BNL 50994

149
4/23/80

Hr. 1084

MASTER

ANNUAL ABSTRACTS OF THE NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS

December 1978

NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS
DEPARTMENT OF ENERGY AND ENVIRONMENT

BROOKHAVEN NATIONAL LABORATORY
ASSOCIATED UNIVERSITIES, INC.

UNDER CONTRACT NO. EY-76-C-02-0016 WITH THE
UNITED STATES DEPARTMENT OF ENERGY

DISCLAIMER

BNL 50994
UC-13
[General, Miscellaneous, and
Progress Reports (Nonnuclear) – TID-4500]

ANNUAL ABSTRACTS OF THE NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS

December 1978

NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS
DEPARTMENT OF ENERGY AND ENVIRONMENT

BROOKHAVEN NATIONAL LABORATORY
UPTON, NEW YORK 11973

NOTICE

Printed in the United States of America
Available from
National Technical Information Service
U.S. Department of Commerce
5285 Port Royal Road
Springfield, VA 22161
Price: Printed Copy ~~$7.25~~ A07; Microfiche ~~$3.00~~ A01

September 1979 285 copies

PREFACE

The National Center for Analysis of Energy Systems at Brookhaven has been in operation since January 1976. The *1978 Annual Abstracts* report illustrates the scope of activities of the Center involving the integrated analyses of technological, economic, environmental, and social aspects of energy at the regional, national, and international levels.

The major ongoing activities of the Center include:

- analysis of energy-economic relationships,
- regional energy and environmental policy,
- comparative health effects of alternative energy systems,
- technology assessment and energy R&D priorities,
- development of energy-economic-environmental models and data bases,
- R&D strategies for International Energy Agency, and
- energy technologies for developing countries.

The objectives of the Center and major accomplishments of 1978 are described in the *Annual Highlights of the National Center for Analysis of Energy Systems*, BNL 50969. The energy data bases and analytical models used in the course of policy analyses are also described.

The multi-disciplinary approach used in the Center, and the close interaction with other analytical groups in universities and industry, provides a unique perspective on the energy situation. This is evidenced by the broad range of activities cited in this *Annual Abstracts* report.

THIS PAGE

WAS INTENTIONALLY

LEFT BLANK

TABLE OF CONTENTS

Title	Page No.
I. Regional Studies	
Some Extensions of Mills' Method for Urban Population Density Gradient Estimation	2
Political Implications of Clustered Nuclear Siting	3
A Linear Programming Model for Country Level Electric Facility Siting	4
Coal Utilization in the Northeast, Vol. I: Issues and Siting Scenarios	5
The Locational Response to Regulatory Policy: A Regional Analysis of Energy Facility Location	6
Coal Utilization in the Northeast: Vol. III. An Assessment of the Acid Rain Problem	7
Coal Utilization in the Northeast, Vol. V: Offshore Siting for Coal Fired Electric Generating Facilities	8
Coal Utilization in the Northeast, Vol. VI: Industry Energy Use	9
Coal Utilization in the Northeast, Vol. VIII: Solid Waste Management Issues and Impacts	10
Energy-economic Modeling for Policy Decision	11
Analysis of Nuclear Energy Center Water Supply Systems	12
Long-range Regional Power Plant Siting Model	13
The Solid Waste Impacts of Increased Coal Utilization	14
New England's Future: Water, Energy and Economic Development	15
An Analysis of Water Resources Constraints to Power Plant Siting in the Mid-Atlantic States	16
Noise Radiation from Energy Center Cooling Towers	17
The Energy Situation in the Mid-Atlantic Region	18
An Assessment of the Solid Waste Management Impacts of the National Energy Plan	19

TABLE OF CONTENTS
(Continued)

Title	Page No.
I. Regional Studies (Contd.)	
Program Presto--Preparation of Reference Energy Systems Through Time	20
An Assessment of Energy Research, Development and Demonstration Priorities for New York State, Vols. I and II	21
The Future Demand for Electricity in the Nassau-Suffolk Region	22
On the Use of Wood as an Energy Source in the State of Maine	23
II. Economic Analysis	
The Long Term Economic and Environmental Consequences of Phasing Out Nuclear Electricity	26
Assessment of Policy and Program Alternatives for Energy Savings in Buildings	27
Transition to a Decentralized Energy Future	28
Load Management Applied to Solar Water Heating with Electric Backup	29
A Comprehensive Areal Model of Residential Heating Demands	30
Assessing the Employment Implications of Alternative Energy Supply, Conversion and End Use Technological Configurations: The Case of Firewood Versus Fuel Oil in New England in 1985	31
Utility Load Management and Solar Energy: Study Background and Outline	32
Energy Use Modeling of the Iron and Steel Industry	33
Energy-economy Interactions in an Optimal Control Framework	34
Energy Demand and Conservation Analysis	35

TABLE OF CONTENTS
(Continued)

Title	Page No.
II. Economic Analysis (Contd.)	
A Study of Transmission and Protection Elements for Wind Energy Generating Systems, Volume II (Appendices)	36
Hydrogen Energy: Economic Issues	37
Some Measures of Regional-industrial Interfuel Substitution Potentials	38
A Hierarchical Decomposition Approach to Environmental Policy Analysis	39
Internalizing the Externalities of Solar Technology: Methodologies for Incorporating Externalities in the Assessment of Policy Options and Technology Assessments of Solar Energy Initiatives and R&D Programs Using Brookhaven Models	40
Fleet Operator Study: Geographic Aspects	41
A General Equilibrium Approach to Energy/Environmental Economic Analysis	42
Energy Conservation--Technology Push or Pull?	43
Solar System Performance Data for Use in Regional Models	44
Utility Load Management and Solar Energy: Study Background and Preliminary Market Potential Analysis	45
An Integrated Methodology for Assessing Energy-economy Interactions	46
A Method for the Comparative Economic Assessment of Storage Systems	47
Underground Piping Systems for District Heating with Particular Application to Geothermal District Heating in Utah	48
The Marginal Cost of Electricity Used as Backup for Solar Hot Water Systems: A Case Study	49
Why Should Energy Models Form a Crucial Policy Input in an Uncertain Political World?	50

TABLE OF CONTENTS
(Continued)

Title	Page No.
II. Economic Analysis (Contd.)	
Estimation of Sectoral Prices in the BNL Energy Input-output Model	51
The Effect of Energy Conservation on Environmental Emissions: Utility, Residential and Commercial Sectors	52
The Effect on Air and Water Emissions of Energy Conservation in Industry	53
The Brookhaven Buildings Energy Conservation Optimization Model	54
The Use of the Pulp and Paper Industry Process Model for R&D Decision Making	55
Wind Power and Electric Utilities: A Review of the Problems and Prospects	56
A Study of Transmission and Protection Elements for Wind Energy Generating Systems, Vol. I	57
Documentation of the Brookhaven Energy I-O and I-O BESOM Linkage	58
Energy Demand Analysis in the Workshop on Alternative Energy Strategies	59
Economic Impacts of a Transition to Higher Oil Prices	60
Documentation of an Interactive Program for Projecting Space Heating Energy Demand	61
Oil Supplies, Energy Conservation, and Global Stability	62
Brookhaven Energy Transportation Submodel (BETS) Documentation and Results	63
Methodology for Modeling Geothermal District Heating for Residential Markets	64
Energy, Employment, and Environmental Impacts of Accelerated Investment in Conservation and Solar Technology in Buildings	65
Solar and Geothermal Energy Utilization in SF-2: A Sensitivity Analysis	66

TABLE OF CONTENTS
(Continued)

Title	Page No.
II. Economic Analysis (Contd.)	
Comparative Assessment of Energy-economy Interactions: Price Versus Growth	67
Energy Conservation Policies: Possibilities, Mechanisms and Impacts	68
III. Biomedical and Environmental Assessment	
Comparative Effects of Coal and Nuclear Fuel on Mortality	70
A Probabilistic Methodology for Estimating Air Pollution Health Effects from Coal-fired Power Plants	71
Databook for the Quantitation of Health Effects from Coal Energy Systems	72
Sulfur Control in Coal-fired Power Plants: A Probabilistic Approach to Policy Analysis	73
Exposure to Indoor Pollution	74
Factors Influencing the Public Perception of Risks to Health and Safety: A Brief Summary	75
Energy Conservation and Indoor Air Pollution	76
Analysis of Heating System-generated Air Pollution	77
ESUSA: U.S. Endangered Species Distribution File	78
Potential Ambient Standards for Atmospheric Sulfates: An Account of a Workshop	79
A Data Band for the Geographical Allocation of Future U.S. Energy Supply Facilities by County	80
Hazards of Organic Working Fluids	81
Outdoor Sources of Indoor Air Pollution	82
Medical Data Base: A Tool for Studying the Relationship of Energy-related Pollutants to Ill Health	83

TABLE OF CONTENTS
(Continued)

Title	Page No.
III. Biomedical and Environmental Assessment (Contd.)	
The Endangered Species Act and Energy Facility Planning: Compliance and Conflict	84
Preliminary Report on Some Health, Environmental, and Economic Costs and Benefits of Energy Conservation and Fuel Substitutions	85
IV. Technology Assessment	
Systems Framework for Materials Policy Analysis	88
Multiobjective Analysis in a National Energy System Model	89
A Method for the Comparative Economic Assessment of Storage Systems	90
Regional Reference Energy Systems: Electric Utility Applications	91
Glazing and The Trombe Wall	92
The Role of Storage in Solar Total Energy Systems	93
A Comparison of the Total Annual Costs of Solar and Conventional Heating and Hot Water Systems: Effects of Electricity Rate Schedules and Tax Incentives	94
The Marginal Cost of Electricity Used to Backup Residential Solar Heating and Hot Water Systems	95
An Evaluation of Crop Residues for Generation of Electricity	96
Energy Analysis and Policy-some Observations	97
The Application of Energy Systems Analysis to Policy and Technology Studies	98
Long-term Strategic Analysis (Towards an Energy Doctrine)	99
On the Economic Assessment and Optimization of Energy Storage Systems	100

TABLE OF CONTENTS
(Continued)

Title	Page No.
IV. Technology Assessment (Contd.)	
Future Energy Requirements--The Basis of Energy Policy	101
Whither Energy--Future Shock or a Greening?	102
Energy Use in Japan and the United States	103
Impact of Selected Energy Conservation Technologies on Baseline Demands	104
A Study of Potential Coal Utilization 1985-2000	105
Proceedings of the Workshop on World Oil Supply-demand Analysis	106
An Alternative, Semi-automated Method for Performing Multiobjective Analyses	107
Long Term Energy Projections	108
V. Energy Data and Models	
The Utilization of Energy--Information Requirements for Policy	110
A Demand Elasticity Representation Methodology and Calibration	111
The Brookhaven Time Stepped Energy System Optimization Model (TESOM)	112
An Approach to Hierarchical Multiobjective Analysis	113
The Reference Energy System--A Framework for Energy Information	114
The Reference Materials Systems--A Framework for Substitution Analysis	115
Technological-economic Models for Energy Analysis	116

TABLE OF CONTENTS
(Continued)

Title	Page No.
V. Energy Data and Models (Contd.)	
Coal in Transition 1980-2000 Demand Considerations	117
The Brookhaven Energy System Optimization Model--Its Variants and Uses	118
VI. International Programs	
Outline of a Study of the Energy Needs, Uses, and Resources of Developing Countries and the Implications for Aid Programs	120
Some Considerations on the Role of ERDA in the Development and Analysis of Energy Technologies for Developing Countries	121
Capacity Expansion in Electric Generation with Reference to Developing Countries	122
Some Considerations on the Role of ERDA in the Development and Analysis of Energy Technologies for Developing Countries	123
A System Framework for Interregional Resource Allocation for Energy Supply in Developing Countries: The Case of Coal and Water Resources in India	124
A System Approach to Energy Planning	125
On the Application of Resource Allocation Models to the Problems of Regional Energy Policy in Large Developing Countries	126
Energy Needs, Uses and Resources in Developing Countries	127
An Analytical Framework for the Assessment of Energy Resource and Technology Options for Developing Countries	128
Less Developed Countries Energy System Network Simulator LDC-ESNS	129
Programmatic Areas for U.S. Assistance for Energy in the Developing Countries	130

AUTHOR - INDEX
for the
NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS

December 1978

Author	Page No.
J. Allentuck	10, 20, 119, 120
J. Appleman	20
E. Beardsworth	19, 120, 124, 127
D. J. Behling, Jr.	24, 66
M. Beller	95, 102
N. K. Bhagat	85, 93, 102, 112
G. W. Boyce	49
S. R. Bozzo	78, 81
J. P. Brainard	17, 82
R. N. Bright	30, 43, 47, 91, 92
C. E. Calef	77, 81, 82
S. C. Carhart	25, 33, 52, 57, 58, 60, 63, 96, 105
T. O. Carroll	20, 21
S. S. L. Chang	32
E. A. Cherniavsky	109, 110, 114
H. Davitian	27, 30, 43, 45, 54, 64, 87, 91, 92, 93, 97
A. Doernberg	100, 101
R. Dullien	24
J. Elliot	7
J. T. Fraser	56
F. Galdos	81
R. J. Goettle IV	32, 35, 36, 44, 65
G. Goldstein	19
P. J. Groncki	40, 44, 49
D. Gunwaldsen	102
S. Hale, Jr.	124
L. D. Hamilton	76, 81, 83
R. W. Hardy	14
A. L. Hermelee	88
B. Hobbs	5, 15

Author	Page No.
K. C. Hoffman	85, 94, 96, 98, 99, 103, 105, 107, 111, 112, 113
E. A. Hudson	44, 65, 66
E. Kaplan	14
J. Karkheck	62
A. S. Kydes	108, 109, 114, 115
R. La Sala	64
T. Le	9, 13, 18
R. W. Leigh	45, 87, 89, 90, 97
S. Linke	34, 55
J. Lukachinski	24, 44, 65
R. Malone	126
W. Marcuse	24, 25, 26, 30, 37, 38, 41, 43, 48, 58, 60, 64, 109
M. McCoy	4
T. H. McCoy	1
E. Medine	8
A. K. Meier	69, 71
P. M. Meier	1, 2, 3, 4, 5, 7, 9, 11, 12, 13, 15, 18, 121, 123
M. Messinger	7
R. E. Meyers	6
F. Moore	16
D. Morell	2, 7
M. G. Morgan	69, 71
S. C. Morris	68, 69, 70, 71, 76
P. D. Moskowitz	83
V. Mubayi	118, 120, 121, 123
S. S. Mulherkar	52, 63
J. S. Munson	14, 17
J. Nagy	77, 82
National Center for Analysis of Energy Systems	29
R. Nathans	20, 122, 124, 127
J. Naughton	39
K.M. Novak	70, 81

Author	Page No.
P. F. Palmedo	2, 20, 21, 118, 120, 122, 124, 127
D. A. Pilati	31, 41, 53
Policy Analysis Division	117, 125
R. W. Pouder	89, 93
P. D. Raskin	50, 51
M. K. Reckard	42
A. Reisman	111, 126
W. R. Rish	71
R. A. Rosen	31, 50, 51, 53
H. Rostoker	13
M. D. Rowe	76
E. S. Rubin	8, 9, 18
Y. Sanborn	52
J. Schank	86, 104, 110
D. Schneider	59
J. Schwam	63
H. P. Serry	46
D. P. Serwer	4, 83
W. A. Sevian	7, 8
D. L. Shenk	69
D. F. Shreeve	82
S. Silberstein	72, 74, 75, 79, 80
F. T. Sparrow	41
R. Stern	4, 18, 21
A. Teshome	34, 55
R. G. Tessmer, Jr.	28, 35, 44, 49, 58, 60, 62
G. Tschannerl	127
J. R. Wagner	39, 61
R. Wilson	73
A. J. Van Horn	73
T. Von Foerster	22
P. D. Yehsakul	34, 55
J. Zakaria	16
E. N. Ziegler	6

SECTION I

Regional Studies

SOME EXTENSIONS OF MILLS' METHOD FOR URBAN POPULATION DENSITY GRADIENT ESTIMATION*

BNL 22153-R

P. M. MEIER AND T. H. McCOY

National Center for Analysis of Energy Systems

This paper extends Mills' method for estimating urban population density gradients to general noncircular and asymmetrical urban forms, using Gauss-Legendre quadrature embedded in a Newton-Raphson root finding algorithm. We also examine the sensitivity of the Mills method to measurement errors in the assumptions. Several issues arising from the comparison of analytical, Mills type estimation procedures with statistical procedures are explored, particularly in light of recent work that questions the negative exponential formulation of urban density gradients. We note in particular the influence of secondary population centers as a source of estimation bias.

*Published in Geographical Analysis Vol. X, No. 2, April 1978, pp. 163-173.

Program: Regional Studies

Sponsor: U.S. Department of Energy

POLITICAL IMPLICATIONS OF CLUSTERED NUCLEAR SITING

BNL 23246

P. M. MEIER, D. MORELL AND P. F. PALMEDO

National Center for Analysis of Energy Systems

The sociopolitical ramifications of nuclear energy centers, as emerging from a case study in Ocean County New Jersey, are examined from the standpoint of identifying key issues of public controversy, and with emphasis on implications for national energy planning and the course of nuclear debate. Various dimensions of institutional tension are analysed, including inter-state issues and federal preemption, and the ability of the institutional and political framework to address the many equity issues that are exacerbated by clustered siting. The evolution of public attitudes, and the subsequent mobilization of effective political channels in opposition to proposed NEC's are discussed in light of New Jersey experience. The degree to which energy centers affect public attitudes to nuclear power is identified as the key issue requiring further analysis before widespread implementation of the concept can be advocated.

Program: Regional Studies

Sponsor: ERDA AEA, NRC Office of Special Studies

A LINEAR PROGRAMMING MODEL FOR COUNTY LEVEL ELECTRIC FACILITY SITING

BNL 23388

P. M. MEIER

National Center for Analysis of Energy Systems

A mathematical programming approach to the disaggregation of regional electric sector energy scenarios is developed, with particular emphasis on integration with the Brookhaven Regional Energy System Optimization model that defines the regional generation mix, and the Brookhaven atmospheric transport models that allow computation of air quality given emissions at the county level. The model sites generation and transmission facilities by county, in such a way as to satisfy exogenously specified generation constraints at the power pool level. Land use, water resources and air pollution constraints, as well as cost penalties for various cooling and air pollution control modes, are included. The objective function can be specified either in terms of costs, or in terms of minimizing emissions subject to fiscal constraints. The model is particularly suited to the evaluation of siting strategy trade-offs, and as a component of integrated environmental-economic analysis of energy planning options.

Program: Regional Studies

Sponsor: ERDA AES, Division of Technology Overview

COAL UTILIZATION IN THE NORTHEAST VOL. I:
ISSUES AND SITING SCENARIOS

BNL 23596

P. M. MEIER, R. STERN AND M. MCCOY

National Center for Analysis of Energy Systems

This report is one of a series prepared by Brookhaven National Laboratory for the National Coal Utilization Assessment, a nationwide study focused on the health and environmental impacts of increased coal use in the United States. Nine volumes cover the issues, impacts and constraints to coal utilization in the Northeast.

This volume contains the scenario analysis and general introductory material for the other volumes. It summarizes the issues confronting the use of coal as designed by the national scenarios for the Northeast. Besides the issues involved with coal use, it outlines the levels of coal utilization as defined by the scenario analysis and describes the baseline powerplant siting scenarios and its methodology.

Program: Regional Studies

Sponsor: ERDA AES, Division of Technology Overview

THE LOCATIONAL RESPONSE TO REGULATORY POLICY: A REGIONAL ANALYSIS OF ENERGY FACILITY LOCATION

BNL 23597

P. MEIER AND B. HOBBS

National Center for Analysis of Energy Systems

The Brookhaven Regional Energy Facility Siting Model has been applied to a simulation of a number of alternative regulatory strategies that affect the location of power plants. An analysis of alternative definitions of Best Available Control Technology, as called for by the 1977 Amendments to the Clean Air Act, and associated revisions of New Source Performance Standards, are shown to have significant influence over least cost locations of coal burning power plants, with the result that despite large reductions of SO_2 emissions under the more stringent emissions limitations, the locational shifts under cost minimizing behavior results in higher population exposure to SO_2. The impact of River Basin Commission policy on low flow objectives, and on State Regulatory policy in limiting interstate power transfers, are also examined.

Program: Regional Studies

Sponsor: DOE/DTO

COAL UTILIZATION IN THE NORTHEAST, VOL. III: AN ASSESSMENT OF THE ACID RAIN PROBLEM

BNL 23598

E. N. ZIEGLER AND R. E. MEYERS

Department of Energy and Environment

The levels of precipitation acidity in the Northeast (often below pH 4) and of nitrate (often above 10 ppm) are potentially hazardous to human, terrestrial and aquatic systems, with no improvement projected in the near future. Though some uncertainty exists in the data, annual mean values of sulfate and acidity in precipitation increased prior to 1970, with little change since then. Nitrate values have increased continuously. The acidity of rain in hourly and event samples will usually increase with increasing concentrations of either sulfate or nitrate.

Annual U.S. emissions of NO_x are continuing to increase. SO_2 emissions have not changed appreciably since 1970. Since the levels of nitrate and sulfate in rain have followed similar patterns their dependence on emissions of NO_2 and SO_2 are suggested. Northeastern U.S. urban/suburban SO_2 ambient concentration levels have decreased annually over the period 1964-1974. Some annual data on NO_x ambient concentrations are discussed but no trends are inferred.

A vast improvement in routine precipitation chemistry monitoring over the Eastern U.S. is now possible and should be implemented to afford definitive answers with respect to rain composition and acidity trends. Field and laboratory studies on precipitation meteorology,. chemistry and ecological impact should be instituted in conjunction with modeling studies.

Newly developed methods of sampling and chemical analysis of precipitation should be added to stations which are currently monitoring ambient pollutant concentrations and meteorological variables. Pollutant removal rates by precipitation should be incorporated in long-range transport models to predict the impact of existing and planned emission sources on ground level pollution and rain compositions.

Program: Regional Studies

Sponsor: ERDA, AES, Division of Technology Overview

COAL UTILIZATION IN THE NORTHEAST,
VOLUME V: OFFSHORE SITING FOR COAL FIRED ELECTRIC GENERATION FACILITIES

BNL 23600

D. MORELL, J. ELLIOT, M. MESSENGER AND P. MEIER

National Center for Analysis of Energy Systems

This preliminary assessment explores the feasibility of offshore coal electric and coal fired electric generating plants. The principal rationale for such a proposal is based on minimizing the population at risk to fossil fuel derived pollutants, since given the prevailing wind patterns, the optimal location of coal fired plants in the Northeast from this standpoint is as far east of the metropolitan corridor as possible, namely offshore. Siting difficulties of the type that led to the proposal for the offshore nuclear generating station also provide incentives for offshore coal siting in the region.

Our preliminary findings suggest that fixed, offshore platforms, based on the technology developed for North Sea Oil production platforms, represent the most likely configuration, both from the standpoint of cost (since alternatives requiring breakwaters or artificial islands are more expensive) as well as on grounds of some practical engineering advantages over the floating or semi-submersible modes (presenting easy solutions to the transmission problem not involving flexible or interruptible connections to the undersea cable link to shore, and offering the opportunity to utilize pneumatic pipelines as the ultimate coal supply mode, avoiding the problems of coal barge unloading under varying weather and tidal conditions).

Program: Regional Studies

Sponsor: ERDA AES, Division of Technology Overview

COAL UTILIZATION IN THE NORTHEAST, VOL. VI: INDUSTRIAL ENERGY USE

BNL 23601

E. S. RUBIN AND E. MEDINE

National Center for Analysis of Energy Systems

The purpose of this report is to provide a general background on the nature of industrial energy utilization in the Northeast, particularly with regard to the factors affecting the substitution of coal for oil and natural gas. We have also assembled in a series of appendices all of the available data bases on industrial energy use in the Northeast, thereby addressing the need for a single source document suited to the aggregation level necessary for state and regional policy analysis in the region.

The report provides information in the following general areas:

1. The types, sizes and locations of major industrial operations in each state of the Northeast.

2. The types and quantity of fuels or equivalent energy feedstock used by major industrial categories in each state.

3. Quantities of energy used in boilers, non-boilers and other end-use applications in major industrial processes.

4. Environmental regulations applicable to industrial processes in each state, particularly air pollution regulations governing fossil fuel combustion.

5. Status of current air pollutant emissions and constraints imposed by nonattainment of ambient air quality standards.

Program: Regional Studies

Sponsor: DOE/DTO

COAL UTILIZATION IN THE NORTHEAST: VOL. VIII
SOLID WASTE MANAGEMENT ISSUES AND IMPACTS

BNL 23603

T. LE, E. RUBIN AND P. MEIER

National Center for Analysis of Energy Systems

The report addresses the solid waste management problems that arise in various stages of the coal fuel cycle, with particular emphasis on coal ash and scrubber sludge disposal, and with a geographic focus on the Northeastern United States. The coal use scenarios of the National Coal Utilization Assessment are used to identify issues, impacts and constraints in both the electric utility and industrial sectors. Waste management and disposal in the utility sector is adjudged as being a tractable issue that would not materially impede increased coal utilization given proper environmental engineering input to site selection and waste management practice. In the industrial sector, however, a number of potential problems are identified that pose significant constraints to increased coal utilization.

Program: Regional Studies

Sponsor: Department of Energy

ENERGY ECONOMIC MODELING FOR POLICY DECISIONS

BNL 23943 [a]

J. ALLENTUCK

National Center for Analysis of Energy Systems

Understanding the nature of the links between the energy sector and the economy is fundamental to the formulation of energy policy and is the key to meaningful modeling of energy-economy interactions. The range of description of these links is broad and the options offered to modelers are varied. At a highly aggregated level, the link may be described in terms of the fraction of GNP attributable to energy transactions. For instance prior to the oil embargo of 1973 this statistic amounted to four percent of GNP and the subsequent doubling in the real price of oil raised this proportion to seven percent. However, when the formulation of energy policy embraces such far ranging topics as the appropriate tariff on oil imports, the regulated price of natural gas, the development of breeder reactor, the requirements for effluent controls in coal fired power plants, the federal budget allocation for energy technology development and the limitations on gas guzzling automobiles, to mention only a few, the assessment of economic consequences requires a highly sophisticated identification not only of energy-economy links but of interactions within the energy sector.

In this paper, those models are examined which employ significantly different approaches to simulating energy-economy links and varying levels of descriptive detail of the energy sector. The association of these models with specfic categories of policy formulation is described. Limitations on their utility and a discussion of their weaknesses and strengths are presented in the context of model structures and assumptions.

Program: New York State Energy Information System

Sponsor: DOE

ANALYSIS OF NUCLEAR ENERGY CENTER WATER SUPPLY SYSTEMS

BNL 24073

P. M. MEIER

National Center for Analysis of Energy Systems

An optimization model for the analysis of water supply systems for nuclear energy centers is presented. Features of the model include consideration of the relationship between electric system reliability and stochastic variations in water demand; the ability to include tunneled as well as near surface conduits (which require an inequality constrained cost minimization), and gradient present worth analysis to capture the very long construction periods. The model is applied to a hypothetical site in Ocean County, New Jersey, and sensitivity analyses are conducted to key input parameters. Particular emphasis is devoted to analyzing the trade-offs between water conveyance costs and transmission costs as locational determinants.

Program: Regional Studies

Sponsor: NRC, Office of Special Studies

LONG-RANGE REGIONAL POWER PLANT SITING MODEL*

BNL 24213

PETER M. MEIER

National Center for Analysis of Energy Systems

A limear programming model for long range regional power plant siting is presented. Designed for use in energy planning studies as a bridge between energy scenarios and environmental transport models, it can also be used by siting agencies to analyze alternative siting strategies in terms of cumulative environmental impacts on a region, and to assess the economic penalties associated with various regulatory strategies. The model includes consideration of air, water, and land use constraints, and is applied to the New York Power Pool in a simulation of the impact of various air pollution control strategies.

*Published in Journal of the Energy Division, ASCE, Vol. 105, No. EY1, Proc. Paper 14322, January 1979, pp. 117-135.

Program: Regional Studies

Sponsor: U.S. Department of Energy

THE SOLID WASTE IMPACTS OF INCREASED COAL UTILIZATION

BNL 24786

T. LE, P. M. MEIER AND H. ROSTOKER

Policy Analysis Division

This report identifies the solid waste management problems of the coal fuel cycle, with particular emphasis on mining wastes, coal ash and scrubber sludge disposal. A coal utilization scenario prepared for an analysis of the Administration's National Energy Plan is used to identify issues, impacts and constraints in the mining, electric utility, and industrial sectors. Waste management and disposal in the utility sector is judged as a tractable issue that would not significantly impede increased coal utilization given proper environmental engineering input to site selection and waste management practice, albeit at some cost due to other recently enacted Federal Legislation, particularly the Resource Conservation and Recovery Act and the 1977 Clean Air Act Amendments. In the industrial sector, a number of potential institutional and environmental problems are identified that pose significant constraints to increased coal utilization.

Program: Regional Studies

Sponsor: DOE

NEW ENGLAND'S FUTURE: WATER, ENERGY AND ECONOMIC DEVELOPMENT

SUMMARY OF THE WORKSHOP OF THE IMPACTS OF WATER AVAILABILITY ON NEW ENGLAND ENERGY AND ECONOMIC FUTURES (October 27-28, 1977)

BNL 24788

E. KAPLAN, R. W. HARDY AND J. S. MUNSON

Policy Analysis Division

A workshop entitled The Impact of Water Availability on Electric Energy Production in New England: Implications for Economic Development, was conducted on October 27-28, 1977 under the joint sponsorship of the Brookhaven National Laboratory and the New England Council of Water Center Directors. The workshop was the first step in a developing systematic and coherent research strategy for analyzing the technological, economic and institutional factors governing the dynamic relationships between water use, electric power generation and economic development patterns in New England.

This report is the synopsis of the results of the workshop as interpreted by the authors and is to serve as a point of departure for drawing up the details and carrying out the subsequent research strategy.

Program: Regional Studies

Sponsor: DOE, Division of Regional Assessment

AN ANALYSIS OF WATER RESOURCES CONSTRAINTS TO POWER PLANT SITING IN THE MID-ATLANTIC STATES

BNL 25094

B. HOBBS AND P. MEIER

Policy Analysis Division

Expansion of the electrical generation system in the Pennsylvania-Jersey-Maryland power pool will impact, and be constrained by, inland water availability. Future interpretations of the Federal Water Pollution Control Act Amendments of 1971 regarding evaporative cooling towers for coastal power plants, offshore siting and energy centers, and the policies and public acceptability of low flow augmentation reservoirs are some of the issues examined in this paper using scenarios generated by the Brookhaven National Laboratory Regional Energy Facility Siting Model (REFS). REFS is a multicommodity, transshipment-location linear programming model used here to allocate power plants among counties in a power pool under a minimization of cost objectives. The solutions are sensitive to the water resources assumptions in the model. For the year 2000, the amount of low flow augmentation allowed in the region's river basins and whether offshore siting becomes a reality are the two water resources related issues which most affect the scenarios. The results show that decisions regarding specific water problems can have region wide implications for water and non-water related issues.

Program: Regional Studies

Sponsor: DOE, Division of Regional Assessment

NOISE RADIATION FROM ENERGY CENTER COOLING TOWERS

BNL 50564

J. ZAKARIA AND F. MOORE

National Center for Analysis of Energy Systems

Noise radiation from the cooling towers of clustered and dispersed arrays of cooling towers for large power plants is presented, and a procedure presented for the prediction of noise levels at some distance from the rim of single isolated tower. Two types of cooling systems, namely mechanical-draft wet and natural-draft wet cooling towers, are considered, which are assumed to act as the sole source of noise generation in power plants.

The procedure for the prediction of noise levels from single isolated towers is then extended to determine noise levels at some point on the site boundary of energy centers being proposed for the future.

It is concluded that if one wishes to minimize the area impacted by objectionable noise levels, then for concentrated power centers either mechanical-draft or natural-draft towers may be chosen, while for more widely dispersed centers natural-draft systems must be recommended. Special emphasis has been placed upon the A-weighted sound levels, which correlate well with human sound perception. One dimensional free wave spreading and atmospheric absorption are the attenuation factors taken into account.

Program: Regional Studies

Sponsor: Department of Energy

THE ENERGY SITUATION IN THE MID-ATLANTIC REGION

BNL 50703

J. S. MUNSON AND J. P. BRAINARD

Energy Policy Analysis Division

This report presents a review of the energy situation in the Mid-Atlantic Region. It describes the patterns of energy production, supply and demand by state and compares these to national and regional averages. It presents a picture of existing energy and environmental interactions and a view of potential energy and environmental conflicts. A review of the major issue by energy sector is included as is a description of the existing energy factors and their major energy programs.

Program: Regional Energy Studies

Sponsor: DOE

AN ASSESSMENT OF THE SOLID WASTE MANAGEMENT IMPACTS OF THE NATIONAL ENERGY PLAN

BNL 50708

P. MEIER, E. RUBIN, T. LE AND R. STERN

National Center for Analysis of Energy Systems

This report addresses the solid waste management implications of the National Energy Plan, focused in particular on coal ash and scrubber sludge disposal in both utility and industrial sectors by 1985. The analysis is premised on full implementation of Best Available Control Technology in both the Base and NEP scenarios used as a starting point for assessment. In the electric sector, the only significant effect of NEP is to shift the regions distribution of impacts, with a total national increase of coal ash by only 1%, and a decrease in scrubber sludge production of up to 10%. In the industrial sector, however, the steep increase in coal utilization hypothecated by the NEP scenario will result in a number of significant solid waste management problems, which may impede conversion to coal at the plant and firm level. The shift to non sludge producing FGD systems in the industrial sector with discharge of dissolved solids to sewers and receiving waters, is noted as evidence of this conclusion.

Program: Regional Studies

Sponsor: DOE

PROGRAM PRESTO--PREPARATION OF REFERENCE ENERGY SYSTEMS THROUGH TIME

BNL 50723

E. BEARDSWORTH AND G. GOLDSTEIN

National Center for Analysis of Energy Systems

PRESTO is an interactive computer program to provide a convenient framework for energy accounts to specify quantitatively the flows in the U.S. energy system over time, and to permit manipulation of their values while maintaining internal consistency. Then, once a scenario is defined, several of its attributes and implications are calculated (costs, total resource use, and environmental effects). It is based on the Reference Energy System methodology, a diagrammatic description of energy flows, but with the explicit incorporation of the time dimension.

Program: Regional Studies

Sponsor: U.S. Department of Energy

AN ASSESSMENT OF ENERGY RD&D PRIORITIES FOR NEW YORK STATE INTERIM REPORT VOLUME I

BNL 50735

J. ALLENTUCK, J. APPLEMAN, T. O. CARROLL, P. PALMEDO AND R. NATHANS

National Center for Analysis of Energy Systems

In compliance with its mandate to accelerate the development and use of energy technologies in furtherance of the state's economic growth and the best interests of its population the New York State Energy Research and Development Authority (NYSERDA) initiated, in March 1977, an assessment of energy research and development priorities. This project was undertaken as a collaboration between the Authority, Brookhaven National Laboratory, the State University of New York at Stony Brook and the firm of Donovan, Hamester and Rattien.

The report, presents a view of the energy supply-demand future of the state, and the ways in which this future can be affected by external contingencies and concerted policies. That view takes into consideration energy supplies that may be available to the state as well as energy demands as they are affected by demographic and economic changes within the state. Also included are the effects of national energy policies and technological developments as they modify both supplies and demands in New York State. Finally this report proceeds to identify those general technological areas in which the Authority's program can be of greatest potential benefit to the state's social and economic well being. This effort is preliminary to the work of subsequent phases of the project which will aim at a cost-benefit analysis determination of RD&D priorities.

The preliminary analysis conducted in the study thus far indicates the following RD&D areas as being of highest priority: energy conservation in buildings (promotion and execution of RD&D) and industry; district heating; fuel cell demonstration; solar heating and cooling (analysis, demonstration and information dissemination); energy-environment interaction (analysis); energy information services; and, in general, the attraction of federal RD&D programs to the state.

Program: New York State ERDA

Sponsor: ERDA

THE FUTURE DEMAND FOR ELECTRICITY IN THE NASSAU-SUFFOLK REGION

BNL 50757

T. O. CARROLL, P. F. PALMEDO, AND R. STERN

National Center for Analysis of Energy Systems

Traditional approaches to load forecasting for electric utilities are based primarily upon extrapolation of historic trends and consider the electric sector in isolation from other fuel forms. In more recent years, the Long Island Lighting Company (LILCO) has turned to improve techniques utilizing econometric forecasts of short-range growth in electrical demand, logistic curves for long-term estimates, and a multiplicity of other techniques and specific forecasts prepared by outside consulting groups. However, within such forecasts, it is often difficult to identify specific impacts of conservation, new technology, fuel substitution, and the like both in terms of maximum potential increase or decrease in the demand for electricity and the likelihood that such shifts in the demand for electricity will be realized.

A new approach has been used to forecast the demand for electricity in the Long Island Lighting Company service area. The method includes three specific objectives.

> Demand for electricity should be placed in a total energy perspective so that substitutions between electricity and other fuels can be examined.
>
> The impact of conservation, new technology, gas curtailment, and other factors upon demand for electricity should be able to be analyzed with the methodology.
>
> Some idea should be given of the likelihood of alternative levels of future demand.

Program: LILCO/Long Island Study

Sponsor: Department of Energy/Long Island Lighting Company

ON THE USE OF WOOD AS AN ENERGY SOURCE IN THE STATE OF MAINE

BNL 50898

T. VON FOERSTER

Policy Analysis Division

We present a detailed study of the availability and use of wood as an energy resource for the State of Maine. Although there are no good data on the total resources of Maine's forests, the best estimates indicate that one could obtain about 1/2 quad (10^{15} Btu) per year from thinning overstocked stands and harvesting dead trees; current logging operations could produce about the same amount of energy in the form of logging residues and thinnings, an amount that could be increased manyfold by intensive forest management. The costs of wood for fuel can be estimated on the basis of current logging and transportation costs. The corresponding energy prices, while high, are competitive with current fossil fuel prices.

Using any energy source requires not only the fuel but also a furnace. The total energy costs are thus not only the cost of current fuel use but also those of the capital investment in the furnace. We have estimated these for systems of two sizes, one for a small house, the other for an apartment building or small commercial establishment. In both cases, our estimates indicate, that wood-fueled systems can be economically competitive.

Wood is currently used as a fuel on a large scale in the pulp and paper industry. With some increase in wood harvesting efforts and some alterations of furnaces that industry could achieve energy self sufficiency. Other large-scale uses are still speculative but deserve further investigation. A state-owned energy corporation could serve to provide a market for currently wasted wood and to investigate the conversion of wood to other forms of energy.

The combustion of wood is not associated with environmental effects that are different in kind or in magnitude from those associated with the combustion of fossil fuel.

Program: Regional Studies

Sponsor: DOE

THIS PAGE

WAS INTENTIONALLY

LEFT BLANK

SECTION II

Economic Analysis

The Long-term Economic and Environmental Consequences of Phasing Out Nuclear Electricity

BNL 22735

D. J. BEHLING, JR., W. MARCUSE, J. LUKACHINSKI AND R. DULLIEN

National Center for Analysis of Energy Systems

This study is one of a series of studies prepared by different modeling groups for Resources for the Future concerning the potential energy/economic environmental impacts which would result from a policy decision to halt any further construction of nuclear power plants. Wherever possible, each modeling group used the same set of model input parameter values to estimate the impacts.

This study is based on the use of an integrated modeling system incorporating the Data Resources Inc. Long-term Interindustry Transaction Model (LITM), the Brookhaven Dynamic Energy System Optimization Model (BESOM) and several groups of interface equations. This model system is first described and then used to estimate four alternative energy/economic/environmental futures. In the Base Case scenario, it is assumed that growth in the nuclear sector will not be constrained by safety or security considerations, so that, when economical, nuclear reactors will build up at reasonable rates, including advanced uranium and breeder reactors, starting in 2000.

Program: Economic Analysis

Sponsor: ERDA-APAE

ASSESSMENT OF POLICY AND PROGRAM ALTERNATIVES FOR ENERGY SAVINGS IN BUILDINGS

BNL 23853[a]

STEVEN C. CARHART AND WILLIAM MARCUSE

National Center for Analysis of Energy Systems

The Brookhaven linear programming optimization model has been used for technology assessment for supply technology R&D decisions. This model has now been extended to assess and evaluate end use convention alternatives in the residential and commercial sectors.

Assessment is performed over four geographical regions for nine building types, for three sets of building shells and for a large variety of space conditioning, water heating, appliance and illumination alternatives. The methodology has been applied for the DOE MOPPS study and is used by the Division of Buildings and Community Systems of the Department of Energy for assessment and evaluation of policy alternatives and program initiatives.

Program: Economic Analysis Division

Sponsor: Joint National Meeting of the Institute of Management Sciences and Operations Research Society of America, May 1-3, 1978.

TRANSITION TO A DECENTRALIZED ENERGY FUTURE

BNL 23854[a]

WILLIAM MARCUSE

National Center for Analysis of Energy Systems

An alternative energy future characterized by a changed energy consumption "ethic" and based upon "soft" technologies has been proposed. It is attractive not only in that it projects a shift from non-renewable to renewable energy sources but also in that it predicates increased control of the individual citizen over the political, social and technical environment. This paper does not address the likelihood, economic, feasibility, or social adjustment necessary to achieve the goal of a decentralized energy future. Instead, it addresses the question of making the transition, given that the existing energy using infrastructure is in place and that the new system comes into existence through the addition of new and replacement capital stock. The analysis is performed at the level of the use of energy services. The methodology is to assume two populations, one an extension of current practices and the second characterized by the new consumption patterns and supply technologies. This model greatly oversimplifies the problem but should provide insight into the transition characteristics.

Program: Economic Analysis Division

Sponsor: AAAS Annual Meeting, Washington, D.C. (February 12-17, 1978)

LOAD MANAGEMENT APPLIED TO SOLAR WATER HEATING WITH ELECTRIC BACKUP

BNL 23935[a]

H. DAVITIAN

Economic Analysis Division

As a backup for solar space heating and water heating systems in new dwellings and commercial buildings, utility electricity has the advantages of being readily available and lowest in added user incurred capital costs. Unless some control is placed over the time of day at which backup power is required, however, use of electricity in this application can add to peak loads (compared to heaters that do not use any electricity) and can result in high unit costs for generating the backup electricity. This study attempts to determine: (1) whether load management control strategies can be devised which will substantially lower the unit costs of generating the backup electricity, and (2) what utility rate structures for users of electrical backup fairly reflect the costs of generating that electricity given an appropriate load management strategy.

In this paper, initial results for the solar hot water application will be presented. The economics of the use of solar hot water systems with electrical backup under several load management schemes and rate schedules will be compared to the economics of solar hot water systems with gas backup and with electricity only systems. The conditions under which electric backup is economically competitive will be detailed. The effect of the varous load management strategies upon utility operations will be described.

Program: Electricity Use for Solar Backup

Sponsor: DOE, Office of Assistant Secretary for Conservation and Solar Applications

A COMPREHENSIVE AREAL MODEL OF RESIDENTIAL HEATING DEMANDS *

BNL 24998

R. G. TESSMER, JR.

Economic Analysis Division

Data sources and methodology for modeling annual residential heating demands are described. A small areal basis is chosen, census tract or minor civil division, to permit estimation of demand densities and economic evaluation of community district heating systems. The demand model is specified for the entire nation in order to provide general applicability and to permit validation with other published fuel consumption estimates for 1970.

*Published in Proceedings of the Second Lawrence Symposium on Systems and Decision Sciences, Lawrence School of Science, Berkeley, Calif., Oct. 3-4, 1978.

Program: Geothermal District Heating

Sponsor: DOE, Division of Geothermal Energy

ASSESSING THE EMPLOYMENT IMPLICATIONS OF ALTERNATIVE ENERGY SUPPLY, CONVERSION AND END USE TECHNOLOGICAL CONFIGURATIONS: THE CASE OF FIREWOOD VERSUS FUEL OIL IN NEW ENGLAND IN 1985

BNL 24048

National Center for Analysis of Energy Systems

Assessing the forest resources of New England, it is estimated that it would be possible to substitute an additional .1 quads of firewood for fuel oil to meet New England's residential and commercial space heating requirements by 1985. On an activity-by-activity basis, the direct labor requirements for producing this firewood and the direct labor requirements for providing fuel oil in New England are calculated. The study assumes that 40 to 70 percent of the .08 quads of residential firewood consumption is purchased, and 90 percent of the .02 quads of commercial firewood consumption is purchased (the remainder being cut by the user). This implies that between 10,200 and 16,500 additional jobs could become available if the above technological substitution were to take place. However, only the direct employment impacts have been estimated. The effects on other industries (e.g., wood stove manufacturing) and on the rest of the nation have been ignored.

Program: Secondary Alternate Fuel Combustion

Sponsor: DOE, Power Systems Division

UTILITY LOAD MANAGEMENT AND SOLAR ENERGY: STUDY BACKGROUND AND OUTLINE

BNL 24149

H. DAVITIAN, R. BRIGHT AND W. MARCUSE

National Center for Analysis of Energy Systems

The large-scale use of electrically assisted solar heating, hot water, and air conditioning (solar/electric HHWAC) systems can have a substantial effect on electric utilities. Under some conditions, peak loads may be increased causing electricity generation costs to rise. This study analyzes the economic, environmental, and social impacts of various rate schedules and load management strategies governing the use of solar/electric HHWAC systems. Target costs for the solar/electric HHWAC systems will be developed based upon comparison with electric-only HHWAC systems (with a storage option).

Program: Electricity Use for Solar Back-up

Sponsor: DOE, Barriers and Incentives Branch, Conservation and Solar Applications

ENERGY USE MODELING OF THE IRON AND STEEL INDUSTRY

BNL 24268

DAVID A. PILATI AND RICHARD ROSEN

National Center for Analysis of Energy Systems

A dynamic process optimization model is presented for the iron and steel industry. Energy use projections are made for a variety of future energy prices. Energy intensities (Btu/ton) are predicted to decrease by as much as 36% by the turn of the century.

Program: Process Models-EIA

Sponsor: 1978 Summer Computer Simulation Conference, Newport Beach, California, July 24-26, 1978.

ENERGY-ECONOMY INTERACTIONS IN AN OPTIMAL CONTROL FRAMEWORK

BNL 24285

RICHARD J. GOETTLE IV AND SHELDON S. L. CHANG*

National Center for Analysis of Energy Systems

In this paper, we describe the dynamical integration of a detailed energy system process model and an aggregate energy-economy model and the conversion of the entire analytical framework into an optimal control problem. Model formulation, solution strategies, and applictions are discussed.

*Associate Economist, Brookhaven National Laboratory and Professor of Engineering, State University of New York at Stony Brook, respectively.

Program: Economic Analysis

Sponsor: ORSA/TIMS Meeting on November 13-15, 1978, Los Angeles, California.

ENERGY DEMAND AND CONSERVATION ANALYSIS

BNL 24328

STEVEN C. CARHART

National Center for Analysis of Energy Systems

Prior to the oil embargo of 1973, energy demand was commonly assumed to increase in proportion to economic growth. Extensive research since then has revealed that while energy demand is certainly related to economic activity, the relationship varies depending upon the rate of growth, energy prices, government policies, and other factors. As these factors act over the longer term, technologies change in the economy, allowing the substitution of labor, materials, and capital for energy in energy using activities. Several quantitative estimates of the magnitude of these possible substitutions are presented. At the same time, we note that any sudden disruption of energy supply will cause serious economic harm, since the capital stock cannot be adjusted to compensate for reduced energy availability. Policies required to offset this contingency are very different, and include options such as stockpiling and rationing. Intelligent policies for energy demand should include encouragement of long range investment to improve efficiencies, and preparation of stockpiles and contingency plans to manage any unexpected disruptions of supply.

Program: Economic Analysis

Sponsor: U.S. Information Service

A STUDY OF TRANSMISSION AND PROTECTION ELEMENTS FOR WIND ENERGY GENERATING SYSTEMS--Volume II (Appendices)

BNL 24345

S. LINKE, A. TESHOME, AND P. D. YEHSAKUL

National Center for Analysis of Energy Systems

Results are reported of a study at Cornell University on transmission, distribution, and protection systems for large wind-energy generators (WEG) connected to an electric utility grid. These results are fully documented in Volume I (BNL 50851). Volume II contains the appendices. This is a semi-formal document, prepared by NYSEG, containing data and background material.

Program: Solar

Sponsor: Technology Assessment

HYDROGEN ENERGY; ECONOMIC ISSUES

BNL 24365

RICHARD J. GOETTLE IV AND RAYMOND G. TESSMER, JR.

National Center for Analysis of Energy Systems

This report has been prepared for presentation at the Workshop on the Societal Aspects of Hydrogen Energy Systems, Reston, Virginia - June 4-7, 1978. Its purpose is to examine the potential economic repercussions associated with the increased utilization of non-captive hydrogen in the nation's energy system.

The paper begins with an overview of the economy-wide adjustment to the large-scale introduction of a new technology as a possible response to development in the energy sector. Next, a brief discussion of the comprehensive framework required to analyze these energy-economy interactions is presented. Concluding the paper is a partial, "first-order," assessment of the comparative economic implications between two alternative energy futures.

Program: Economic Analysis

Sponsor: DOE, NBS, et al.

SOME MEASURES OF REGIONAL-INDUSTRIAL INTERFUEL SUBSTITUTION POTENTIALS

BNL 24368

RICHARD J. GOETTLE IV

National Center for Analysis of Energy Systems

One of the more important issues in the current energy dilemma concerns the potential for the substitution of coal for oil and gas in the manufacturing sector. Among the parameters required for such an assessment are the degrees to which various energy forms (oil, coal, gas, and electricity) substitute for one another in response to changes in their relative prices. This paper presents the partial and preliminary results of a research effort designed to comparatively examine substitution and demand elasticities within the manufacturing sectors of several important regions of the United States.

Demand functions for the alternative energy inputs are derived from a more general model of producer behavior. Data for the manufcturing sectors of thirty-three states for the years 1971, 1974, and 1975 are pooled into three regional groupings. Two statistical specifications are then estimated. The first is predicated on the assumption that the response parameters are completely heterogeneous across the three regions. The second has regional equality imposed on the parameter estimates and is identical to the complete pooling of the observations. From the above, the regional interfuel substitution and demand elasticities are determined and comparatively examined.

Several notes of caution are introduced regarding the use of these (or representative) elasticities as an aid in the policy formulation and evaluation process. The paper demonstrates the extreme care which must be taken in both interpreting and comparing alternative elasticity estimates from "energy-only" models. In addition, potentially serious misinformation is shown to occur when completely pooled cross-regional and time series data are used to estimate national (or sub-national) average response parameters. A discussion of the additional limitations of the analysis and suggested directions for future research concludes the paper.

Program: Economic Analysis

Sponsor: Western Economic Association

A HIERARCHICAL DECOMPOSITION APPROACH TO ENVIRONMENTAL POLICY ANALYSIS

BNL 24444

W. MARCUSE

Economic Analysis Division

This paper summarizes work by others on utilizing a hierarchical structure for assessing energy-economy-environment interactions. It also presents an approach using models available at Brookhaven National Laboratory for performing such analyses at the appropriate level of aggregation--national, regional, or local. Appended is a brief description of models and data bases available at the National Center for the Analysis of Energy Systems at Brookhaven

Program: Solar

Sponsor: DOE, Office of Assistant Secretary for Conservation and Solar Applications

INTERNALIZING THE EXTERNALITIES OF SOLAR TECHNOLOGY: METHODOLOGIES FOR INCORPORATING EXTERNALITIES IN THE ASSESSMENT OF POLICY OPTIONS AND TECHNOLOGY ASSESSMENTS OF SOLAR ENERGY INITIATIVES AND R&D PROGRAMS USING BROOKHAVEN MODELS

BNL 24445

W. MARCUSE

Economic Analysis Division

Simple cost-benefit analysis is inadequate for providing guidance for solar programs. Evaluation and assessment of R&D and policy initiatives based upon "out of pocket" costs ignores both the environmental and renewable resource aspects of solar applications. To fully account for the environmental effects, differences in residuals production between scenarios should be converted to impacts upon human health, property, and ecological systems. Similarly, proper accounting for the renewable aspects of solar energy requires in the short run a measure of its value in increasing national security through reduced energy imports and in the long run a quantification of the intergenerational effect of stretching out the availability of non-renewable fossil fuel resources. The "ideal" methodology would convert non-market benefits and costs into a market measure--dollars. This quantification of externalities would be added to the "out-of-pocket" costs when comparing alternatives.

We cannot presently and may never be able to internalize these costs. In the meantime, budget allocation decisions must be made. It is the purpose of this paper to identify capabilities currently in existence at Brookhaven National Laboratory that help to provide answers, albeit crude, to the value of increasing the contribution of solar energy. Several alternative approaches are suggested

Program: Solar

Sponsor: DOE, Office of Assistant Secretary for Conservation and Solar Applications

FLEET OPERATOR STUDY: GEOGRAPHIC ASPECTS

BNL 24708

JOSEPH R. WAGNER AND JOANNE NAUGHTON

National Center for Analysis of Energy Systems

The EAD is performing a study of light-duty highway vehicles (i.e., passenger cars and light trucks) used in corporate and government fleets. This work is funded by DOE's Division of Transportation Energy Conservation. A data base has been assembled from survey data representing 362,205 fleet vehicles. This report is a preliminary description and analysis of the regional characteristics of the data base.

Program: Fleet Automobile Study

Sponsor: DOE, Division of Transportation Energy Conservation

A GENERAL EQUILIBRIUM APPROACH TO ENERGY/ENVIRONMENTAL ECONOMIC ANALYSIS

BNL 24781

P. J. GRONCKI

Economic Analysis Division

The energy/environmental crisis has spawned several modeling systems for assessing the impacts of alternative policies. The detailed information concerning the technological structure of the industries included in input-output models makes them ideal for this type of modeling framework. However, the assumption of fixed technological coefficients limits the usefulness of these models in that it ignores the flexibility and responsiveness of the economy. This paper proposes and discusses a methodology for capturing the general equilibrium nature of allocative changes in the economy in a disaggregate input-output model given the existence of aggregate, flexible coefficient, general equilibrium input-output models. The methodology utilizes an iterative-linear programming framework for adjusting a recent, known, disaggregate input-output table given the aggregate information for a future year. Several weighting schemes for the objective function are examined and the implicit assumptions which they embody concerning the nature of technological change are discussed. Preliminary results of the testing of this methodology on historic input-output tables are presented.

Program: Energy Strategy and Integrated Analysis

Sponsor: DOE, Office of Analytical Services, Assistant Secretary for Policy and Evaluation

ENERGY CONSERVATION-TECHNOLOGY PUSH OR PULL?

BNL 24885

WILLIAM MARACUSE, DAVID A. PILATI, F. T. SPARROW

National Center for Analysis of Energy Systems

A fundamental problem facing government energy conservation makers is the proper mix of two polar strategies designed to encourage energy conservation in the private sector:

a. "Policy Pull" strategies, in which accelerated depreciation for energy conserving devices, Btu taxes, and other broad based policy instruments are used to increase the demand for energy conserving devices, or modes of operation;

b. "Technology Push" strategies, in which the private sector and the government collaboratively fund research, design, or development of new energy conserving devices.

The need for government-provided energy conservation incentives beyond those now provided the private sector by current elevated energy prices is assumed to be based upon the tendency of current energy prices to be below the true replacement cost of the energy, and the apparent tendency of the private sector to systematically underestimate future increases in energy prices. Thus, policies aimed at adjusting private sector costs and/or benefits of energy conservation options are appropriate responses, since they focus upon the reason for government intervention in the first place.

Both strategies have their uncertainties, drawbacks, and benefits: this paper explores these aspects of each, develops an interactive model of government policy choice and private sector response where two distinct sets of variables are under the control of the two groups, applies the model to energy conservation programs in the iron and steel industry, and draws some conclusions about the usefulness of the two policies.

Program: Conservation Options-Industry

Sponsor: DOE

SOLAR SYSTEM PERFORMANCE DATA FOR USE IN REGIONAL MODELS

BNL 24993

M. K. RECKARD

National Center for Analysis of Energy Systems

This report describes the cost and performance data for solar hot water heating systems and combined hot water and space heating systems which have been developed for use in regionalized computer models. Two sets of data were developed; one for use in BECOM (including data for systems in nine building types in each of four regions), and one for use in RESOM (including one building type in nine regions).

The systems modeled here are all assumed to be liquid transfer systems circulating an antifreeze solution. The systems were not "optimized" in an economic sense; rather, they were sized to provide about 50-70% of the load for water heating systems. These were assumed to be typical of this kind of system.

Program: Conservation and Solar Applications

Sponsor: Department of Energy

UTILITY LOAD MANAGEMENT AND SOLAR ENERGY--STUDY BACKGROUND AND PRELIMINARY MARKET POTENTIAL ANALYSIS

BNL 25038

H. DAVITIAN, R. N. BRIGHT, AND W. MARCUSE

Economic Analysis Division

The large-scale use of electrically assisted solar heating and hot water (solar/electric HHW) systems can have a substantial effect on electric utilities. Under some conditions, peak loads may be increased causing electricity generation costs to rise. However, with appropriate control and thermal storage equipment tied to the HHW system, the timing of the delivery of electricity to the HHW system can be controlled so that it is accomplished during those times of the day when utility supply costs are lowest. In this study various load management schemes for these applications are being investigated to determine their effect on the cost of generating the backup electric power and on the cost of the required control and storage system. Solar/electric HHW systems are compared to electric-only systems (electric hot water or heating and hot water systems with a storage system included) for several utilities and several HHW system designs. This paper describes the issues underlying the study, the methods of investigation, and presents the results of the first phase of the study. In this phase a preliminary analysis of the maximum market potential for night-time precharge electric-only hot water systems in either utilities was conducted. This analysis indicated that if about 20-40% of the residential customers used these appliances in a load managed mode, the 10 PM-8 AM valley in the utility load curve would be filled. For combined electric heating and hot water, the corresponding fraction is 6-12%. It is estimated that in each case, roughly twice the number of residential customers could be accommodated in the valley if solar/electric systems were used instead.

Program: Electricity Use for Solar Backup

Sponsor: DOE, Office of Assistant Secretary for Conservation and Solar Applications

AN INTEGRATED METHODOLOGY FOR ASSESSING ENERGY-ECONOMY INTERACTIONS

BNL 25226 a

R. J. Goettle[IV], P. J. Groncki, J. Lukachinski, R. G. Tessmer, Jr., and E. A. Hudson

National Center for Analysis of Energy Systems

The National Center for Analysis of Energy Systems (NCAES) at Brookhaven National Laboratory (BNL) has collaborated in the development of integrated technological and econometric representations of the nation's energy and economic systems. Among the applications of this integrated methodology are: assessments of energy-economy interactions (price versus growth, availability versus growth, etc.); probabilistic benefit-cost analyses of policy effectiveness and the value of information; comparative scenario analyses, strategic, multi-objective, supply and demand studies related to energy and energy RD&D policies and technological change.

The components of this analytical system include: (1) A simulation model of the aggregate structure and growth of the U.S. economy. The model features a flexible, interindustry representation of sectoral production and final demand (variable input and expenditure patterns). Further, it represents the combined influences of productivity, investment, and labor supply on the temporal expansion of the productive capacity of the economy; (2) A detailed input-output model of the structure of the U.S. economy which maps the outputs of traditional energy supply and conversion sectors into functional, nonsubstitutable, energy service demands originating in the interindustry sectors and final demand; (3) Detailed technological models of energy supply, conversion, and/or end-use demand, representing the full, feasible range of substitution in the nation's energy system and its sectors.

In this paper, we describe the theoretical foundations and computational algorithms linking these components to form the integrated model system. The technical focus of the paper concerns the interrelationships among variables from a specific set of energy and economic system models. However, in the context of the aforementioned applications and independent of the component methodologies, it is the philosophical approach, theoretical structure, and informational content of general equilibrium modeling that are emphasized.

Program: Economic Analysis

Sponsor: DOE, Policy and Evaluation

A METHOD FOR THE COMPARATIVE ECONOMIC ASSESSMENT OF ENERGY STORAGE SYSTEMS

BNL 25291

H. DAVITIAN AND R. W. LEIGH

National Center for Analysis of Energy Systems

This paper outlines a method for the comparative economic evaluation of various energy storage devices in a given application. The method is particularly useful in examining the economics of devices with short lifetimes and can be employed whenever a device lifetime can be expressed as a function of physical parameters which are related to the manner in which the device is used. Given a detailed description of the pattern of use of the device in the application, the device lifetime can be calculated. The economic consequences of changes in lifetime result from the dependence of the capital recovery factor on device lifetime. It is shown how analyses can be made of changes in technical performance characteristics or changes in the pattern of use of the storage device to determine their effects upon the annual cost of energy storage and to determine minimum cost systems.

Program: Energy Storage Systems Analysis

Sponsor: DOE, Application Analysis Branch, Division of Energy Storage

UNDERGROUND PIPING SYSTEMS FOR DISTRICT HEATING WITH PARTICULAR APPLICATION TO GEOTHERMAL DISTRICT HEATING IN UTAH

BNL 25494

H. P. SERRY

Economic Analysis / Engineering Divisions

This report presents preliminary findings concerning the technical aspects of underground piping systems with particular application to geothermal district heating in Utha. The technical aspects investigated are: types of pipe for hot water transport and applicable pipe coatings and insulations. A detailed analysis of pipe length requirements and correlations between geothermal resources and population centers was made for the main cities in Utah.

Program: Economic, Policy and Planning Analysis Program to Assess the Potential for Geothermal District Heating

Sponsor: DOE, Division of Geothermal Energy

THE MARGINAL COST OF ELECTRICITY USED AS BACKUP FOR SOLAR HOT WATER SYSTEMS: A CASE STUDY

BNL 25501

R. BRIGHT AND H. DAVITIAN

Economic Analysis

In this study, a method is developed for estimating the long run marginal cost to electric utilities of providing backup service for solar residential heating and hot water (HHW) systems. This method accounts for all investment, fuel, and operating costs required to provide the added electric service for HHW. From the information produced using this method, the impacts of various rate design philosophies and of government tax and regulatory policies on annual homeowner costs, fuel consumption patterns, environmental pollutants, and the net social cost of providing HHW service can be computed. Also, the differences in these parameters among solar, electric, and conventional HHW systems can be compared.

In an initial study, it was found that for one Northeastern utility the estimated marginal cost of electricity for backup to solar hot water (HW) systems was less than that for comparable electric HW systems for the period of the mid to late 1990's. Load management (shifting all electricity use to off-peak periods) substantially reduced marginal costs for both electric and solar systems and essentially eliminated any difference between them. In all cases, the marginal cost was lower than the average cost of all electricity generated for market penetration rates that can realistically be expected to be experienced. The impact on total annual costs to homeowners of various electricity rate schemes and the impacts of Federal tax credits and property tax exemptions were computed. Net changes in resource consumption patterns due to the use of solar systems were estimated.

Program: Electricity Use for Solar Backup

Sponsor: DOE, Office of Assistant Secretary for Conservation and Solar Applications

WHY SHOULD ENERGY MODELS FORM A CRUCIAL POLICY INPUT IN AN UNCERTAIN POLITICAL WORLD?

BNL 25599

W. MARCUSE

Economic Analysis

Models have been and are being used by the U.S. Department of Energy to provide inputs into the decision process. The question is often asked as to the accuracy of their forecasts and the methods used for validation. It is asserted that energy models can not be predictive, and that validation based on experience with models of physical systems is inappropriate. Asking the question as to the accuracy or validity of an energy system model is not useful. The usefulness of energy models for policy analysis or technology assessment lies in the comparative results generated for alternative scenarios, initiatives, and actions.

Program: Economic Analysis

Sponsor: DOE, Policy and Evaluation

ESTIMATION OF SECTORAL PRICES IN THE BNL ENERGY INPUT-OUTPUT MODEL

BNL 50768

RAYMOND G. TESSMER, JR., PAUL GRONCKI, AND GLENN W. BOYCE, JR.

National Center for Analysis of Energy Systems

Value added coefficients have been incorporated into Brookhaven's Energy Input-Output Model so that one can calculate the implicit price at which each sector sells its output to interindustry and final demand purchasers. Certain adjustments to historical 1967 data are required because of the unique structure of the model. Procedures are also described for projecting energy sector coefficients in future years that are consistent with exogenously specified energy prices.

Program: Economic Analysis Division

Sponsor: DOE, Policy and Evaluation

THE EFFECT OF ENERGY CONSERVATION ON ENVIRONMENTAL EMISSIONS: UTILITY, RESIDENTIAL, AND COMMERICAL SECTORS

BNL 50814

PAUL D. RASKIN AND RICHARD A. ROSEN (ENERGY SYSTEMS RESEARCH GROUP, INC.)

Office of Environmental Policy

Environmental emissions in the utility, residential, and commercial sectors are estimated for four U.S. energy system scenarios and two future target years. Total utility emissions are estimated by specifying, for each scenario and year, total energy demands, fuel mixes, generating technologies, and air pollution control levels. In the residential and commercial sectors energy end-use requirements for space heating and cooling are determined and combined with end-use specific emission coefficients to calculate total emissions. The analyses show that emissions do not vary significantly among scenarios even though total energy use differs by as much as 45 quads. Low-energy demand scenario emissions increase relative to high-energy demand scenarios principally because of the relative increase in coal usage. Utility sector emissions are greater than residential and commercial sector emissions.

Program: Environmental Policy Analysis

Sponsor: DOE, Office of Technology Impacts/ASEV

THE EFFECT ON AIR AND WATER EMISSIONS OF ENERGY CONSERVATION IN INDUSTRY

BNL 50815

PAUL D. RASKIN AND RICHARD A. ROSEN (ENERGY SYSTEMS RESEARCH GROUP, INC.)

Office of Environmental Policy

Environmental emissions for five large energy consuming industries plus "others" are estimated for four U.S. energy system scenarios for 1985 and 2000. Emissions are estimated by specifying fuel mixes to steam boilers and direct heat, combustion efficiencies, shifts in the relative shares of alternative industrial processes, use of industrial cogenerators, and penetration of pollution control technologies. Analyses show that emissions do not vary significantly among scenarios principally because of increased coal use and the reduced penetration rate of advanced pollution control technologies in the low energy demand scenarios. Within scenarios, emissions from the chemical and iron and steel subsectors dominate all aggregate estimates. Hydrocarbon and carbon monoxide process emission coefficients for the chemical subsector must be improved.

Program: Environmental Policy Analysis

Sponsor: DOE, Office of Technology Impacts/ASEV

THE BROOKHAVEN BUILDINGS ENERGY CONSERVATION OPTIMIZATION MODEL

BNL 50828

S. C. CARHART, S. S. MULHERKAR, AND Y. SANBORN

Economic Analysis Division

The Brookhaven Buildings Energy Conservation Optimization Model is a linear programming representation of energy use in buildings. Beginning from engineering and economic data on cost and performance of energy technologies used in buildings (including both conversion devices such as heat pumps and structural improvements) the model constructs alternative flows for energy through the technologies to meet demands for space heating, air conditioning, thermal applications, and electric lighting and appliances. Alternative paths have different costs and efficiencies. Within constraints of total demand for energy services, retirement of existing buildings, constraints on seasonal operation of certain devices, and other constraints, the model calculates an optimal configuration of energy technologies in buildings.

The penetration of the various basic technologies within this configuration is specified at a high level of detail, covering new and retrofit markets for nine building types in four regions. Each market may choose from several appropriate conversion devices and four levels of new and four of retrofit structural improvement.

The principal applications for which the model was designed include: market penetration analysis, showing the role of individual technologies within a system context; policy analysis, to show the effect of buildings sector policies on the technologies in the building stock; analysis of RD&D programs; sensitivity analysis of the preferred configuration to changes in price or other variables; analysis of the effect or rates of implementation of technologies on overall energy; and the environmental and supply system effects of buildings conservation.

Program: Conservation Options for BCS

Sponsor: DOE, Division of Buildings and Community Systems

THE USE OF THE PULP AND PAPER INDUSTRY PROCESS MODEL FOR R&D DECISION MAKING

BNL 50839

DAVID A. PILATI AND RICHARD ROSEN

National Center for Analysis of Energy Systems

A regional paper and pulp industry process model was used to assess the maximal market penetration of new energy conservation technologies for that industry under various energy price assumptions. This linear programming optimization model was used to calculate the systemic impacts on the industry of each technology separately, and as a group. The attractiveness of various co-generation technologies derived from the model was also evaluated with and without an investment tax credit. These were compared to the market penetration levels estimated in a report prepared by Resource Planning Associates, Inc. The implication of the model runs for R&D funding decision making within the DOE Division of Industrial Conservation were discussed.

Program: Conservation Options-Industry

Sponsor: DOE, Division of Industrial Conservation

WIND POWER AND ELECTRIC UTILITIES: A REVIEW OF THE PROBLEMS AND PROSPECTS

BNL 50849

H. DAVITIAN

National Center for Analysis of Energy Systems

The upper limit on the practically exploitable energy annually available from wind power in the United States is roughly 1-2 x 10^{12} KWh per year. Electric utilities comprise the largest potential market for wind machines in the megawatt power range. The use of windpower poses a variety of problems for utilities primarily due to the uncontrollability of the power source and the high degree of variability of the wind. Differences in the dynamic behavior of the wind and of utility load patterns and the problems that arise from these differences are described in this paper. Utility capacity expansion methods and modifications to them to incorporate the characteristics of wind machines into the analytic procedure are outlined and results from initial studies employing these modifications are reviewed. These results indicate that, in general, storage devices are too expensive to be purchased by utilities if they serve mainly to balance the output of the wind machines; wind machines tend to supplant purchases of conventional baseload capacity but require additional peaking units; and the economic value of wind machines to utilities is composed of savings in both fuel and capacity related expenditures for conventional equipment. Estimates of the value of wind machines to utilities are in the $500-700 per kilowatt range in favorable regions of the U. S. Engineering design studies suggest tha the cost of producing and installing wind machines might be brought down to this level with mass production and anticipated advances in design and production processes. Given the availability of high winds, the most favorable locations for the early use of wind generators are in isolated areas currently relying on small, petroleum fueled generating units and in regions with large hydropower authorities since such systems contain immense reservoirs of stored energy which could provide an ideal compliment to wind generation.

Program: Program Analysis

Sponsor: DOE, Office of Energy Research

A STUDY OF TRANSMISSION AND PROTECTION ELEMENTS FOR WIND ENERGY GENERATING - SYSTEMS - VOLUMES I AND II (APPENDICES)

BNL 50851

S. LINKE, A. TESHOME, AND P. D. YEHSAKUL

National Center for Analysis of Energy Systems

Results are reported of a study at Cornell University on transmission, distribution, and protection systems for large wind-energy generators (WEG) connected to an electric utility grid. Configurations for wind farms on flat terrain, mountain-peak clusters, and installations along a ridge were examined. Computer studies of load-flow and short-circuit behavior confirmed the technical feasibility of the proposed systems. Realistic unit costs for the projected transmission and protection schemes range from $109 to $317 per kW, depending upon choice of configuration and distance from the grid. Cost of protective equipment is found to be a major factor in most cases, tending to be equal of greater than transmission line costs when the WEG units are located five miles or less from the grid. Several alternatives are suggested for future study. An alternate, less expensive, protection design involving the use of high-capacity fuses instead of oil circuit breakers, coupled with a disregard for the disconnection of one or more WEG units for considerable periods of time, is discussed.

Program: Solar

Sponsor: Technology Assessment

DOCUMENTATION OF THE BROOKHAVEN ENERGY I-O AND I-O/BESOM LINKAGE

BNL 50856

J. T. FRASER

Economic Analysis Division

The BNL I-O model provides an accounting framework for the estimation of functional end-use energy requirements, detailed capital and labor requirements, and material requirements. The model is composed of energy and nonenergy sectors with the output of the energy sectors expressed in terms of physical Btu units and the nonenergy output in terms of constant dollars. The outputs of the energy supply sectors are distributed to energy conversion sectors for transformation into conventional energy forms. The outputs of these supply/conversion sectors are then distributed to "pseudo-"energy product or service sectors. Specification of energy input requirements to nonenergy sectors in terms of energy products permits interfuel substitution.

Inclusion of a capital investment subroutine provides intertemporal capital adjustment, hence, equilibrium between the capital investment required and the capital investment supplied in the model. A balance of payments subroutine estimates shifts in the pattern of domestic production resulting from changes in energy import levels; i.e., changes in imports of crude oil, residual fuel oil, and processed natural gas.

Linkage of the I-O model with the LP model, BESOM, permits endogenous determination of specific energy coefficients and total demands for energy products. The integration of the two models provides the capability to investigate the economy-wide impact of changes in energy prices and/or energy technologies in a future planning year. In addition, the feedback effect on energy production and conversion resulting from policies exogenous to the energy sector can be evaluated.

Program: Energy Strategy and Integrated Analysis

Sponsor: DOE, Planning and Evaluation

ENERGY DEMAND ANALYTSIS IN THE WORKSHOP ON ALTERNATIVE ENERGY STRATEGIES

BNL 50863

STEVEN C. CARHART

National Center for Analysis of Energy Systems

The Workshop on Alternative Energy Strategies, conducted from 1974 through 1977, was an international study group formed to develop consistent national energy alternatives within a common analytical framework and global assumptions. A major component of this activity was the demand program, which involved preparation of highly disaggregated demand estimates based upon estimates of energy consuming activities and energy requirements per unit of activity reported on a consistent basis for North America, Europe, and Japan. Comparison of the results of these studies reveals that North America requires more energy per unit of activity in many consumption categories, that major improvements in efficiency will move North America close to current European and Japanese efficiencies, and that further improvements in European and Japanese efficiencies may be anticipated as well. When contrasted with expected availabilities of fuels, major shortfalls of oil relative to projected demands emerge in the eighties and nineties. Some approaches to investment in efficiency improvements which will offset these difficulties are discussed.

Program: Conservation/Solar Policy and Planning

Sponsor: Conservation and Solar Applications, DOE; Resources for the Future.

ECONOMIC IMPACTS OF A TRANSITION TO HIGHER OIL PRICES

BNL 50871

R. G. TESSMER, Jr., S. C. CARHART, AND W. MARCUSE

Economic Analysis Division

Economic impacts of sharply higher oil and gas prices in the eighties are estimated using a combination of optimization and input-output models. A 1985 Base Case is compared with a High Case in which crude oil and crude natural gas are, respectively, 2.1 and 1.4 times as expensive as in the Base Case. Impacts examined include delivered energy prices and demands, resource consumption, emission levels and costs, aggregate and compositional changes in Gross National Product, balance of payments, output, employment, and sectoral prices.

Methodology is developed for linking models in both quantity and price space for energy service--specific fuel demands. A set of energy demand elasticities is derived which is consistent between alternative 1985 cases and between the 1985 cases and an historical year (1967).

A framework and methodology are also presented for allocating portions of the DOE Conservation budget according to broad policy objectives and allocation rules.

Program: Conservation/Solar Policy and Planning

Sponsor: DOE Office of Planning and Policy Evaluation, Conservation and Solar Applications

DOCUMENTATION OF AN INTERACTIVE PROGRAM FOR PROJECTING SPACE HEATING ENERGY DEMAND (IPPSHED)

BNL 50887

D. SCHNEIDER

Economic Analysis Division

The model presented here is designed to be a tool for analyzing the effects of conservation strategies in reducing building energy demands. The purpose of the model is to project residential space heating demands for defined structural types. The user obtains energy demand projections, interactively, for different geographic regions. These energy demands are derived by incorporating theoretical building energy loads, projected housing and fuel mixes, and the efficiencies of both the structures and the conversion devices. The User's Guide in Appendix A contains the necessary information for running the model.

Program: Conservation Options

Sponsor: DOE, Division of Buildings and Community Systems

OIL SUPPLIES, ENERGY CONSERVATION, AND GLOBAL STABILITY

BNL 50899

S. C. CARHART, W. MARCUSE, AND R. G. TESSMER, JR.

Economic Analysis Division

Recent projections of possible major increases in the price of oil on the world market create an entirely new planning environment for energy policy, including conservation and solar applications. Alternative policies may be developed to cope with either a pessimistic or an optimistic outcome with respect to world oil supplies. Policies to cope with possible much higher oil prices would need to be much stronger than current National Energy Plan proposals. Initial indications are that much higher prices would be absorbed without catastrophic impact on the U.S. economy, particularly if there is anticipation of such prices in energy policy. Possible impacts on world financial institutions could be more severe. Areas for development of policies which would mitigate the impact of major oil price increases are identified and discussed.

Program: Conservation/Solar Policy and Planning

Sponsor: DOE Office of Planning and Policy Evaluation, Conservation and Solar Applications

BROOKHAVEN ENERGY TRANSPORTATION SUBMODEL (BETS) DOCUMENTATION AND RESULTS

BNL 50902

J. R. WAGNER

Economic Analysis Division

The Brookhaven Energy Transportation Submodel (BETS) has been developed to calculate the amount of energy needed by the United States to transport energy materials under alternative energy scenarios. Categories of energy materials examined are: uranium, crude petroleum, crude natural gas, oil shale, refined products (except refined gases), hydrogen, refined natural gas, and four separate ranks of coal. Categories of transportation modes used are: pipeline, rail, truck, and water.

BETS is a submodel of the Brookhaven Energy System Optimization Model (BESOM). BESOM is a linear program that identifies the lowest cost combination of energy resources necessary to satisfy a set of assumed energy demands in the United States. This report presents the results of a BETS analysis performed on three BESOM scenarios. One scenario is a base case with moderate energy prices and moderate government R&D. Another scenario has higher energy prices, successful government R&D, and aggressive conservation. The third scenario has substantially higher energy prices and no fruitful government R&D. For each scenario BETS calculates energy consumption values attributable to the movement of each type of energy material on each transportation mode.

Program: Transportation/Conservation

Sponsor: Division of Transportation Energy Conservation-DOE

METHODOLOGY FOR MODELING GEOTHERMAL DISTRICT HEATING FOR RESIDENTIAL MARKETS

BNL 50905

J. KARKHECK AND R. G. TESSMER, JR.

Economic Analysis Division

Methodology is presented for modeling geothermal district heat service and for evaluating the economic market potential for such nonelectrical utilization of the geothermal resource. It is based upon accurate determination of the heating demand and its spatial and temporal profile in each potential market, determination of the cost to provide such service, and correlation of markets and resource sites.

Two components of the model are discussed in this report. The residential demand submodel and data base, which includes building characteristics and population distribution on a census tract or minor civil division grid for the nation, projects heating demand densities and temporal profiles along with building service modifications and costs. The service submodel and data base designs and costs a subtransmission and distribution network, and it evaluates operating losses at design conditions.

Program: Geothermal District Heating

Sponsor: DOE, Division of Geothermal Energy

ENERGY, EMPLOYMENT, AND ENVIRONMENTAL IMPACTS OF ACCELERATED INVESTMENT IN CONSERVATION AND SOLAR TECHNOLOGIES IN BUILDINGS

BNL 50918

S. C. CARHART, S. S. MULHERKAR, AND J. SCHWAM

Economic Analysis Division

One major energy conservation issue is the interaction of energy conservation with overall economic activity. One approach is to apply a hierarchical linkage to different models representing highly aggregated overall economic activity, the energy system at a greater level of detail, and one or more sector models representing the part of the economy in which the efficiency improvement is to occur. This paper presents results from an initial implementation of this general approach applied to the buildings sector.

The disaggregated models of the economy as a whole, the energy system, and the buildings sector are calibrated with alternative long term, aggregated projections of economic activity and energy prices. Then, possible buildings conservation policies are introduced into the buildings sector model. These policies are illustrative of initiatives which might be considered as an extension of the buildings conservation and solar policies proposed as part of the National Energy Plan, but do not represent any specific proposals now under consideration in DOE.

The buildings sector model projects improved efficiency and increased investment in buildings conservation technologies. These projections are used to modify the coefficients in the disaggregated economic model representing buildings sector energy efficiencies and investment component of buildings sector final demand. Solving the hierarchical system indicates that the conservation initiatives generate major reductions in energy consumption, environmental emissions, and oil imports in the system as a whole, while total employment increases due to the change in composition of economic output.

Program: Conservation/Solar Policy and Planning

Sponsor: DOE, Office of Planning and Policy, Assistant Secretary for Conservation and Solar Applications

SOLAR AND GEOTHERMAL ENERGY UTILIZATION IN SF-2: A SENSITIVITY ANALYSIS

BNL 50922

H. DAVITIAN, R. LA SALA, AND W. MARCUSE

Economic Analysis Division

This paper reports the results of a study conducted by the National Center for Analysis of Energy Systems for the Office of the Assistant Administrator for Solar, Geothermal and Advanced Energy Systems (ASGA) of the Energy Research and Development Administration (ERDA). The purpose of the study was to conduct a sensitivity analysis of the utilization levels for ASGA technologies during the 1985-2000 time period that were selected by the Office of the Assistant Administrator for Planning and Evaluation (APAE) for the ERDA 77-1 plan. In particular, the sensitivity of the utilization levels was tested with respect to both analytical techniques and to specific parameter assumptions. The sensitivity to analytical techniques was examined insofar as certain criteria, used by APAE to judge the overall "optimality" of alternative scenario possibilities, were examined to elucidate their importance in determining the level of use of the ASGA technologies. As a basis for this sensitivity analysis, the "SF-2" forecast for the year 2000 was chosen.

Program: Solar

Sponsor: DOE, Office of the Assistant Administrator for Solar, Geothermal and Advanced Energy Systems

COMPARATIVE ASSESSMENT OF ENERGY-ECONOMY INTERACTIONS: PRICE VERSUS GROWTH

BNL 50923

R. J. GOETTLE, IV, E. A. HUDSON, AND J. LUKACHINSKI

Economic Analysis

The role of energy in the U.S. economy is explored using the combined Brookhaven National Laboratory/Dale W. Jorgenson Associates (BNL/DJA) energy-economy model system. The BNL component of the system is a technological model of energy extraction, conversion and end-use and represents the economic and technical characteristics of the future substitution possibilities among new and conventional energy technologies and energy sources. The DJA model depicts production and spending throughout the economy on a sectoral basis within a flexible interindustry framework which permits substitution among capital, energy, labor, and materials in producing the goods and services that comprise the gross national product. The combined models give a comprehensive long-run representation of energy use and energy-economy interactions. Three alternative energy futures are analyzed within this system. These futures characterize the uncertainty which exists in the planning environment and result from the combination of several energy price forecasts with an invariant set of energy policies. The price trajectories are of different intensities and, with no assumed policy response, yield different levels of energy prices; they are labeled the Low, Medium, and High price cases.

A second objective of the analysis is to compare the results with those obtained from the Data Resources, Incorporated (DRI) quarterly macroeconomic model. This model had previously been used to simulate the effects of the three price futures under the same policy conditions. The numerical differences in the results of the two model systems are analyzed in terms of the structural nature of each of the models and are related to the scope of their respective equilibration processes. The nature of the energy-economy interaction is substantially less comprehensive and detailed in the DRI model than in the BNL/DJA system. Also, unlike the BNL/DJA system, the DRI model does not analyze economic supply and the process of economic growth. The methodological issues reflected in the comparison of the two modeling systems serve only to accentuate the importance of quality information to the design and evaluation of energy policy.

Program: Energy Strategy and Integrated Analysis

Sponsor: DOE, Office of Analytical Services, Assistant Secretary for Policy and Evaluation

ENERGY CONSERVATION POLICIES: POSSIBILITIES, MECHANISMS AND IMPACTS

BNL 50956

E. A. HUDSON AND D. J. BEHLING JR.

Economic Analysis

This study examines the possibilities for, and the consequences of, slowing the rate of increase of U.S. energy consumption over the remainder of this century. Four packages of energy policies incorporating combinations of taxes, subsidies, tariffs, and direct regulations are examined. These packages are structured in order of increasing severity; if implemented, they would yield successive reductions in the rate of growth of energy use, with the most severe package leading to zero energy growth. Estimates are presented of the magnitude of the energy savings that can be achieved by the various policy measures. In addition, estimates are given of the type and intensity of the policy measures which would be required to achieve specified reductions in energy use.

Analysis is also made of the impact of these policy measures on the structure of the energy system. The effect of the policies on the development of the energy system is investigated with particular attention being given to the consideration of changes in the fuel mix, in the degree of electrification and in the volume of energy imports.

The effects of such policy-induced energy changes on the economy are also subject to extensive analysis. The focus of this analysis is on the reduction in the level of economic activity which would accompany the reductions in energy input or, equivalently, the reduction in the rate of growth of the economy which would accompany reductions in the future growth of energy input. In addition, the more detailed aspects of changes in the economic structure caused by the energy changes are examined, along with the processes and mechanisms which relate changes in energy to changes in the level and pattern of economic activity.

Program: Energy Strategy and Integrated Analysis

Sponsor: DOE, Office of Analytical Services, Assistant Secretary for Policy and Evaluation

SECTION III

Biomedical And Environmental Assessment

COMPARATIVE EFFECTS OF COAL AND NUCLEAR FUEL ON MORTALITY

BNL 23579

S. C. MORRIS

Biomedical and Environmental Assessment Division

Results are reported of a standardized approach to estimation of effects of coal and nuclear fuel cycles on mortality. Linear damage functions are employed to calculate excess or attributable deaths associated with each stage of both fuel cycles. This level of exposure and the size population exposed to each risk is considered and estimates of both total impact and individual level of risk is produced. The annualized impact of coal electric generation is estimated to be greater than that of nuclear electric, with a fair possibility that coal has a relatively much greater impact on mortality than nuclear. Neither coal nor nuclear has a very big impact on mortality relative to other factors.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Environment

A PROBABILISTIC METHODOLOGY FOR ESTIMATING AIR POLLUTION HEALTH EFFECTS FROM COAL-FIRED POWER PLANTS*

BNL 23581

M. G. MORGAN, S. C. MORRIS, A. K. MEIER, AND D. L. SHENK

National Center for Analysis of Energy Systems

Published estimates of the local health impact from sulfur air pollutants released by large coal-fired power plants vary widely, and as a consequence, provide rather limited guidance for policy makers. Uncertainties are introduced in such estimates through the meteorological and epidemiological models used and by incomplete knowledge of the critical model parameters. Subjective probability distributions reflecting present knowledge of the value of each parameter were used with a model that assumes Gaussian plume dispersion, linear chemistry, and a linear functional relationship between air pollution levels and health damage. A stochastic simulation was employed to generate the probability density functions for excess mortalities and person-years lost per year of plant operation. Example simulations were based on a 1000 MWe plant, Pittsburgh meteorology, and population distributions around four plant locations in the Pittsburgh area. All previously published estimates of local health effects lay within the 80 percent confidence interval of our estimates for plants in the vicinity of urban areas. The greatest uncertainty in this problem is contributed by uncertainty in the health-damage function. The next largest contribution is from the oxidation rate coefficient. While the methodology demonstrated in this paper should contribute to the policy analysis of energy and environmental problems, we are hopeful that the primary impact of this work will be to promote growing attention to uncertainty in the analysis of public policy.

*Published in Energy Systems and Policy 2, 287-309 (1978).

Program: Biomedical and Environmental Research

Sponsor: DOE/DTO/EV

DATABOOK FOR THE QUANTITATION OF HEALTH EFFECTS FROM COAL ENERGY SYSTEMS

BNL 23606

S. C. MORRIS AND K. M. NOVAK

Biomedical and Environmental Assessment Division

This handbook provides a common set of health damage functions for use by participants in the Department of Energy's National Coal Utilization Assessment in estimating the health impact of coal energy cycle scenarios. Damage functions are expressed as excess or premature deaths, or injuries or disabilities per energy unit. Explicit consideration is given of uncertainties. Coal mining, processing, transportation, and combustion are covered.

Program: Regional Studies

Sponsor: ERDA/AES, Division of Technology Overview/Environment

SULFUR CONTROL IN COAL-FIRED POWER PLANTS: A PROBABILISTIC APPROACH TO POLICY ANALYSIS*

BNL 23850

M. G. MORGAN, S. C. MORRIS, A. K. MEIER, AND W. R. RISH

Biomedical and Environmental Assessment Division

The optimum level of sulfur pollution control for a coal-fired power plant is the point where the sum of societal costs due to pollution and control costs is minimized. This basic microeconomic concept has been of limited practical value due to considerable uncertainty in estimating both costs. A probabilistic approach is used to characterize these uncertainties quantitatively for a hypothetical 1000-MWe plant located near Pittsburgh, PA. Only mortality effects within a distance of 80 km of the plant have been included. The results allow explicit consideration of attitude toward risk and appropriate level of investment to prevent deaths. Limitations of the findings are discussed. Implications are described for policy based on alternative sets of values and assumptions.

*Published in J. Air Pollution Control Assoc. 10, 993-97 (1978).

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Environment

EXPOSURE TO INDOOR POLLUTION

BNL 23891

SAMUEL SILBERSTEIN

Biomedical and Environmental Assessment Division

Conservation measures will enable us to burn less fuel to heat and cool our buildings. They accomplish this in part by inhibiting air exchange with the outdoors; thus, may raise indoor air pollutant levels. We project residential pollutant concentrations for lower air exchange rates (v) and future population exposure to these levels. The population at risk is estimated to be composed of people living in homes heated by direct fuel-fired forced air systems. For most homes v is probably in the neighborhood of 1 air change per hour (ach). Existing evidence suggests that forced air heating systems contribute about 0.08 mg/m^3 to prevailing NO_2 background levels in these homes. If v were reduced to ½ ach, then NO_2 contribution would rise to 0.12 mg/m^3, and if v were reduced to ¼ ach, to 0.2 mg/m^3, the current 1 hour U.S. Environmental Protection Agency National Primary Ambient Air Quality Standards (NPAAQS). Calculations indicate that pilot lights may raise kitchen CO and NO_2 levels above NPAAQS if v is reduced 4-fold.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Assistant Administrator for Environment and Safety

FACTORS INFLUENCING THE PUBLIC PERCEPTION OF RISKS TO HEALTH AND SAFETY: A BRIEF SUMMARY

BNL 24000

ANDREW J. VAN HORN AND RICHARD WILSON (Harvard University)

Biomedical and Environmental Assessment Division

The factors which influence the public perception of risk are summarized and the three basic methods of discovering the public perception -- the revealed preference method, the expressed preference method, and the implied preference method -- are briefly reviewed.

Program: Biomedical and Environmental Research

Sponsor: DOE-DTO/AES

ENERGY CONSERVATION AND INDOOR AIR POLLUTION

BNL 24301

S. SILBERSTEIN

Biomedical and Environmental Assessment Division

Energy conversation measures that reduce a building's air exchange (ventilation + infiltration) rate, v, can degrade indoor air quality. A widely used model predicts that an indoor pollutant source contributes a pollutant concentration inversely proportional to v, over the long term. Because this is only true if the pollutant production rate is independent of v, we have modified the model so that it can account for pollutant sources, like heating systems, whose pollutant emission rates vary with v. Assuming that a heating system emits pollutants at a rate linear in v, we found that when v is lowered 4-fold from 1 to ¼ ach, the long-term contribution to the pollutant concentration is only tripled. (This is because the whole point of building conservation is to permit a lower level of heating system operation.)

We also examined the effect of lowering v on pollution due to cooking. As an example, we calculated that after one hour of oven use in a small kitchen having v = ¼ ach, the CO concentration will remain above the one-hour Environmental Protection Agency standard for 4½ hours after the oven is turned off.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology/Environment

ANALYSIS OF HEATING SYSTEM-GENERATED AIR POLLUTION

BNL 24302

S. SILBERSTEIN

Biomedical and Environmental Assessment Division

We derive a differential equation that describes the contribution of heating system operation to indoor levels of any pollutant. Because our model does not assume either a building's air exchange rate, v, or the temperature difference between indoors and outdoors, ΔT, to be constant, the differential equation is complex enough to require numerical integration, for which we give a simple APL program. By permitting v and ΔT to vary sinusoidally, we find the maximum nightly pollution contribution to be $1\frac{1}{2}$ times as high as when v and T are assumed constant at their average daily values. However, in estimating the effect of pollutant levels of lowering the air exchange rate by conservation measures, there is little difference between constant and varying v and ΔT so our previous conclusions[4] continue to hold.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology/Environment

POTENTIAL AMBIENT STANDARDS FOR ATMOSPHERIC SULFATES: AN ACCOUNT OF A WORKSHOP *

BNL 24916

M. D. ROWE, S. C. MORRIS, AND L. D. HAMILTON

Biomedical and Environmental Assessment Division

In June 1977, the Brookhaven National Laboratory Office of Environmental Policy sponsored a workshop to help frame estimates of air quality standards for sulfates and to gauge effects of these potential standards on the present and future national energy system. Workshop participants developed a list of standards with estimates of the time at which each might be promulgated. Within 1 to 2 years, only EPA National Ambient Air Quality Standards based on total water-soluble sulfates seem likely. Under the most stringent standard considered likely, constraints on sulfur emissions could have extensive effects on the entire energy system and would require substantial efforts to elucidate meteorological, economic, and legal relationships and to develop workable control strategies that account for long-range transport of sulfates. Under the least stringent standards considered feasible, constraints on sulfur emissions could be minimal and confined to a small area of the northeast. In either case, long-range formation and transport of sulfates over distances of hundreds of kilometers makes the problem of equity of sulfate control strategies particularly acute.

*Published in J. Air Pollution Control Assoc. 28, 772-75 (1978).

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Environment

ESUSA: U.S. ENDANGERED SPECIES DISTRIBUTION FILE

BNL 24488

J. NAGY AND C. E. CALEF

Biomedical and Environmental Assessment Division

This paper describes a file containing distribution data on federally listed or proposed endangered species of the United States. Included are (a) the common name; (b) the scientific name; (c) the taxonomic family; (d) the OES/FWS/USDI group (mammal, bird, etc.); (e) the status; (f) the geographic distribution by counties; and (g) Federal Register references. Status types are endangered, threatened, proposed, under review deleted, and rejected. Distribution is by Federal Information Processing Standard (FIPS) county code and is of four types: designated critical habitat, present range, potential range, and historic range.

The file is currently being used in conjunction with similar data on projected future energy facilities to anticipate possible conflicts. However, the file would be useful to any project correlating endangered species with location information expressed by county. An example is as an aid in evaluating Forest Service or Bureau of Land Management proposed wilderness areas.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Environment

A DATA BANK FOR THE GEOGRAPHICAL ALLOCATION OF FUTURE U.S. ENERGY SUPPLY FACILITIES BY COUNTY

BNL 50754

WALTER A. SEVIAN AND SALVADOR R. BOZZO

Biomedical and Environmental Assessment Division

A county-level data bank developed to permit the geographical allocation of planned future U.S. energy supply facilities is presented in this report. The data bank is organized by facility type and the county in which the facility is to appear. The facility type is further classified according to the fuel type, the supply activity to which the facility belongs, and the process type to be implemented. A numerical indexing scheme is assigned to all classification elements for purposes of retrival, updating and model interfacing. All formats for the individual facilities are tabulated along with descriptions of the data elements. A system under development to interface the data bank of future facilities with other biomedical, environmental, and technological models and data bases is discussed.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Environment

HAZARDS OF ORGANIC WORKING FLUIDS

BNL 50761

SAMUEL SILBERSTEIN

Biomedical and Environmental Assessment Division

We present several brief reviews on working fluids proposed for use in organic Rankine and bi-phase bottoming cycles. These were prepared for the U.S. Energy Research and Development Administration, Assistant Administrator for Environment and Safety/Division of Technology Overview during its preparation of an Environmental Development Plan for the ERDA Division of Conservation Research and Technology. There are several general problems with many organic working fluids: flammability, toxicity, and a tendency to leak through seals. Besides, two of the proposed working fluids are to be used at temperatures above the manufacturer's maximum recommended temperature and one is to be used in a way different from its customary usage.

It may, in some cases, be more profitable to first seek alternative working fluids before committing large amounts of time and money to research projects on unsafe working fluids.

Program: Biomedical and Environmental Research

Sponsor: DOE-DTO/AES

OUTDOOR SOURCES OF INDOOR AIR POLLUTION

BNL 50762

SAMUEL SILBERSTEIN

Biomedical and Environmental Assessment Division

Conservation measures that seal a building, like storm window installation, can significantly reduce its energy requirements. These measures also protect its occupants from air pollutants having outdoor sources but amplify any harmful effects of those generated indoors. A simple measure of the daily variation of pollutant concentrations and indoor production rates is derived from their Fourier series. Maximum indoor concentration of any pollutant generated solely outdoors lags behind and is lower than the outdoor maximum to an extent depending in an inverse manner on a building's air exchange rate, v. Lowering v will protect a building's occupants if the outdoor peak or variation above its average is much greater than its average, and the peak is short-lived.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology Overview/Assistant Administrator for Environment and Safety

MEDICAL DATA BASE: A TOOL FOR STUDYING THE RELATIONSHIP OF ENERGY-RELATED POLLUTANTS TO ILL HEALTH

BNL 50840

S. R. BOZZO, F. GALDOS, K. M. NOVAK, C. E. CALEF, AND L. D. HAMILTON

Biomedical and Environmental Assessment Division

The Medical Data Base (MEDABA) was developed to permit the examination of the effects of energy-related pollutants on ill health. Since geographical, as well as statistical considerations place certain requirements on the development of such a data base, the county was chosen as the basic unit of analysis. The file was organized in such a manner as to permit the aggregation of data in as many ways as possible, thus maximizing its usefuleness in serving a wide and varied number of specific research objectives. The data base is described and one of its specific uses as a research tool discussed in the light of the development of a population dynamic and mortality effects model. Input data for this model produced by MEDABA is presented in accompanying tables.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology/Environment

THE ENDANGERED SPECIES ACT AND ENERGY FACILITY PLANNING: COMPLIANCE AND CONFLICT

BNL 50841

D. F. SHREEVE, C. E. CALEF, AND J. NAGY

Biomedical and Environmental Assessment Division

New energy facilities such as coal mines, gasification plants, refineries, and power plants because of their severe environmental impacts may if they are sited haphazardly jeopardize endangered species. By law conflicts between energy facility siting and endangered species occurrence must be minimized. To assess the likelihood of such conflicts arising, we have used data from the Fish and Wildlife Service that describes species ranges by county. We have matched this data set with county level occurrences of imminent energy developments to find counties of overlap and hence potential conflict. An index has been developed to measure the likelihood of actual conflict occurring in such counties. Factors determining the index are: numbers of endangered species inhabiting the county, number of energy-related developments, and to what degree the county remains in a wild or undeveloped state. Maps have been prepared showing (1) geographic ranges of endangered species by taxonomic groups (mammals, fish, etc.) and (2) counties of conflict.

Program: Biomedical and Environmental Research

Sponsor: DOE, Division of Technology/Environment

PRELIMINARY REPORT ON SOME HEALTH, ENVIRONMENTAL, AND ECONOMIC COSTS AND BENEFITS OF ENERGY CONSERVATION AND FUEL SUBSTITUTIONS

BNL 50876

P. D. MOSKOWITZ, J. BRAINARD, D. P. SERWER, AND L. D. HAMILTON

Office of Environmental Policy

Some health, environmental, and economic costs and benefits of energy conservation and fuel substitution strategies are discussed. Impacts were assessed through detailed analyses of four complete energy scenarios for 1985 and 2000. The scenarios, including the President's National Energy Plan, describe reasonable paths that this country might follow and encompass a broad spectrum of fuel mix and environmental policy options.

The analyses show only small differences in emission estimates among scenarios even though total energy resource consumption varies by as much as 55 quads. This apparent anomaly is caused by fuel substitutions, reduced penetration of advanced pollution control technologies, and introduction of specific industrial process changes which produce higher emission levels. Emissions from the industrial and utility sectors dominate all aggregate estimates irrespective of the conservation strategies analyzed. The analyses also show that: improved load management and use of cogeneration do not appear to affect national emission levels significantly; strategies that reduce demand for electricity may reduce excess deaths by limiting emissions; conservation strategies in the residential/commercial sector producing tighter buildings could significantly increase indoor air pollution and potential health hazards; small shifts towards smaller and lighter automobiles could increase occupant fatalities; reductions in electrical demand could significantly reduce capital costs for emission controls; and rising energy costs may decrease GNP.

Program: Environmental Policy Analysis

Sponsor: DOE, Division of Policy Analysis/Office of Technology Impacts

THIS PAGE

WAS INTENTIONALLY

LEFT BLANK

SECTION IV

Technology Assessment

SYSTEMS FRAMEWORK FOR MATERIALS POLICY ANALYSIS

BNL 21958 [a]

N.K. BHAGAT AND K.C. HOFFMAN

National Center for Analysis of Energy Systems

A comprehensive systems framework for materials policy analysis, the Reference Materials System (RMS) is described in this paper. The RMS provides a systematic approach to organizing process type information regarding material flows, energy requirements, costs and environmental impacts on all processes that the raw materials have to go through to become the end use products. This system can be used for the assessment of materials, technologies, and policies.

Program: Energy Research

Sponsor: Department of Energy

[a] Abstract

MULTIOBJECTIVE ANALYSIS IN A NATIONAL ENERGY SYSTEM MODEL

BNL-24371

J. SCHANK

National Center for Analysis of Energy Systems

Multiple criteria are required to fully characterize the quality of any energy system. Past multiobjective analyses performed with the Brookhaven Energy System Optimization Model have relied upon the generation of pairwise tradeoffs between competing objectives. This process proved computationally burdensome. This study develops an automated methodology for such analyses. Both the previous and automated procedures are executed upon a variant of the 1985 National Energy Plan scenario and the respective results are compared.

Program: Energy Research

Sponsor: Department of Energy

A METHOD FOR THE COMPARATIVE ECONOMIC ASSESSMENT OF STORAGE SYSTEMS

BNL 24473

H. DAVITIAN AND R. W. LEIGH

National Center for Analysis of Energy Systems

This paper outlines a method for the comparative economic evaluation of various energy storage devices and applications. We have dealt with the economic aspects of the comparison and have employed total annual costs or costs per unit of delivered energy as the relevant economic measures. Briefly, the method involves a description of the application by a load duration curve and the use of this curve in conjunction with the cost and performance characteristics of specific storage devices to derive the annual operating costs. We then demonstrate how variations in the technical characteristics of storage devices in the context of a given application, or variations of the applications in which a particular device is used, give rise to variations in the costs of delivered energy.

Program: Energy Storage Systems Analysis

Sponsor: DOE, Division of Energy Storage

REGIONAL REFERENCE ENERGY SYSTEMS: ELECTRIC UTILITY APPLICATIONS

BNL 24627

A.L. HERMELEE

National Center for Analysis of Energy Systems

Reference Energy Systems have been developed for the region serviced by the Tennessee Valley Authority for the base year 1975 and projections developed for the years 1980, 1985 and 2000. This systems formulation has traditionally been applied to the assessment of energy technologies and policies on a national level. This paper presents a reformulation of the projection methodology in order to apply the Reference Energy Systems format to an electric utility region (e.g., the Tennessee Valley Authority). The Reference Energy System is a network representation of the technical activities required to supply various forms of energy to end-use activities. Technologies are defined for all operations involving specific fuels including resource extraction, refinement, conversion, transportation, distribution, and utilization. Each of these activities is represented by a link in the network for a given year with the levels of energy demand and supply specified.

A unique advantage of using the system presented here for utility planning is its integrative view of the entire energy system as opposed to an analysis limited exclusively to the electric sector. This systems approach incorporating all resources, technologies and uses of energy allows a utility to assess the impact of alternate technologies and policies across the entire energy system. Demand patterns for twenty-five end-use demand categories within the residential, commercial, industrial, and transportation sectors are developed for a base case scenario representing reasonable energy use patterns derived in a consistent manner by applying engineering techniques to the best available information. The impact of a new technology in terms of resource consumption may be evaluated by modifying the energy flow paths to incorporate the new technology. Alternate paths through the network reflect the substitutability of resources and technologies for one another.

Program: Energy Research

Sponsor: Department of Energy

GLAZING AND THE TROMBE WALL

BNL 24637

R. W. POUDER AND R. W. LEIGH

National Center for Analysis of Energy Systems

Single, double and triple glazing are examined for use in passive solar Trombe walls and south facing windows. Net gains and losses are calculated employing regional weather data and annual contribution to heating load reduction is evaluated. The study concentrates on the reflectivity of each glass pane, including the dependence of relectivity on the angle of incidence of the radiation, and resulting heat gains and losses. This facet of passive design heretofore has been inadequately treated and is shown to be significant. The marginal value of each additional pane is investigated with regard to heat gain, energy savings and total costs. Additionally, attention is given to the effects of Trombe wall energy storage.

Program: Energy Storage

Sponsor: DOE, Energy Storage Division

THE ROLE OF STORAGE IN SOLAR TOTAL ENERGY SYSTEMS

BNL-25085[a]

R. W. LEIGH

National Center for Analysis of Energy Systems

We present results from a current study of the "breakeven costs" of various energy storage technologies in the context of solar total energy systems providing electricity and space heat for a community of 500 dwelling units or for a single family house.

The energy systems, based on both solar thermal devices and photovoltaics, are examined to establish breakeven costs which the energy storage technologies must achieve in order to compete with fuel fired backup devices. The storage devices investigated include high temperature thermal storage, batteries, flywheels and other electro-mechanical devices and low temperature thermal storage for space heating. The value of "passive" energy storage in thermal mass in the buildings is also examined.

The energy delivery systems are "optimized" in that the mix of solar collectors, storage capacities and other components are adjusted to produce the lowest cost supply system for a given energy demand. The breakeven costs are taken to be those costs for the energy storage devices which permit such an "optimized" system to derive a specified fraction of its energy from the sun. The study is based on hour by hour simulations of the technical performance of the various systems, using the SOLMET weather and solar insolation data for five U. S. weather stations from diverse regions of the country. We thus test the sensitivity of breakeven prices to heating loads and available sunshine as well as to regional fuel price variations. The dependence of the results on the assumed solar collector costs and on the solar fraction demanded of an optimized system is also examined.

Program: Economic Analysis (17)

Sponsor: DOE, Division of Energy Storage

[a]Abstract

A COMPARISON OF THE TOTAL ANNUAL COSTS OF SOLAR AND CONVENTIONAL HEATING AND HOT WATER SYSTEMS: EFFECTS OF ELECTRICITY RATE SCHEDULES AND TAX INCENTIVES

BNL 25117[a]

H. DAVITIAN AND R. BRIGHT

National Center for Analysis of Energy Systems

A key measure of the relative advantages of a residential heating and hot water (HHW) system is the total annual cost of that system to a homeowner. The total annual cost is composed of annualized capital recovery payments, fuel and operating costs, and taxes. In this paper, total annual costs for solar HHW systems with electric backup are compared to the costs for electric-only and conventional oil or gas HHW systems in two regions of the U. S. The effects of marginal and average cost pricing for electricity and of load managing the electricity on the costs of the solar and electric systems are compared. The impact of the Federal tax credit and of local property tax exemptions on total annual costs are determined. Net changes (combined utility and residential) in resource consumption patterns and in pollutant emissions due to the use of solar systems are estimated.

As an example of some of the results, it was found that for one northeastern utility, given marginal cost pricing and assuming a doubling in the price of crude oil, the total annual cost of solar and oil fired hot water (HW) systems would be comparable by the year 2000 while the cost for an electric system would be substantially higher. This result assumed no Federal tax credit for solar investments but did assume local property tax exemptions. Load management had a negligible impact on the total annual cost of the solar system but it resulted in lowering the cost of the electric system to a level comparable to the costs of the others. Average cost pricing for electricity raised the cost of solar and electric systems so that a clear rank ordering of system costs emerged with electric highest, solar next, and oil lowest in cost. Net oil consumption for solar load managed HW systems was 20% of that required for a conventional oil system and an even lower fraction of that needed to provide electricity for electric-only HW heaters. Consequently, substantial savings in oil (or gas) could be achieved at no net additional societal cost and no net additional annual costs to the homeowner if marginal cost pricing were adopted for the electricity used by solar HW systems.

Program: Load Management and Solar Energy

Sponsor: DOE, Barriers and Incentives Branch

[a] Abstract

THE MARGINAL COST OF ELECTRICITY USED TO BACKUP RESIDENTIAL SOLAR HEATING AND HOT WATER SYSTEMS

BNL-25118[a]

R. BRIGHT AND H. DAVITIAN

National Center for Analysis of Energy Systems

In this study, the long run marginal cost to electric utilities of providing backup service for residential HHW systems is investigated. The marginal cost for solar backup is compared to that for electric-only systems and also to the average cost of all electric service provided by the utility. In addition, the effects of load managing the electricity used for HHW systems is determined.

A central feature of this analysis is that, unlike most previous studies of this issue, changes in the utility's optimal long-term capacity expansion program which would result from changes in demand patterns due to the addition or substitution of solar systems are accounted for. Historical hourly solar insolation and load data are employed for each utility region studied to provide a realistic simulation of operating conditions. An assumed 25 year market penetration rate is employed for the solar systems or, in the comparison cases, for the electric systems.

As an example of some results, it was found that for one northeastern utility, the marginal cost of electricity for backup to a solar hot water (HW) system was estimated to be less than that for an electric HW system in the year 2000. Load management substantially reduced marginal cost for both electric and solar systems. In all cases, the marginal cost was noticeably lower than the average costs. Consequently, substantial savings would accrue to owners of solar or electric HW systems under marginal cost pricing as compared to average cost pricing.

Program: Load Management and Solar Energy

Sponsor: DOE, Barriers and Incentives Branch

[a] Abstract

AN EVALUATION OF CROP RESIDUES FOR GENERATION OF ELECTRICITY

BNL-25119[a]

R. POUDER, N. BHAGAT AND H. DAVITIAN

National Center for Analysis of Energy Systems

Crop residues, the portion of extractable plant material which remains after crop harvest, are investigated as an alternative energy supply for electric power generation in agricultural regions of the United States. Current estimates indicate that the energy value of the U. S. annual production of residues is about 5 quads. However, in practice, it may be possible to collect only a fraction of this amount for use as an energy resource due to the valuable soil conditioning properties of residues when left on fields. Rough estimates place the yield fraction at about 25%. Cost estimates for preparation of residues as fuel indicate cost-competitiveness with conventional fuels. Costs range from $.75 to $1.25 per million Btu depending on crop type. Two small-scale (several kilowatts) gas generator power systems and one larger system are assessed to estimate their potential as generators of electricity on the farm and for larger scale applications; the market potential of these devices is discussed. Breakeven capital costs for the generators are estimated using purchased electricity as a baseline. Small-scale power systems with waste heat recovery for use on farms and larger units of about 5-10 mW capacity for use in a dispersed generation mode, were found to be most likely to be competitive with existing alternatives. These units became economically competitive at electricity prices slightly higher than current prices. The study concludes that future use of crop residues for generating electricity will be determined on a regional basis and will be determined by: the cost and availability of competing fuels, disposition and market value of residues for other uses (including the production of fuels other than electricity), and soil characteristics.

Program: Fossil Energy

Sponsor: DOE, Division of Power Systems

[a]Abstract

ENERGY ANALYSIS AND POLICY-SOME OBSERVATIONS

BNL 25194[a]

KENNETH C. HOFFMAN

NATIONAL CENTER FOR ANALYSIS OF ENERGY SYSTEMS

A variety of analytical models have been developed to assist in energy policy analysis. These involve simulation and optimization techniques as well as other specialized methods. Mechanisms for making more effective use of these models are discussed. New and innovative approaches to the use of analysis in policy are evolving and will be reviewed.

Program: Energy Strategy and Integrated Analysis

Sponsor: DOE - Office of Policy and Evaluation

[a] Abstract

THE APPLICATION OF ENERGY SYSTEMS ANALYSIS TO POLICY AND TECHNOLOGY STUDIES

BNL- 25207[a]

M. BELLER

National Center for Analysis of Energy Systems

The National Center for Analysis of Energy Systems at Brookhaven National Laboratory (BNL) has been engaged in the development of models and methodologies for application to energy policy and R,D&D studies. Additionally, these methodologies are combined with technology characterization studies to assess the impacts of various existing and future technologies on the U. S. energy system in the mid and long term. These assessments have been applied in program planning at the State and Federal level in the U. S. over the past six years.

The major techniques used in various policy and technology evaluations are the Reference Energy System, the Brookhaven Energy System Optimization Model (BESOM) and combined model systems incorporating these with macroeconomic growth and interindustry models. The role of these techniques will be described as applied to mid and long range forecasting. The methods employed permit the direct incorporation of new technologies, resources, and policies in an economic framework. The use of systems analysis tools for benefit-cost analysis and multiobjective analysis will also be described. Limitations of the techniques will be discussed.

Program: Technology Assessment

Sponsor: Department of Energy

[a]Abstract

LONG-TERM STRATEGIC ANALYSIS (TOWARDS AN ENERGY DOCTRINE)

BNL 25250

Kenneth C. Hoffman and Steven C. Carhart

National Center for Analysis of Energy Systems

The formulation of long-term energy strategies requires the synthesis of a large number of economic, social, technical, and environmental factors with due regard to regional and international needs and constraints. It is also clear that the long-term uncertainties are great and that any strategy must be adaptive in being able to respond to new circumstances and events. There is a need to debate and develop the strategic basis of energy policies and to test policies against the uncertainties and contingencies that are identified in the strategic basis.

Policy options that would lead to government involvement in energy markets should be analyzed and evaluated in terms of clearly defined objectives with means established to monitor their effectiveness. The orderly functioning of the decision process in industry and government requires a base of analysis and information on strategic issues.

This paper outlines an approach to strategic analysis in the energy sector. Emphasis is placed on the logic of the approach to strategic planning and analysis. The process begins with the definition of overall goals and objectives. A range of policy options may be defined to achieve the objectives and these must be integrated into a coherent strategy to achieve the objectives. Supporting analysis can indicate the effectiveness of the policy and the continuing need to modify objectives and policies as events unfold, uncertainties are resolved, or new situations developed.

PROGRAM: Energy Programs

SPONSOR: DOE

ON THE ECONOMIC ASSESSMENT AND OPTIMIZATION OF ENERGY STORAGE SYSTEMS

BNL 25291

H. DAVITIAN AND R.W. LEIGH

National Center for Analysis of Energy Systems

A method is described for the economic optimization and comparative evaluation of various energy-storage systems in a given application. The method is particularly useful in examining the economics of devices with short lifetimes and can be employed whenever a device lifetime can be expressed as a function of physical parameters which are related to the manner in which the device is used. Given a detailed description of the pattern of use of the device in the application, the device lifetime can be calculated. The economic consequences of changes in lifetime result from the dependence of the capital-recovery factor on device lifetime. It is shown how analyses can be made of changes in technical performance characteristics or changes in the pattern of use of the storage device to determine their effects upon the annual cost of energy storage and to determine minimum cost systems.

Program: Division of Energy Storage Systems

Sponsor: DOE, Technical and Economic Analysis Branch

FUTURE ENERGY REQUIREMENTS--THE BASIS OF ENERGY POLICY

BNL No. 25517[a]

Kenneth C. Hoffman

Department of Energy and Environment

Traditionally the role of the engineer has been to develop and deploy technology that serves the needs of society. As we enter an era where our energy and material resources are strained to meet the requirements of economic and social development, the engineer must play a more active role in formulating national policies that affect the supply and use of resources in the economy.

Mathematical techniques have been developed that combine engineering analysis of the supply and appropriate use of energy with a general economic framework. These techniques have been used to project the fuel as well as electricity required to satisfy the houing, transportation, and employment needs of the nation. Analysis of these requirements for energy, and consideration of the environmental effects forms the logical basis of energy policy. Projections of future energy demands and strategic approaches to energy policy will be reviewed.

PROGRAM: Energy Programs

SPONSOR: DOE

---

[a] Abstract

WHITHER ENERGY - FUTURE SHOCK OR A GREENING?

BNL 50686

KENNETH C. HOFFMAN

National Center for Analysis of Energy Systems

The United States stands on the threshold of new energy policies, which will determine the future course of energy supply and demand. It is clear at this point that we must accommodate our society over the next 30 years to reduced supplies of conventional oil and gas and to high energy costs. This transition poses a challenge to our ingenuity, patience, and perserverance. Some see a very close relationship between energy use and national income, or GNP, and are not very hopeful for a future of reduced energy supply. Others see the decisions and choices that are forced on us by recent crises and by the longer-term realities as leading to an improved and more sustainable society where resources are used frugally and the air is pure.

There are difficult problems to be overcome during this transition period with regard to the distribution of energy use among various income groups in the U.S. and among the developed, developing, and less developed countries of the world. The management of this transition to new energy sources and a more efficient economy will require close coordination of energy policy with other domestic policies and with foreign policy to ensure that social strains and international tensions resulting from energy supply and trade problems do not get out of control.

The lecture will address these policy relationships and will include some projections of our energy future on regional, national, and international levels.

Program: Energy Programs

Sponsor: DOE

ENERGY USE IN JAPAN AND THE UNITED STATES

BNL 50713

A. DOERNBERG

National Center for Analysis of Energy Systems

The comparative study of energy consumption in Japan and the United States was undertaken in much the same spirit as a Sweden - United States comparison done earlier, i.e., a search for unique technological features that help explain at least in part the energy per capita differential between the two countries. In the case of Sweden there are technological differences (district heating, insulation); in the case of Japan for the most part there are not.

For background information, brief sections on the energy supply and electric generation situation in Japan are included followed by the body of the report devoted to the energy consumption sectors.

The industrial sector merits most of our attention because Japan's industrial capacity is second only to that of the United States among industrialized nations and it is here where an intercountry comparison can reveal possibilities of technology transfer. First, a gross energy efficiency indicator for all industry is established. This is followed by detailed presentations of specific energy inputs (per ton of product) for four energy intensive industries.

Sections on the transportation, residential and commercial energy use reveal large differences in consumption largely due to what is labelled "standard of living" (housing size, automobile ownership, selection of transportation modes). In large part, however, the differences in energy use have their roots incultural idiosyncrasies. Technical features generally do not emerge in the comparison of these consumption sectors.

Finally, the section on conclusions underscores the usefulness of intercountry comparisons for industrial processes and delineates the limitations of such studies with respect to personal use of energy.

Program: Policy Analysis and Evaluation

Sponsor: ERDA

IMPACT OF SELECTED ENERGY CONSERVATION TECHNOLOGIES ON BASELINE DEMANDS

BNL 50745

A. DOERNBERG

National Center for Analysis of Energy Systems

This study is an application of the modelling and demand projection capability existing at Brookhaven National Laboratory to specific options in energy conservation. Baseline energy demands are modified by introducing successively three sets of conservation options. The implementation of improved building standards and the use of cogeneration in industry are analyzed in detail and constitute the body of this report. Two further sets of energy demands are presented that complete the view of a low energy use, "conservation" scenario. An introduction the report covers the complexitics in evaluating "conservation" in view of the ways it is inextricably linked to technology, prices, policy and the mix of output in the economy. The term as used in this report is narrrowly defined, and methodologies are suggested by which these other aspects listed can be studied in the future.

Program: Office of Policy, Analysis and Evaluation

Sponsor: ERDA

A STUDY OF POTENTIAL COAL UTILIZATION 1985-2000

BNL 50771

D. GUNWALDSEN, N. BHAGAT, AND M. BELLER

National Center for Analysis of Energy Systems

Growing energy requirements beyond 1985 will require continued expansion of coal use and will impose a considerable strain on the mining and transportation industries. National projections tend to obscure the reality that the impacts of this expansion will not be borne equally throughout the nation, but will fall heavily on the coal producing regions.

To examine these factors, regional supplies and demands for coal, oil, and natural gas were estimated for 1985 and 2000. National coal supplies of 1018 million tons in 1985 (consistent with FEA's 1976 National Energy Outlook) and 1836 million tons in 2000 were employed in our analysis. Coal transportation and use patterns for electric utilities, industrial steam, and synthetic fuel producers were determined by linking the supply, demand, and cost estimates and solving the resulting network through a cost-minimizing linear program formulation.

The coal use patterns generated through this formulation constituted the basis of an investigation of constraints which might preclude this development. Major findings of this study include:

1. Under existing environmental regulations, western coal will be competitive in utility markets well east of Chicago. With the passage of the Best Available Control Technology (BACT) proposal in the amendments to the Clean Air Act, requiring flue gas desulfurization for all new coal-burning power plants, this eastward penetration will be substantially reduced; the prospects for nuclear power are improved by passage of BACT.

2. Serious doubts exist as to whether the impacts of intensive coal rail traffic would be acceptable to communities located along western rail corridors. Granting eminent domain privileges for slurry pipelines is a viable option for relieving some of this strain and a means of introducing a degree of competition to western coal transport.

Program: Office of Policy, Analysis and Evaluation

Sponsor: ERDA

PROCEEDINGS OF THE WORKSHOP ON WORLD OIL SUPPLY-DEMAND ANALYSIS

BNL 50782

Kenneth C. Hoffman

National Center for Analysis of Energy Systems

On June 1 and 2, 1977, some of the country's leading experts on energy and economic analysis met at Brookhaven for a workshop on the analysis of world oil supply and demand. The meeting was sponsored by ERDA's Office of the Assistant Administrator for Planning, Analysis, and Evaluation. About 40 experts attended, including representatives from various government agencies, private industry, and universities. The group included economic and financial experts as well as geologists, engineers, and systems analysis specialists.

The purpose of the Workshop was to review the state-of-the-art of analysis of world oil supply and demand and to recommend approaches to be used in incorporating the results of such analysis in the planning of the nation's energy research and development program. Recommendations were also made for research and studies to increase our understanding of the impact of world oil price and availability on trade and economic growth.

Some conclusions of the Workshop were that most of the economic models now being used are effective for midterm and long-run equilibrium analysis. However, given the fact that oil supply prices are set on the basis of monopoly or dominant supplier considerations, and that the prices of domestic resources may be subjected to some degree of control, increased attention should be given to modeling and analysis under disequilibrium conditions. The basic characteristics of a potential world oil crisis have been described; however, further analysis is needed of the scope of the problem and of contingency plans involving technological and economic measures that may be implemented to ease the transition from conventional crude oil to alternative sources and a less energy intensive economy.

PROGRAM: Energy Programs

SPONSOR: DOE

AN ALTERNATIVE, SEMI-AUTOMATED METHCD FOR PERFORMING MULTIOBJECTIVE ANALYSES

BNL 50892

J. SCHANK

National Center for Analysis of Energy Systems

Multiple criteria are required to fully characterize the quality of any energy system. Past multiobjective analyses performed with the Brookhaven Energy System Optimization Model have relied upon the generation of pairwise tradeoffs between competing objectives. This process proved computationally burdensome. This study develops an automated methodology for such analyses. Both the provious and automated procedures are executed upon variants of the 1985 and 2000 National Energy Plan scenarios and the respective results are compared.

Program: General Systems Studies

Sponsor: Department of Energy

LONG TERM ENERGY PROJECTIONS

BNL 50915

Kenneth C. Hoffman and Steven C. Carhart

National Center for Analysis of Energy Systems

Long term energy planning requires a quantitative background which will illustrate the range of possibilities which must be considered. Such considerations are embodied in long term energy projections. In view of the high degree of uncertainty inherent in the long term future, these projections are conditioned on many assumptions concerning key factors influencing energy demand which arise outside the energy system. Based on specific assumptions concerning these factors, long term projections may be developed using a variety of analytical techniques which emphasize certain structural aspects and relationships within the energy system which may be highlighted for purposes of making particular decisions.

Long term projections for the United States are most appropriately performed within the context of world projections. Three of these are surveyed, with the more recent revealing trends toward lower energy consumption per unit of Gross National Product, and a high degree of uncertainty with respect to world oil supply, leading to substitution for other fuels. U.S. projections are far more numerous, and reveal a large range of demand growth estimates and fuel mix projections. Limits to conventional oil supply are a major consideration in these projections, with the result that long term projections are critically dependent upon efficiency improvements, renewable energy sources, nuclear energy, and coal as substitutes for the rapid growth in oil which has characterized the energy situation in the last few decades. Ranges of possible penetration of these alternative technologies are explored, along with alternative possibilities for reducing the amount of energy required per unit of economic activity. Areas of future work are also identified which could reduce the degree of uncertainty in projections.

PROGRAM: EIA/Policy and Evaluation

SPONSOR: DOE/EIA

SECTION V

Energy Data And Models

THE UTILIZATION OF ENERGY--INFORMATION REQUIREMENTS FOR POLICY

BNL 23643

Kenneth C. Hoffman

National Center for Analysis of Energy Systems

An understanding of the role of energy in economic and social development is essential to the development of energy policies. A comprehensive information base is needed to monitor progress in the conservation of energy and fuel substitution resulting from national policies and to serve as a basis for future policy actions. Unlike past energy policies, many new energy policies are designed to affect specific energy utilization activities, such as automobile fuel efficiency and building insulation characteristics. In order to analyze the effects of such policies, aggregated historical data on past patterns of energy utilization must be further disaggregated. In addition, where entirely new energy technologies are anticipated, historical energy data must be supplemented with data on these new energy processes. Thus, the basic elements of energy utilization must be identified and analyzed in the light of new policy initiatives.

This paper outlines an integrated approach involving the use of aggregated energy-economic data, as well as more detailed data at the activity level involving the characterization of specific energy utilization processes in the residential, commercial, and industrial sectors. Such information goes beyond the traditional treatment of resource utilization and delivered fuels to incorporate the concepts of energy services delivered, and of the direct plus indirect energy content of goods and services that are consumed.

The present situation is therefore one of transition from a period where analysis was governed by the availability of data to one where information must be developed to support the needs of policy analysis. The current information base is summarized and recommendations are made for the future development of an information base and analytical capability that will support energy utilization policy analysis.

Program: Energy Program

Sponsor: DOE

A DEMAND ELASTICITY REPRESENTATION METHODOLOGY AND CALIBRATION

BNL-24222a

A. S. KYDES

National Center for Analysis of Energy Systems

This paper describes the methodologies (and several case studies used in calibration) which have been incorporated within a version of the Brookhaven Energy System Optimization Model (BESOM) to yield first order approximations of the response of a national energy system, in economic equilibrium, to changes in prices, quantity of fuel availabilities and technological options. While the methodology cannot provide comprehensive energy-economic analysis, it is an inexpensive tool for performing first order sensitivity analysis around an established energy-economic "equilibrium" point derived from a full economic equilibrium procedure.

Program: Model Evaluation

Sponsor: Department of Energy

---

[a] Abstract

THE BROOKHAVEN TIME STEPPED ENERGY SYSTEM OPTIMIZATION MODEL (TESOM)

BNL-24223 a

A. S. KYDES, E. A. CHERNIAVSKY AND W. MARCUSE

National Center for Analysis of Energy Systems

The Brookhaven Time Stepped Energy System Optimization Model reflects uncertainties inherent in the energy planning process. Market penetrations/retirements of technologies are incorporated. The effects of severe energy supply/price dislocations can be analyzed over time with TESOM's extensive automated simulation capability. The model and an application are discussed.

PROGRAM: Model Evaluation

SPONSOR: Energy Information Administration

---

a Abstract

AN APPROACH TO HIERARCHICAL MULTIOBJECTIVE ANALYSIS*

BNL-24354 [a]

E. A. CHERNIAVSKY AND J. SCHANK

National Center for Analysis of Energy Systems

We describe an approach to multiobjective analysis of linear programs under the condition of a user-specified priority ordering of the objectives. The approach employs a minimax formulation, and requires the desision-maker to select relative weights for the normalized secondary objectives. The normalization factors and sensitivity analyses upon the weights facilitate decision-making consistency across all priority orderings.

PROGRAM: Energy Research

SPONSOR: Department of Energy

[a] Abstract

THE REFERENCE ENERGY SYSTEM - A FRAMEWORK FOR ENERGY INFORMATION

BNL 24819 a

K. C. Hoffman and A. Reisman

National Center for Analysis of Energy Systems

A comprehensive energy information system must incorporate a variety of data elements covering resources, supply and utilization technologies, economics and environmental effects. Available data bases that span the desired space, lack consistency with respect to units, sectoral definition, and geographical scope. The Reference Energy System (RES) has been employed at several levels of planning and analysis and could provide a logical structure for an Energy Information System. The current status of the data base that underlies the RES and the documentation is described.

PROGRAMS: Energy Programs

SPONSOR: DOE

[a] Abstract

THE REFERENCE MATERIALS SYSTEMS - A FRAMEWORK FOR SUBSTITUTION ANALYSIS

BNL 24820

N. K. BHAGAT AND K. C. HOFFMAN

National Center for Analysis of Energy Systems

A comprehensive systems approach to materials policy analysis, the Reference Materials System (RMS), has been developed and is described in this paper. The RMS provides a systematic approach to organizing diverse materials on all processes ranging from extraction of resources through their refinement, transportation, fabrication, installation, and maintenance at the point of end use, as well as recycling. This system can be used for the assessement of material technologies, substitutions and policies, and has been applied to assess the role of renewable materials as substitutes for energy intensive nonrenewables.

The format employed for the RMS is similar to that of the Reference Energy System (RES) used for energy analysis. It provides an engineering process description of material flows and related efficiencies, environmental impacts, and costs. The utilization of materials in the economy may be shown by using the RMS in conjunction with interindustry models of the economy of the input/output variety. When used in conjunction with such economic models the methodology allows for the analysis of materials policies and of the needs for renewable and nonrenewable materials to meet the demands of continued economic and social development in developed and less developed countries.

Program:Energy Systems Studies

Sponsor:Department of Energy

TECHNOLOGICAL-ECONOMIC MODELS FOR ENERGY ANALYSIS

BNL 24821

KENNETH C. HOFFMAN

National Center for Analysis of Energy Systems

A comprehensive set of energy system and economic models have been assembled at Brookhaven National Laboratory to analyze the long term relationships between technological change as driven by research and development, economic and social development, and environmental issues. The analytical techniques employed describe the flow of energy from resources, through supply side conversions and end use devices, to the utilization of the delivered energy in economic and social activity. Inter-fuel substitution possibilities and alternative conversion process are incorporated in the models. The scope and general structure of these models are described along with an outline of applications that have been accomplished.

Program: Energy Programs

Sponsor: DOE

COAL IN TRANSITION 1980 - 2000 DEMAND CONSIDERATIONS

BNL-50844

A. S. KYDES AND E. A. CHERNIAVSKY

National Center for Analysis of Energy Systems

Eight potential energy futures are examined by focusing on parameters expected to be important in determining the pattern of future coal consumption in the United States. The report describes the methodology, results and conclusions of this study performed by Brookhaven National Laboratory as part of a larger study administered by the Energy Modeling Forum (EMF). The EMF study, addressing the topic "Coal in Transition: 1980-2000", comprises the efforts of modeling groups from a number of organizations.

Model assumptions were chosen by a consensus of modelers, electric utility representatives and policymakers. The cases presented are not to be interpreted as "likely" futures but, rather, as cases which are designed to test the sensitivity of the individual models to the parameters of interest.

Program: Energy Technologies

Sponsor: DOE

THE BROOKHAVEN ENERGY SYSTEM OPTIMIZATION MODEL ITS VARIANTS AND USES

BNL-50873

A. S. KYDES

National Center for Analysis of Energy Systems

This paper provides a general overview of the Brookhaven Energy System Optimization Model (BESOM), two of its variants, and two examples of characteristic applications. BESOM is a linear programming model that was developed for the quantitative evaluation of energy technologies and policies within a systems framework. The model is designed to examine interfuel substitutions in the context of constraints on the availability of competing resources and technologies. BESOM provides a "snapshot" of the national energy system configuration, while MARKAL and TESOM provide, respectively, a farsighted time dimension and a simulation capability for the examination of the evolution of a national energy system over a time horizon.

PROGRAM: Energy Research

SPONSOR: Department of Energy

SECTION VI

International Programs

OUTLINE OF A STUDY OF THE ENERGY NEEDS, USES AND RESOURCES OF DEVELOPING COUNTRIES AND THE IMPLICATIONS FOR AID PROGRAMS

BNL 23300

POLICY ANALYSIS DIVISION

National Center for Analysis of Energy Systems

A study is outlined which will satisfy the requirement in the International Development and Food Assistance Act of 1977 for the President to carry out "studies to identity the energy needs, uses, and resources which exist in developing countries." The study will also consider those policies and programs in the energy area which can most effectively carry out the intent of the Act and AID's overall mandate.

Program: Developing Countries Energy Program

Sponsor: AID/ERDA

SOME CONSIDERATIONS ON THE ROLE OF ERDA IN THE DEVELOPMENT AND ANALYSIS OF ENERGY TECHNOLOGIES FOR DEVELOPING COUNTRIES

BNL 23669

P. F. PALMEDO AND V. MUBAYI

National Center for Analysis of Energy Systems

There is a clear rationale, indeed an implicit responsibility, for the Energy Research and Development Administration to be involved in the assessment and development of energy technologies for developing countries. That rationale is based on two types of considerations, the commercial and the (international) political. In the commercial area there is not only the possibility of significant exports of U.S. technologies but also the prospect of aiding the demonstration and commercialization process of technologies such as solar photovoltaic that are not yet economically competitive in this country. On the political side new energy technologies and energy planning methods could be very strong instruments in the implementation of foreign policy goals with respect to developing countries. This is particularly true for those energy-poor LDCs whose development prospects are dangerously impaired by current and anticipated costs of oil imports.

Program: Developing Countries Program

Sponsor: AID/DOE

CAPACITY EXPANSION IN ELECTRIC GENERATION WITH REFERENCE TO DEVELOPING COUNTRIES

BNL 24260

J. ALLENTUCK

National Center for Analysis of Energy Systems

In this short paper, the manner in which key economic and technical factors enter the electric capacity expansion planning problem in underdeveloped countries is examined. The problem is discussed in the context of a conventional expansion planning model. Subsequently a methodology for extending the bounds of the decision making process to include environmental and locational objectives and constraints is introduced. Considerations of the valuation of indigenous labor and fuel resources are discussed. The effects of the social rate of discount on technology choice are also examined.

Program: Developing Countries

Sponsor: Department of Energy

SOME CONSIDERATIONS ON THE CHOICE OF COUNTRIES FOR U.S. ASSISTANCE UNDER TITLE V OF THE NUCLEAR NONPROLIFERATION ACT OF 1978

BNL 24274

V. MUBAYI, J. ALLENTUCK, E. BEARDSWORTH AND P. F. PALMEDO

National Center for Analysis of Energy Systems

The Nuclear Nonproliferation Act of 1978 established a program of assistance to developing countries in meeting their future energy requirement. This report presents some preliminary considerations and criteria that should guide the selection of countries under this program. Three basic categories of criteria that derive from the intent of Title V of the above act are discussed in some detail. There are: (a) U.S. nonproliferation Objectives, including both the technical (nuclear power reactor) and strategic (interest in nuclear weapons) (b) Energy supply problems of developing countries, especially considerations related to oil availability, and (c) U.S. political and strategic interests. Data and analysis of issues related to these considerations for a large number of countries is presented and discussed.

Program: Developing Countries

Sponsor: Department of Energy

A SYSTEMS FRAMEWORK FOR INTERREGIONAL RESOURCE ALLOCATION FOR ENERGY SUPPLY IN DEVELOPING COUNTRIES: THE CASE OF COAL AND WATER RESOURCES IN INDIA

BNL 24952

P. M. MEIER AND V. MUBAYI

National Center for Analysis of Energy Systems

The inter-regional allocation of, and competition for, natural resources for energy development is assuming increasing importance in many large countries, particularly in countries such as India where state governments and regional agencies have significant planning powers. This paper explores the application of regional energy system planning frameworks designed for analysis of coal utilization and facility siting issues in the United States, but which have application to large developing countries that are in the more advanced stages of industrialization. The resource allocation model developed for the U.S. National Coal Utilization Assessment is applied to India, with particular focus on interstate competition for coal and water resources, and the locational implications for future energy development in India.

Program:

Sponsor: DOE

A SYSTEMS APPROACH TO ENERGY PLANNING

BNL 25523

P. F. PALMEDO AND R. NATHANS

National Center for Analysis of Energy Systems

Many developing countries are embarking on a petroleum intensive path of development just at a time in history when petroleum is about to become scarce and expensive. At the same time the use of traditional forms of energy--wood, crop residues and animal waste--is meeting with a variety of problems. Long range integrative National energy planning has become urgent. That planning should consider a wide range of geographical scales, from the household and village to the world scene. It should extend at least 25 years into the future. An overall framework for analysis is presented based on a normative, scenario approach.

Program: BNL Developing Countries Energy Program

Sponsor: United States Agency for International Development (USAID)

ON THE APPLICATION OF RESOURCE ALLOCATION MODELS TO THE PROBLEMS OF REGIONAL ENERGY POLICY IN LARGE DEVELOPING COUNTRIES

BNL 25537

P. M. MEIER AND V. MUBAYI

National Center for Analysis of Energy Systems

The interregional allocation of, and competition for, natural resources for energy development is assuming increasing importance in many large developing countries, particularly in countries such as India that are in the more advanced stages of industrialization, and where state governments and regional agencies have significant planning powers. This paper explores the applicability of optimal resource allocation models designed primarily for already developed economies, such as that of the U.S., Canada and Western Europe, to the emerging problems of such developing countries. In particular the potential application of electric utility siting models is discussed in the context of electric grid expansion in the State of Andhra Pradesh in Southern India. Specific topics addressed include the degree to which models can be effectively used in the rather different conditions and priorities of industrializing countries; the requirements for basic model reformulations to account for unique factors of geography (climate, hydrology, the extant conditions of the infrastructure within which any development must occur); and the ability to include and quantify environmental impacts of energy development as well as policy considerations relevant in the context of developing countries. The paper identifies desirable research directions, indicates data needs, and assesses those aspects of subnational energy planning problems that should receive better emphasis in national and international energy planning efforts.

Program: Regional Studies Program

Sponsor: DOE

ENERGY NEEDS, USES AND RESOURCES IN DEVELOPING COUNTRIES

BNL 50784

P. F. PALMEDO, R. NATHANS, E. BEARDSWORTH, AND S. HALE, JR.

National Center for Analysis of Energy Systems

Prepared for the Agency for International Development in response to a request by Congress, the report identifies the energy needs, uses, and resources in the developing countries of the world and examines the energy options available to them for their continued social and economic growth.

If traditional patterns of development are to continue, oil consumption in the non-OPEC LDCs will grow steadily to become comparable with current U.S. consumption between 2000 and 2020. Attempts to exploit indigenous hydrocarbon resources even in those LDCs with untapped reserves will be limited by shortages of capital and technical manpower. In the absence of major actions to replace noncommercial fuels or to increase the effectiveness with which they are used, a large fraction of the 3-4 billion LDC rural population in the year 2000 will not be able to raise their energy usage above subsistence levels.

There is a wide variety of solutions to these problems, many of them emerging directly from the changed economics of energy. For example, most LDCs have not adequately explored and developed their own indigenous resources; in virtually all energy conversion and utilization processes there are opportunities for improvements in efficiency and substitution of renewable energy forms. In virtually all these areas there are opportunities for effective assistance activities.

Program: BNL Developing Countries Energy Program

Sponsor: United States Agency for International Development (USAID)

AN ANALYTICAL FRAMEWORK FOR THE ASSESSMENT OF ENERGY RESOURCE AND TECHNOLOGY OPTIONS FOR DEVELOPING COUNTRIES

BNL 50800

POLICY ANALYSIS DIVISION

National Center for Analysis of Energy Systems

An analytical framework is described for the assessment of energy resource and technology options for developing countries. The framework, based on the Brookhaven Reference Energy System approach, is designed to provide an overall view of the energy supply-demand system of a country, integrating data from a variety of sources and specialized models. The current version is designed to support the evaluation of resource and technology options for countries which are part of the Department of Energy International Energy Program.

Program: Developing Country Program

Sponsor: Department of Energy

LESS DEVELOPED COUNTRIES ENERGY SYSTEM NETWORK SIMULATOR LDC-ESNS

BNL 50836

A. REISMAN AND R. MALONE

National Center for Analysis of Energy Systems

Prepared for the Brookhaven National Laboratory Developing Countries Energy Program, this report describes the Less Developed Countries Energy System Network Simulator (LDC-ESNS), a tool which provides a quantitative representation of the energy system of an LDC. The network structure of the energy supply and demand system, the model inputs and outputs, and the possible uses of the model for analysis are described.

Program: Developing Countries Program

Sponsor: Department of Energy

PROGRAMMATIC AREAS FOR U.S. ASSISTANCE FOR ENERGY IN THE DEVELOPING COUNTRIES

BNL 50890

PHILIP F. PALMEDO, ROBERT NATHANS, EDWARD BEARDSWORTH, AND GERHARD TSCHANNERL

National Center for Analysis of Energy Systems

A previous report entitled "Energy Needs, Uses and Resources in Developing Countries" presented an analysis of the energy problems facing the developing countries and the types of solutions that are available to them. In this report a wide variety of U.S. assistance programs which can facilitate those solutions is identified.

The report identifies 28 programmatic areas for assistance activities. In each area specific projects are indicated as examples and the general level of required funding is estimated. Twenty-two programmatic areas cover the development of conventional and renewable energy resources and technologies; six with assessment and planning, energy institutions, and training and education. Two hypothetical overall assistance programs are described with possible project distributions encompassing some twenty countries.

A broadly based U.S. energy assistance program which draws upon the highest quality of U.S. technical capabilities can make a significant contribution to the future economic and sociologic well being of the developing countries of the world.

Program: Developing Countries Energy

Sponsor: Agency for International Development