England consumes a relatively small amount of coal as a feedstock for utility boilers. Any extension of the use of this fuel would require substantial financing for

the building of railroads, development of coal slurry pipelines and possibly inventory financing for utilities. Again, the premise of economic and financial viability will determine the cost and the availability of financing. Based on the condition of the existing transportation network in the Eastern Region of the United States, the Committee does not feel that there will be a rapid increase in the use of coal other than at utility generating plants located close to water, where the DOE might mandate use of coal (assuming the cooperation of the EPA on emission standards).

III. Community-Scale Energy Projects

The second section of this report addresses energy projects at the neighborhood or community-scale. Innovative existing and planned projects include: low-head hydro dams (e.g. Springfield, VT.); wood-fired power plants (e.g. Burlington, VT and Lincoln, ME); cogeneration/district heating (e.g. systems employed in Sweden and Nashville, TN); Integrated Community Energy Systems (e.g. those designed under Department of Energy sponsorship); community-scale solar collector distribution (e.g. Santa Clara, CA's lease program); windmills (e.g. Block Island, R.I.); the building (or retrofitting) of large community buildings to be maximally energy-efficient (e.g. Wilton, ME's sewage treatment plant); and resource recovery systems (e.g. Saugus, MA and Bridgeport, CT).

Many such ideas have been proposed in recent years and some are underway as demonstration projects. Undoubtably many more unique, "one of a kind" installations will be undertaken in New England, financed by federal grants. However, there may be difficulties in attracting financing from conventional sources for large numbers of community-scale projects. Before we highlight these problems, a brief description of the financing mechanisms available is in order.

There are numerous existing mechanisms for financing community-scale energy projects. These mechanisms have been utilized by local governments and private companies for years. However, many of the community-scale projects mentioned above are new and innovative. For these projects, innovative financing mechanisms may possibly be needed.

There are two general areas of financing available for creating and building community-scale energy projects or systems; 1) mechanisms utilized by a private corporation; and 2) types of financing available to a local government.

Private corporations have access of a large variety to funding sources. Corporations are able to finance projects by internal cash generation, by floating bonds, by raising capital through stock issuance, and/or by borrowing from financial institutions. However, private corporations infrequently operate community energy systems. While there are many instances of private corporations providing services to communities in areas other than energy (e.g. trash collection, ambulance service, private transit companies, and private fire departments), few companies are willing at the present time to undertake the perceived risk involved with the relatively new concept of community energy systems.

Local governments, on the other hand, have been very active in community energy projects. An example of this interest is the major study commissioned by the city of Seattle of potential energy demand and supply scenarios in 1975.[1] Another example is the Burlington Electric Department retrofit of an existing 10 MW coal-fired plant to accept wood chips. Communities also have had experience with various public finance mechanisms for many years.

Local governments can obtain money to purchase energy facilities from two sources: current revenues and borrowing. Current revenues can be used to purchase and pay in full as the expenditure is made. "Its principle advantage over other forms of financing is its simplicity. It

[1]*Energy 1990*, City of Seattle commissioned study prepared by Mathematic Sciences Northwest, 1975.

Table 1
Financial Options

	Public Financial Instruments	Private Financial Instruments
Project Financing	Option 1 Revenue Bonds	Option 2 Pollution Control Revenue Bonds (without pledge of corporate general obligation)
General Obligation Financing	Option 3 Municipal General Obligation	Option 4 Corporate Bonds Pollution Control Revenue Bonds (with pledge of corporate general obligation)

Source: U.S. Environmental Protection Agency, Office of Solid Waste. *Resource Recovery Plant Implementation: Guides for Municipal Officials, Financing.* SW-157.4; 1975.

requires few institutional, informational, analytical, or legal arrangements. However, it is dependent upon the community's ability to raise surplus capital, and, therefore, may not be feasible to finance 'big ticket,' capital-intensive purchases."[1] In addition, the purchase of expensive energy equipment might not be politically expedient nor economically feasible in the face of the present Proposition 13 fiscal conservatism.

Due to these constraints, a community will likely have to borrow the necessary funds to purchase the energy equipment. There are three categories of borrowing options for local governments:

1) Short-term options — (1 to 5 years) to purchase assets that cost less than $500,000.

2) Medium-term options — (5 to 10 years) to finance capital purchases between $500,000 and $1,000,000.

3) Long-term options — (10 to 30 years) to finance capital purchases over $500,000.[2]

The use of short-term and medium-term financing mechanisms presents problems to a community because of their large demand on a community's cash flow. Conventional bank loans and leasing agreements are examples of the various mechanisms which are included in these categories. Long-term options, on the other hand, do not overly strain a community and they spread the repayment of the principal over a long period of time.

Long-term municipal financing mechanisms can be further divided into project (revenue bond) financing and general obligation financing. Table 1 illustrates the various options, both public and private.

[1]Randol, *Resource Recovery Plant Implementation: Guides for Municipal Officials*, USEPA, 1974.
[2]Ibid., p. 4.

Project financing is based on the revenues which are produced by the provision of a service. "With project financing, the bond principal and the interest payment are guaranteed by expected revenues (dump fees and recovered product sales). The expected revenues must offset all future operating and capital recovery costs."[1] In the case of an energy producing facility (e.g. municipally-owned low-head hydro plant), the revenue could take the form of user fees or utility rates. There are two types of revenue bonds that could be utilized by a community: municipal revenue bonds and industrial revenue bonds. Municipal revenue bonds are issued by municipalities, authorities, or quasi-public agencies. Industrial revenue bonds are issued by a municipality on behalf of a private enterprise.

Municipal revenue bonds are based on the feasibility of the particular project which is being financed. The revenue bond circular that is provided to investors contains all the pertinent information about the technical and economic feasibility of the project. The effective minimum offer is $1,000,000 and the interest rate is slightly higher than general obligation bonds. A study done in Santa Clara by S.S. White on municipal solar collectors dealt with the tax exempt bonds. The study states that "in order for municipalities to avail themselves fully of bond issuance authority for financing solar facilities, the provisions of the Internal Revenue Code relating to the exclusion of interest on municipal bonds should be amended to include, among the exempt facilities, facilities for the furnishing of heating and cooling by solar energy."[2] Therefore, although most municipal bonds are tax exempt, there could be cases, at present, where the tax-exempt status does not pertain to the financing of a community energy project.

Robert Randol has compiled a list of the characteristics of municipal revenue bonds:

- voter approval is not required
- municipal debt limitations do not apply
- financial responsibility is encouraged
- revenue bond issuance requires detailed information
- the minimum size offering is $1,000,000
- the interest rates are higher than those of general obligation bonds
- they may only be used to finance one project[3]

Industrial revenue bonds (IRB) and Pollution Control Revenue Bonds (PCRB) are issued on behalf of a private corporation. PCRBs are not, however, applicable to most energy projects because facilities are required to have over 65 percent post-consumer solid-waste inputs. Industrial revenue bonds are directed at industrial development. "With an IRB, the municipality technically owns the facility and equipment which it then leases to the private firm. The lease payments are specified to meet the scheduled payments of debt and interest on the bond."[4] Many of the same characteristics of municipal revenue bonds are shared by IRBs. The two major differences are that IRBs finance the construction of a facility by a private corporation and that the use of IRBs is limited by statutes on their use for entry into lengthy service contracts.

General Obligation Financing, on the other hand, is based on the credit worthiness of the local government. Specifically, General Obligation bonds are secured by the full-faith-and-credit of a political jurisdiction, i.e., the general revenues of that jurisdiction. These bonds are tax-exempt

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[1]Ibid, p. 4.

[2]S.S. White, et. al., *Santa Clara, Community Center, Commercial Solar Demonstration Legal Alternatives, Implications, and Financing of Solar Heating and Cooling by a Municipal Corporation*, City of Santa Clara, 1976.

[3]*Ibid.*, p. 6.

[4]Robert E. Randol, *Public Financing Options*, May 23, 1974, p. 12.

and are competitively bid on by underwriters.The interest rate on the bond is based on the credit rating of the community.

The fact that General Obligation bonds are secured by the full-faith-and-credit of the community is important for community energy projects. Until more technical and economic information concerning community energy projects is generated through experience with demonstrations, General Obligation bonds probably will be the only avenue of financing available. Nevertheless, as was mentioned previously, the increasing fiscal conservatism of the general population could obviate a community's investment in these energy projects. This restriction results from the voter approval process that is required for these bonds. Clearly, demonstration projects and educational efforts are needed to increase public and financial acceptance.

In addition to these familiar financing methods, new and innovative financing methods need to be devised. There are at present few examples of innovative solutions. This lack of examples results from: 1) the small number of existing community energy projects; and 2) the adequacy of conventional public financing methods. The City of Santa Clara, one of the examples of working systems, finances its leasing of solar collectors program by borrowing funds from the city's water utility reserve fund.[1] This form of financing is an example of utilizing current revenue sources. Therefore, education and legislation to change existing laws are a more immediate priority than devising new financial methods.

There are numerous problems with the financing of community-scale projects. The traditional sources of capital are less familiar with the risks and problems attendant to such installations and have less enthusiasm for becoming involved. While the total dollars needed to finance projects in this category between now and 1985 may be substantially smaller than for large scale proposals, it is possible to justify some of these units. Hence, adequate financing should be provided. There is a strong probability, however, that the private sector may not provide this funding, or would not provide it without government guarantees to minimize risk and interest rates high enough to cover the added costs of servicing a non-traditional project. A further concern would be the likely technical obsolescence of relatively untried and untested units of this scale in their early years. Special financing arrangements outside those of the traditional marketplace would therefore be called for.

The major factors inhibiting conventional financing of unconventional projects are shown in Table 2. Each project will probably have to jump several of these hurdles before it achieves adequate financing.

The federal government can do relatively little to ease some of these problems. In most cases, however, indirect federal actions can be effective, and in a few cases direct federal action is called for. The following general types of remedies are discussed further below:

A) Education

B) Accelerated technological readiness

C) Regulatory "reform"

D) Institutional accommodation

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[1]Personal communication with the Santa Clara Water Dept., Jan. 5, 1979.

Table 2

Problems In Financing Community-Scale Energy Systems

1) Low financial rewards for investment (low rate of return).

2) Tremendous uncertainty as to the project's viability in the face of a plethora of regulatory delays and burdensome requirements for impact analysis.

3) Lack of clear picture of where the community system fits into an overall state or regional energy plan.

4) Lending institutions' unfamiliarity with such projects.

5) High relative cost of projects which are undertaken early in the history of a technological development (e.g., when oil burners were first introduced in the 1920's, they cost around $2000 — about $8000 in today's dollars).

6) Technical innovativeness (and hence greater risk) of the project.

7) Scale of project may be too large for the small investor, and too small for the major investors.

8) Lack of familiarity on the part of communities with the full range of possible financing options.

9) Institutional problems due to entrenched interests defending themselves against perceived threats to their markets.

10) Difficulties in working out acceptable inter-community agreements for purchase and sale, cost and risk-sharing, etc.

11) Lack of front-end capital to "weather" the aforementioned delays and finance the necessary analytical reports.

12) Local environmental objections.

13) Local concern about property values.

14) Lack of consumer sympathy with the notion of "higher first cost but lower life-cycle cost."

A) Education

Clearly, some problems can be partially solved by effective information-sharing, in which the federal government could assume the role of "knowledge broker." This could be achieved through work with such organizations as trade associations and state energy offices. Problems 3, 10 and 14 are partially resolveable through this means. Perhaps planning funds would be provided by the new State Energy Management Planning Act. Resource recovery systems provide a useful source of information which can be extended to other systems. (See table 1.)

B) Accelerated Technological Readiness

Problems 5 and 6 can be most effectively solved by improvements in the state-of-the-art of community-scale energy technologies. The Department of Energy should devote more time, thought, and funds to the following activities:

1) Researching the total contribution which could be made by such systems.

2) Funding more demonstration projects at the community or neighborhood-scale.

3) Encouraging commercialization[1] of community-scale systems with the same enthusiasm and analytical effort as currently expended on systems for homes, farms and factories.

4) Creating a package of financial incentives for such systems as are proven to be successful.

C) Regulatory "Reform"

In its own regulatory activities, and in analyzing and informing those of state and local governments, the federal government should bear in mind the special hurdles faces by community or neighborhood-scale systems, particularly problems 1, 2, and 11. Regulatory agencies can allow higher rates of return in innovative community-scale systems. Complex licensing procedures, basically for large-scale systems, can be simplified for smaller ones (an example is the simplification of small-scale hydro procedures by the FERC). The federal government can, through analysis, determine where state regulatory procedures are sufficient for small-scale systems and avoid imposing an additional layer of procedures. The federal government can help states, again perhaps as a provision of the new State Energy Management Planning Act, to analyze unnecessary state and community-level regulatory hurdles.

D) Institutional Accommodation

There are two kinds of institutional problems: those caused by institutions that see no need to change or do not want to change to accommodate community-scale energy systems (e.g. problem 7), and those caused by institutions that stand to lose if community scale systems are adopted (problem 9). One solution in both cases is to make it attractive for these institutions to be part of the process of community energy system

[1]"Commercialization" is defined here as accelerating the rate and/or increasing the extent of market penetration of systems which have passed the R & D stage and are "market ready".

development, either through financial incentives or through removal of regulatory exclusions. Of course, institutions, like individuals, have differing degrees of innovativeness and adventurousness: some will be easily motivated to get involved with community scale systems and others with great difficulty. The federal government, through analysis, can determine which institutions are causing hurdles to community scale systems and how best to overcome these barriers.

The last three problems (12, 13, 14) are probably not tractable to federal action. The side effects of community scale projects might be unacceptable. Some projects may be poorly designed. Communities should maintain the right to protect themselves against such projects. To the extent that communities' objections are due to lack of information, however, the federal government can assist state and local governments in providing it.

In summary to this section, the federal government can do much to aid the widespread adoption of community and neighborhood scale energy systems.

IV. Consumer-Scale Energy Projects

The third and final section of this report addresses consumer or homeowner-scale energy projects. Systems to be discussed here include water and space heating devices, small-scale wind generators, domestic solar collectors, conservation technologies, and other household energy-producing or energy-conserving projects. These deserve special consideration due to the small size of the financing package required by any single projects and the importance of such projects in the aggregate.

Existing mechanisms have been satisfactory for the financing of conventional energy systems (e.g. central air conditioning of all-electric homes). Financing is readily available from traditional sources because of the widespread usage and acceptance of these systems, combined with their low initial cost. Risk of system failure is viewed to be slight, due to the accumulated track records of these systems. Risk of default is also relatively low, because the purchase of conventional household energy systems generally does not overly strain the financial resources of the purchaser. This is especially true of electric resistance heating which has a low initial cost, but a high annual energy cost. The small loans needed to purchase these systems (if any are required) are easy to pay back.

Alternative energy systems (solar collectors, windmills, new homes with elaborate energy conserving features), on the other hand, are typically high in initial cost, thereby placing more of a strain on the homeowner and causing him to seek assistance from a financial institution. Such systems also do not have an established performance track record. At this time, the financing modes that are available for such innovative systems are not significantly different than those available to conventional energy systems. The existing matrix of initial mortgages, second mortgages, home improvement loans, and personal loans *may* be useful in financing the bulk of the new alternative energy systems. However, the probable use of these mechanisms is conditioned by changes in the terms of these financing mechanisms.

There are, however, several barriers and problems with the financing of consumer-scale alternative energy systems. The first barrier, newness, results from the fact that traditional sources of capital are less familiar with the risks, benefits and problems attendant to such installations. This uncertainty causes banks to be less enthusiastic about financing the systems. This unfamiliarity and perception of risk is due partly to the amorphous, young solar market and the "confused state of the art, variations in equipment, location, installation, durability, climate, and uncertainty about

the behavior of users, i.e. the nature and extent of the market."[1] Financial institutions assume that residential mortgages are stable investments with few foreclosures and low delinquencies. This market is, in short, "an operation generally characterized by high volumes, growing cost and complexity, low margins, and conservative practice."[2] Given these realities of the mortgage market, the reluctance of financial institutions is understandable. They are in the business of achieving a profit, and they will hedge against a risk. Their perception of risk will change as the experiences of alternative energy are documented in sales, in market values, and in proven economic feasibility. Therefore, the commercialization of solar needs to be accelerated to provide a larger and more visible market. Solar, nevertheless, needs to be economically viable in order to be commercialized to a wide extent.

A financial institution's hedging against the risk of an innovative energy system is manifested in lower loan-to-cost ratios and in the tendency to loan only to affluent individuals. The rationale for the first action is the lack of comparable resale data for homes with alternative energy systems. Therefore, to hedge against possible decrease in market value of the house, the bank will leave the cost of the alternative system out of the mortgage amount (i.e. lower loan-to-cost ratio). This tendency, combined with the perception that an affluent individual would be able to carry the burden of large unforseeable maintenance costs in the future, excludes individuals of middle and lower income from owning residential solar or wind energy systems.

The argument over the proper market among income classes has already begun. For example, RUPI, Inc. has stated that "it does not appear appropriate to seek income redistribution objectives in the design of a residential solar energy incentive program today. There are more reliable and cost-effective means for reducing the energy cost burdens of lower income homeowners (particularly conservation measures), and the limited track records of most solar energy systems imply continuing economic risks that seem unwise for families of limited means."[3] Other analysts believe that depriving low-income individuals access is a formula for urban decay and a further increase in energy prices for these individuals.[4]

These problems of initial commercialization are not unique to innovative systems like solar or wind. Barrett, Epstein and Haar in *Financing the Solar Home* state that electric heating faced some of these same problems:

> Although electric heating, with its lower first costs and higher operating costs, now offers the converse of what solar energy promises, some of the problems faced at the outset were analogous to those facing the solar alternative today: uncertainty as to how well a particular system would perform; concern that a "better" system would be rapidly developed and reduce the market value of earlier systems already installed; and the question of marketability and value of the homes involved.[5]

The difference, however, was the provision of financial incentives to home builders by electric utilities in order to increase its acceptance, and the setting of lower, PUC-approved utility rates for all electric homes.

Government assistance would therefore seem to be appropriate in a number of fashions: first, research and development funds which can improve the economy and the performance of the systems; second, unbiased analysis of the quality and reliability of systems and products that employ unconventional energy sources (it should be noted that some solar manufacturers have

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[1]*Solar Energy Incentives Analysis: Psycho-Economic Factors Affecting the Decision Making of Consumers and the Technology Delivery System*, Jan., 1978, U.S. D.O.E., p. 7.

[2]Peter S. Dannon, *Financing Solar System Costs*, Charlestown Savings Bank, Boston, MA.

[3]Barrett & Epstein, *Federal Incentives for Solar Homes: An Assessment of Program Options*, RUPI, Inc., July, 1977.

[4]Barrett, Epstein & Haar, *Financing the Solar Home: Understanding and Improving Mortgage Market Receptivity to Energy Conservation and Housing Innovation*, RUPI, Inc., June 1976, p. 49.

[5]Steven Ferry, "How Carter's Solar Program Could Eclipse the Cities," *Planning*, Dec. 1978, p. 20.

complained that the present HUD certification program is in some ways too rigid, and may be needlessly driving up the price of these units.); and third, demonstration programs that bring the new technologies before the eyes of financiers and other members of the public.[1]

Hopefully, programs of this sort will first bring new technologies to a condition in which they are ready for mass markets, and then develop the investor and consumer confidence necessary to bring them into widespread use. The second barrier to financing consumer-scale alternative energy systems is their smallness. A major problem here, particularly with conservation programs, is that the projects undertaken by homeowners require an investment of less than $1000. The unfortunate fact is that most banks lose money on direct loans of this size or less. It is costly to process a residential mortgage. The average size of a residential mortgage covers the costs of application, review of credit standings, etc. With a small loan, these costs are proportionately greater. For loans of $1000 or less the effective break-even interest rate annually is between 17-25%. (One study by the Federal Reserve Bank indicates that banks would need to charge nearly 20% on a $750 monthly installment loan with a term of 24 months.[2]) Given these costs, it is understandable that banks are reluctant to service small energy loans which in turn lowers the number of these energy projects that are undertaken. Energy conservation measures which are economically attractive because of their short paybacks are particularly hurt by this reality. They usually cost less than $1000, but are too expensive to qualify for most lines-of-credit.

The result of this situation is that interest rates for loans of this size, a priority item in any energy policy, are significantly higher than the rate for large-scale, capital borrowing. These high interest rates will probably forestall a great deal of potential borrowing for these purposes. Furthermore most banks and other lending institutions have not actively promoted loans for conservation and alternative energy projects at the individual level.

A third barrier is motivational. There is widespread reluctance among banks to the creation of special loan programs. This characteristic is a result of practical differences encountered in these programs and of traditions in bank practice and philosophy. Financial institutions provide necessary capital to individuals and organizations that demonstrate the ability to repay the loan. The financial institution analyzes this ability to repay by investigating the credit rating of the individual, or the financial status of a company or an organization. "The demand for bank services tends to be derived from that for the specific goods or services being acquired by consumers, and not the other way around."[3] Therefore, banks are extremely reluctant to adjust their finance terms to stimulate the demand for a commodity. In addition, the creation of a special energy loan program costs money and time. The bank is not entirely sure that there will be demand for these special services. The question is, briefly, "Can the tail wag the dog?"[4]

One further problem with current lending practices is that lenders do not usually include energy costs in the monthly housing expense used in determining a borrower's ability to meet his or her mortgage payments. Presently, if the total monthly principal, interest, taxes and insurance payments for a home (the PITI ratio) is less than 25% of an individual's monthly pre-tax income, the bank will usually finance the mortgage. A more comprehensive and contemporary measure of an individual's ability to meet mortgage payments would include increasing residential fuel costs. The inclusion of energy costs in this determination would effectively increase the loan amount available to eligible individuals and cover the higher costs of installing solar equipment. It has been suggested that the federal government should work with lenders to overcome difficulties associated with switching to this method of analysis.

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[1]Demonstration programs may employ a variety of subsidies, including direct grants, special tax incentives, and loan guarantees.

[2]"Innovative Financing: Banks and Energy Conservation", for D.O.E., May, 1978.

[3]*Ibid*, p. 51.

[4]*Ibid*, p. 57.

Several methods of getting more capital from conventional sources flowing into conservation and small-scale energy projects have been suggested. One is government guarantee of loans made for these purposes. A major hurdle here is the negative feelings many lenders have with regard to participating in any program of loan insurance, managed by a government entity, e.g. student loans. Negative sentiment towards FHA was the result of the difficulties encountered with federal housing guarantee programs in the past. Many lenders feel that for this kind of program to work, the administering government agency should not be involved in underwriting, or direct review of the underwriting of the total mortgage on a project that will use solar or other such technologies. They would prefer to operate under an arrangement in which the government establishes ground rules, including perhaps performance criteria for equipment and systems, and the lenders can then administer the program within this framework.[1]

One positive step, which has just been incorporated in the National Energy Act, is a raising of the present ceiling on federal mortgage insurance for homes with solar equipment by 20%.[2] This will increase the proportion of the cost of solar homes that can be financed as compared with conventional financing. It should be noted that the impacts of this change will be limited to the small fraction of homebuyers that use FHA programs, and that some believe that those involved in these programs (i.e., lower and moderate income) may not be very inclined to opt for solar technology.

Another loan guarantee approach is "top part of the risk" mortgage insurance. This kind of program insures lenders against losses up to a certain portion of the total mortgage, and relies on lenders for appraisal and underwriting. In a survey of lending institutions by RUPI, Inc., this "top part of the risk" approach was felt to be desirable and efficacious by a majority of the lenders surveyed.[3] The main rationale behind this type of program is the reduction in loan down payments on solar and alternative energy mortgages. The potential decrease in value or the possibility of default, that the lender had hedged against, is insured in this program. The lowered down payment consequently increases the number of potential alternative energy users. A V.A. program and the practice of private mortgage insurance companies (PMIs) exemplify "top of the risk" mortgage insurance. The V.A. loan program guarantees loans for veterans for the first 60% of loans up to $17,500. The PMI's insure the payment of the top part of a loan. The proportion that is insured can range from 5 to 25% of the principle outstanding on loan-to-value ratios of 60 to 95%.[4]

Conversion insurance is another concept that merits consideration. This would involve arrangements for reimbursing lenders for any special costs that resulted from preparing a solar home for resale following foreclosure. This type of program is important because of its psychological effect on lending institutions. Due to their uncertainty over the frequency of foreclosure on houses with innovative energy systems, lenders tend to avoid lending money in these instances. "Insofar as such insurance insulates the mortgagee from specific risks (e.g., total system failure, technical obsolescence), it should eliminate the tendency to discount for these risks in the overall property appraisal or to offer a lower than usual loan-to-value as a hedge against these specific uncertanties."[5]

Another measure included in the NEA is authorization for the Government National Mortgage Association to purchase mortgages on solar equipped homes. The program approved by Congress would result in interest rates for solar homes in the range of 7%-12%, as well as increasing the amount of capital available for solar homes.[6]

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[1]Further information can be found in Barret, et. al, *Financing the Solar Home*, p. 18B-190

[2]Title II, Part 3, Sec. 248 of P.L. 95-619. The National Energy Conservation Act of 1978.

[3]*Ibid.*, p. 193.

[4]*Ibid.*, p. 193.

[5]*Ibid.*, p. 200.

[6]Title II, Part 3, of P.L. 95-619.

In addition to various financial incentives, government can bring to the attention of banks and other traditional lenders programs that have been or could be employed by lending institutions that are good for business, as well as conductive of additional use of conservation and solar technologies.

Banks can also be encouraged by government education programs to try campaigns for promotion of conservation and solar loans that have proved effective elsewhere. For instance, some lenders have offered mortgages with lower down payments or reduced interest rates for the purchase or refinancing of homes meeting certain energy efficiency standards. Others have developed coordinated marketing strategies with utilities, insulation contractors, and hardware outlets, thereby providing to the consumer "one stop shopping" that includes financing. The provision of a direct line of credit to conservation and solar contractors and the development of common financing packages with forms geared to particular kinds and sizes of energy projects is another approach. Some are thinking of working with large employers to develop financing packages for conservation/solar options for their employees, perhaps including payroll deduction plans and other mechanisms designed to reduce administrative costs to the lender. The formation of "energy conservation and solar loan pools," modeled after "high risk loan pools," might prove worthwhile.

The most successful bank energy program has been the Seattle Trust and Savings Bank. The success of their program is a combination of "its comprehensiveness and the quality of its technical supporting materials."[1] The program was designed by independent energy and advertising professionals. Most of the unsuccessful programs of lending institutions did not contain these essential characteristics of comprehensiveness and support.

In addition to these approaches which have focused on traditional private lending sources, there are other avenues involving private and public institutions.

On the federal level, the recently passed "Small Business Energy Loan Act" requires the Small Business Administration to make loans directly (and in conjunction with other lending institutions) "to assist small business concerns in financing" a range of facilities based on renewable sources of energy. This program provides direct loans of up to $350,000 and guaranteed loans of up to $500,000. The basic purpose of the loans are to finance plant facilities and the acquisition of equipment and supplies in the act's specified energy measures. Non-federal sources must be used prior to SBA loans or guarantees and the loans may have a maturity of up to 15 years.[2]

An often discussed concept is having private electric and gas utility companies become involved in the financing of conservation/solar projects for individual homes and businesses. Here the customer would pay for the installation over a period of time in the form of a surcharge on his/her electric bill that represents either a lease payment or an installment payment. The advantage of this kind of scheme is that utilities have access to large amounts of capital which they can make available to solar/conservation programs and that their existing billing process provides the necessary administrative apparatus. (It is felt by some that it would be easier for utilities to make a profit on making these kinds of loans than could traditional lending institutions, since they already have incorporated into their operation the cost of collecting monthly payments from their customers.)

Despite the above-mentioned benefits, most consumer/environmental groups have argued against direct utility involvement in the ownership, installation, or financing of conservation/solar systems for individual households and businesses. Concerns include: fears of excessive profit taking aroused partly by a Federal Energy Administration plan that called for utilities to get a 17% return on investment for customer insulation programs; monopolization of the solar field by utilities; and what is seen as the utility industry's generally negative attitude about alternative

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[1]*Innovative Financing, Op. Cit.*, p. 43.

[2]P.L. 95-315, 92 Stat. 377.

sources of energy and conservation. A consequence of these concerns is that the NEA generally prohibits utilities from directly installing or loaning money for conservation/solar systems at the homeowner level.

One alternative that reduces some of the concerns expressed about having private utilities heavily involved in the solar/conservation financing business is to have public utilities take on this responsibility. For instance, the municipal utility in Santa Clara, California, has a program of purchasing solar equipment wholesale, and then leasing it to homeowners that provides financing equivalent to a 10-year loan at 7 1/2%.

All of the above programs have been presented with the focus on lending insitutions. It should be remembered, at this point, that all the incentives in the world will amount to nothing if consumers are not willing and able to take out financing for conservation/alternative energy projects. Increasing consumer demand is the critical first step in improving the climate for financing of these desirable technologies.

Increasing consumer demand has two components. First, greater consumer awareness of these technologies and enhanced consumer confidence in their effectiveness. Second, overcoming the barrier presented by the high initial costs and long payback period of these systems.

The various loan programs discussed above address the initial cost problem. By allowing consumers to pay for these systems over an extended period, one can make them much more accessible to the average person. For some, lower interest payments are a significant attraction, but most consumers will not care much about the difference between a 15% and 10% interest rate on a $1000 loan if they must pay it back within 6 months or a year. The reason is simple—most people cannot afford to look at the long-term savings represented by a somewhat lower interest rate. They have to deal in terms of their month-to-month cash flow. If the financing for a solar hot water heater can be worked out so that the monthly installment is the same or less than what conventional hot water heating costs, then once consumers are aware of these economics, they should flock to banks and other lenders to request loans with which to install solar systems.

One final incentive for potential conservation/alternative energy customers is a front-end subsidy. These include direct grants such as the HUD Solar Hot Water Demonstration Programs, and tax credits like those included in the just-passed National Energy Act. There are some questions about how many consumers will actually be able to benefit from these programs as they seem to be of greater use to those in the higher income brackets. Again, the key seems to be having a combination of factors that result in the week-to-week and month-to-month cost of the financing of unconventional technology being the same or less than the cost of using conventional energy sources.

APPENDIX I

For purposes of clarity and expediency all recommendations of the Energy Congress have been categorized by subject matter to aid public officials, representatives of the private sector, and interested citizens to identify recommendations of particular interest. Committee recommendations that are relevant are listed under each category and the recommendation itself can be found at the beginning of each committee report or package report.

FEDERAL RECOMMENDATIONS

Loans

Joint Alternatives: II.A.2., V. 4
Demand: 2
Residential Package: 2

Loan Guarantee

Joint Alternatives: I.A.3, I.B.1, IV. 2 & 3

Grants

Joint Alternatives: IV.2, VI. 4-7, X.1

Tax Credits

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N.B. Approximately 25 additional recommendations concerning small-scale hydro are included on the report of the Supply Committee (pp. 18-20).

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APPENDIX II

The final recommendations contained within this report reflect comments of numerous individuals who reviewed the *Preliminary Report for Public Review* of the Energy Congress. This *Preliminary Report* was published in November 1978 to encourage public comment and to aid the Energy Congress delegates in formulating their final recommendations.

The *Preliminary Report* was released at an all day convention in Boston on December 2. Present were more than 100 delegates, six members of the U.S. Congress, one U.S. Senator, five state legislators, the Directors of the six New England State Energy Offices, as well as representatives from various other political constituencies. Each of the six Energy Congress Committees presented its findings and recommendations in a morning session, and five panel discussions were held in the afternoon. Stuart Eizenstadt, Assistant to the President for Domestic Affairs and Policy, addressed the group in the evening.

Six public hearings were held between December 5 and December 15, one in each New England State, and individuals/organizations were encouraged to submit written/oral testimony. Present at each of these hearings were delegates from the host state representing each committee of the Energy Congress, as well as the entire Energy Congress staff. Transcripts of the testimony were made to ensure careful review of all comments.

Written commentary was accepted through the end of January. More than 150 letters were received and reviewed by staff and delegates.

The names below are those individuals who commented on the *Preliminary Report for Public Review* at one of the six state hearings, sent written comments, or both.

Penti Aalto
Braintree, MA
Nancy Alexander
Energy Unlimited, Inc., New Britain, CT
American Society of Mechanical Engineers,
Boston, MA
G. A. Anderson
Medomak, ME
Ray Anderson
Info Line, Norwalk, CT
Bruce W. Andrews
Scientific Atlanta, Burlington, MA
Mrs. Warren P. Armstrong
Friendship, ME
James W. Ashley
W. Danville, VT
Philip Ashton
IEEE Power Engineering Soc., Hartford, CT
Thomas E. Baroody
Stamford, CT
William R. Barton
U.S. Dept. of Interior, Newmarket, NH
John Bickel
Windsor, CT
Robert Blakeney
Concord, NH
Roger Bloomfield
Neill & Gunter, Portland, ME
James Bolton
The Insulation Inspector, Fairfield, CT
John Boultbee
Riverside, CT
Prof. Gilbert Brown
Mass. Voice of Energy, Boston, MA
Peter Brown
Franklin Pierce Law Ctre., Concord, NH

Richard C. Carlson
SRI International, Menlo Park, CA
Dominique P. Casavant
Vermont Joint Energy Comm., Winooski, VT
Robert E. Charlton
Billerica, MA
Stanley Chew
Alternative Directions in Energy & Economics, Inc., Providence, RI
Tom Chmuna
Rhode Island DPU, Providence, RI
Daryl James Christopher
Waldoboro, ME
Eric P. Cody
Watertown, MA
Robert Cox
New England Intervation Group, Providence, RI
Samuel Cropwley
Topsham, ME
Joseph P. Cusker
New England Land Grant Univ., Durham, NH
Duane Day
Dept. of Energy–Region I, Boston, MA
Nancy DeWick
Maine League Women Voters, Woolwich, ME
Mrs. Lewis A. Dibble
Coalition of Conn. Bicyclists, Naugatuck, CT
James G. Doran
Power Engineering Society, Burlington, MA
N. R. Dorrance
IN-O-VEN Corporation, Riverside, CT
Patrick F. Doyle
Boston Edison Co., Boston, MA
William Duessing
Oxford, CT
Susan Durham
League of Women Voters, Holden, MA
John C. Dyer
Rowayton, CT
Robert L. Elgin
Cambridge, MA
Zandra Eliott
Sturbridge, MA
Henry J. Ellis
Public Service Co. of NH, Manchester, NH
Sidney Evans
American Natural Energy Centers, Bridgeport, CT
Charles A. Falcone
Dept. of Energy, Washington, DC
John Flamert
Derby, CT
Mrs. George B. Forbes
Waldoboro, ME
Bernard Fox
Northeast Utilities Service Co., Berlin, CT
John D. Freese
Penquis C.A.P., Inc., Bangor, ME
Nat Frothingham
VT Nat'l Resources Council, Montpelier, VT
Joseph G. Gallagher, P.E.
Sherborn, MA
Daniel Gans, Jr.
Milton, MA
Edward Ganshirt
Lexington, MA
Robert Gardiner
Natural Resource Council of Maine, Augusta, ME
Kirk Gardner
R.P.D., Plainfield, VT
Daniel E. Geer, Jr.
Cambridge, MA
John W. Germond, PE
Auburn, ME
Rev. James Gilchrest
Congregational Church, Norwalk CT
Lucius Gilman
Francestown, NH
Dave Goldberg
Program Planning Development Association, Montpelier, VT
Wilfred Hall
Portsmouth, NH
John N. Harris
International Generation and Transmission Co., Berlin, NH
Philip Hastings
Central Maine Power, Augusta, ME
Robert Haven
Dresden, ME
Dr. David I. Heimann
Dept. of Transportation, Cambridge, MA
Irene Hermanson
Worcester County Extension Service, Worcester, MA
Brenton R. Hill
IEEE–Power Engineering Society, Augusta, ME
Amos M. Hilton
Roslindale, MA
James Hoeveler
B.I.A., Concord, NH
Donald Humphrey
South Hamilton, MA
Charles E. Hurley
United Assocation, Auburn, ME
Frederick E. Hutchinson
University of Maine, Orono, ME

Joesph L. Ignazio
U.S. Army Corps of Engineers, Waltham, MA
Dante Ionata
Rhode Island Governor's Energy Office, Providence, RI
John Jankus
Wormser Scientific Corp., Stamford, CT
Richard Jensen
Tack Force on Human Needs, Auburn, ME
Mansur Johnson
Alternative Directions for Energy & Economics, Hull, MA
Ray Joslyn
Gardiner, ME
Andrew Kadak
New England Power Co., Providence, RI
Mrs. Joyce C. Kathan
Prospect, CT
W. Robert Keating
NE Regional Commission. Boston, MA
Francis H. Killorin
SOLAR SEVEN, Duxbury, MA
Gerald Koeppl
Queens College, Flushing NY
Harlan Lachman
Bennington-Rutland Opportunity Council, Rutland, VT
Kenneth F. Lancaster
Portsmouth, NH
Joseph D. LeBlanc
Central Maine Power Co., Augusta, ME
Robert Ledoux
Bridgeport Area Chamber, Bridgeport, CT
Henry Lee
Mass. Energy Office, Boston, MA
Alan Lishness
Maine Audubon Society, Falmouth, ME
Arthur D. Little, Inc.
Cambridge, MA
George Longenecker
Central VT Safe Energy Coalition, Montpelier, VT
Jack McCarthy
Bridgeport, CT
Daniel McConaghy
IEEE–Power Engineering Society, Warren, RI
Phil McDonough
S.A.P.L., Portsmouth, NH
John McGeorge
Norwalk, CT
John Mahony
Roslindale, MA
Theodore R. Malloch
Gordon College, Wenham, MA
Jeffrey B. Marsh
Boston Edison Co., Boston, MA
Jim Marshall
East Providence, RI
David B. Master
Milford, NH
John Mayer
Worcester Polytechnic Institute, Worcester, MA
Don Megathlin
City of Portland, Portland, ME
Eugene Melinsky, Sr.
Bridgeport, CT
Tom Miller
University of Lowell, Chelmsford, MA
Mrs. Jean S. Murphy
American Assoc. of Univ. Women/Mid-coast Maine
Mrs. Nell E. Munson
American Assoc. of Univ. Women/Mid-coast Maine
Jesse Nalle, Exec. Dir.
Gtr. Bridgeport Regional Plan, Bridgeport, CT
R. W. Newman
Stamford, CT
Donald T. Nightingale
Vermont Castings, Inc., Randolph, VT
Robert Noyes
Dept. of Human Resource, Concord, NH
Robert O'Brien
Tunbridge, VT
Sara O'Brien
Alternative Directions in Energy Economics, Providence, RI
James O'Donnell
City of Portland, Portland, ME
Carl D. Orio
IEEE Energy Committee, Andover, MA
Tonis Ots
Teledyne Laars, No. Hollywood, CA
Richard L. Ouillette
Thames Valley Council for Community Action
Brian Pake
Community Development Dept., Jefferson, NH
Edwin B. Palmer
Newburyport, MA
John Parrotta
Andover, MA
Dan K. Phalen
North Falmouth, MA
James Platts
Newington, CT
A. Paul Priddy
Chas. T. Main, Inc., Boston, MA
Jeffrey W. Raynes
Yarmouth, ME

Kenneth F. Reinschmidt
Littleton, MA
Clinton A. Renfrew
Norwich University, Northfield, VT
Michelle Riba
Connecticut Conference of Municipalities, New Haven, CT
D.W. Robinson, Jr.
Kaman Aerospace Corp., Bloomfield, CT
Edward W. Robotham
Westport, CT
Gerard Roaccapriore
Meridan, CT
Glenn A. Rogers
HUD-Region I, Boston, MA
Rod Ross
Tri-County CAP, New Berlin, NH
Robert Roth
Low Income Planning Agency, Hartford, CT
Ray A. Rothrock
Westboro, MA
Robert Rowe
Boston University School of Law, Boston, MA
Robert H. Rowe
Woodbury & Rowe, Milford, NH
James M. Rubens
NECNP, White River Junction, VT
Thyral Salonen
Waterbury, CT
Kathy Satterson
Arlington, MA
Michael Schedler
Committe on Training & Employment, Stamford, CT
Barry Schiller
Ecology Action for R.I., Providence, RI
A.P. Schmidt
Unique Energy Systems, Inc., Holyoke, MA
Greg Schulz
Rural Housing Institute, So. Paris, ME
Rick Schwolsky
N.E. Solar Energy Association, Brattleboro, VT
Jeffrey Serotkin
Rockingham County CAP, Newmarket, NH
Jim Sheff
Dracut, MA
Stanton Sherman
Center for Energy Economics, Stow, MA
Maryanne Shields
Dorchester, MA
Bruce Sloat
Governor's Commission on Hydropower, Lancaster, NH
Douglas V. Smith
Upper Valley Energy Coalition, W. Lebanon, NH
Leonard Smith
Hudson, NH
Llewellyn C. Smith
City Council, Portland, ME
Richard R. Stewart
Southern Connecticut Gas Co., Bridgeport, CT
Sam Stokes
N.H. Assoc. of R.R. Passengers, Alstead, NH
Art Strenkert
Energy Coordinator, East Norwalk, CT
John Sullivan
First Selectman, Fairfield, CT
John Sununu
Salem, NH
Elizabeth Swain
Maine Audubon Society, Falmouth, ME
R.C. Teitsworth
Darien, CT
Craig A. Thomson
Amtrol, Inc., W. Warwick, RI
James M. Tully
Woodman Assoc., Inc., Wakefield, NH
Charles F. Turner
Amherst, NH
Robert Turner
ERCOM, Augusta, ME
Jacquelyn K. Tuxhill
Audubon Society of N.H., Concord, NH
Dr. Earl M. Uram
University of Bridgeport, Bridgeport, CT
James A. Vail
Newburyport, MA
Barbara Waggoner
Guilford, CT
Charles F. Walters
Dept. of Public Utilities, Wallingford, CT
Jack T. Wark
N.E. Public Power Association, Wellesley, MA
Erin K. Warren
CUOEO, Essex Junction, VT
John Warshow
Plainfield, VT
Washington-Hancock Commision Ag.
Ellswoth, ME
W.W. Wayne, Jr.
Stone & Webster, Boston, MA
Dr. William Wert
Superintendant of Schools, Barrington, RI
Eric Wolfe
American Friends Service Committee, Concord, NH
John I. Woodworth
Hydronics Institute, Berkeley Heights, NJ
Gilbert K. Wooley
Concord, MA

Eric M. Wormser
Wormser Scientific Corp., Stamford, CT
Frank S. Wright
E.S.C. Assoc., N Kingstown, RI
Mrs. Barbara Wyman
Common Cause of N.H., Concord, NH
Harold E. Young
University of Maine, Orono, ME
Frank Zannini
Warwick, RI
Timothy Zorach
Maine Audubon Society, Falmouth, ME

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