Proceedings

SECOND ANNUAL PACIFIC NORTHWEST

Alternative and Renewable Energy Resources Conference

OCTOBER 27-28, 1980
JANTZEN BEACH RED LION INN
PORTLAND, OREGON

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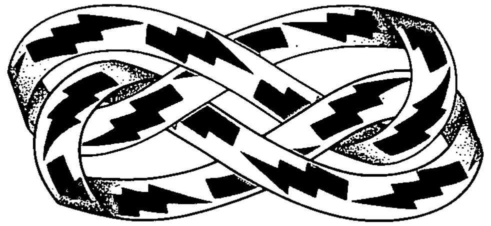

Möbius Strip

If you make a Möbius strip from a piece of paper and then use a pencil to draw a continuous line along the surface, you discover that the strip never runs out. We chose the Möbius strip as the symbol for the Alternative Energy Resources Conference because it is renewable and never ending, just as the resources are.

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SECOND ANNUAL PACIFIC NORTHWEST

Alternative and Renewable Energy Resources Conference

Purpose:

To solicit regional cooperation in promoting the near-term development of such alternative and renewable energy resources in the Pacific Northwest as:

- Cogeneration
- Wind
- Solar End-use Applications
- Biomass
- Small Hydro
- Geothermal Direct Heat Utilization

Participants:

This conference was planned for the directors, managers, and power planners of public and private utilities, industries, state, Federal and local agencies, and others interested in energy development in the Pacific Northwest.

Objectives:

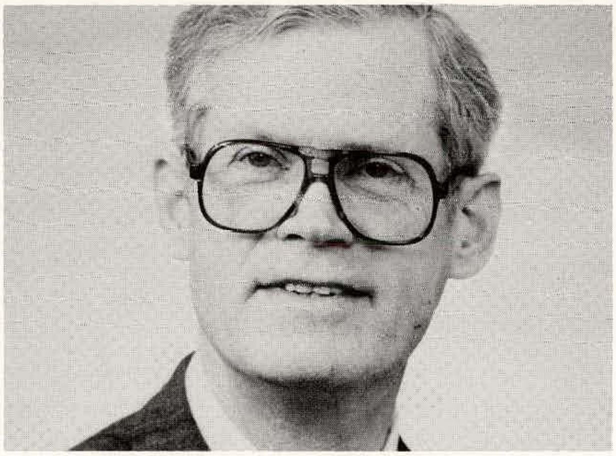
1. Identify alternative and renewable energy resources which can make an impact in the 1980's in the Pacific Northwest.
2. Give utilities and other interested parties who wish to invest in alternative and renewable resources a chance to learn first hand from those who have already done so.
3. Determine how these alternative and renewable resources can be developed in the most expeditious manner.
4. Give all parties who are interested in the development of alternative and renewable energy resources an opportunity to become aware of each other and the incentives and constraints associated with commercial development.

Questions which were addressed:

- Which renewable energy resources can make an impact in the 1980's?
- How do you develop alternative and renewable energy resources from the initial planning stages to the actual installation; what are the costs involved and what sources of financing are available?
- What can we learn from existing alternative and renewable energy resource installations in the Pacific Northwest?
- What are the incentives and constraints?
- What are the roles and responsibilities of utilities, industries and Federal, state, and local governments?
- What Federal and state legislation has been proposed or passed, and what needs to be done by the legislatures and why?

Presentations addressing these questions were interdisciplinary, including viewpoints from Federal, state, utility, engineering, research, legal and legislative speakers.

Ample opportunity was given to question the speakers either at the end of the sessions, at the breaks, or at special functions during the day in the exhibit center.



Jack G. Hornor, Conference Chairman
Assistant Director for Power Resources Division
Bonneville Power Administration

Donald J. Davey, Conference Coordinator
Project Leader for Outreach, Education and Internal Conservation in Energy Conservation Branch,
Bonneville Power Administration

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Panel 3: RESOURCE ASSESSMENT

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Moderator: Nick Cimino

Panel 6: MAKING THE TRANSITION TO ALTERNATIVE ENERGY SYSTEMS

Moderator: Dick Durham


CHARTER

THE SOLAR TOUR

On Sunday, October 26, Gene Ferguson of the Portland Area Office, with assistance from Grant Vincent of the Conservation Division, led a Solar Tour which was designed to familiarize participants with various kinds of solar energy designs. The tour featured commercial and residential buildings which used solar to supply some share of their total energy needs. The need for visits to sites where people have successfully integrated the use of solar energy was confirmed by the enthusiastic response demonstrated by those who took part in this tour. Approximately sixty people showed up on this less than sunny Sunday to dodge raindrops and mud puddles in order to see these examples of working solar buildings and to hear the architects, designers and homeowners describe their systems and discuss their experience with solar energy.

The first site visited was the International Wood Workers Council Building in Gladstone. The architect, Howard Glazer, met us there and explained how the solar assisted heat pump system, in the building which he designed, worked to reduce heating requirements.

The next stop was at the Pioneer Masonary Co. Bldg. on S.E. Belmont. The architect, Jerry Brewster, led us through the building. Jerry pointed out how this building remained one of the few hot spots in the neighborhood during last year's ice storm. "People came from other buildings in the block," Jerry said, "in order to stay warm when the power failed in their buildings, leaving their offices cold and deserted."

The next stop was the Steve and Janet Steven's residence, where the tour had an opportunity to see a house remodeled for passive solar. This stop also featured a coffee and tea break. Cakes and refreshments were provided by Gene's wife Toni. Janet and Steve helped Toni serve the tour members. During this break people found an opportunity to exchange ideas and ask questions. Bruce Bolme, who did the solar design engineering, was there to answer questions.

The final site was at Ann Wikman and David Knepper's residence. Ann and David were site sponsors for a solar water heating workshop conducted by Portland SUN, a local non-profit solar educational group. Ann and David took turns recounting their experiences with the workshop. Ann and David are happy with the performance of their system.

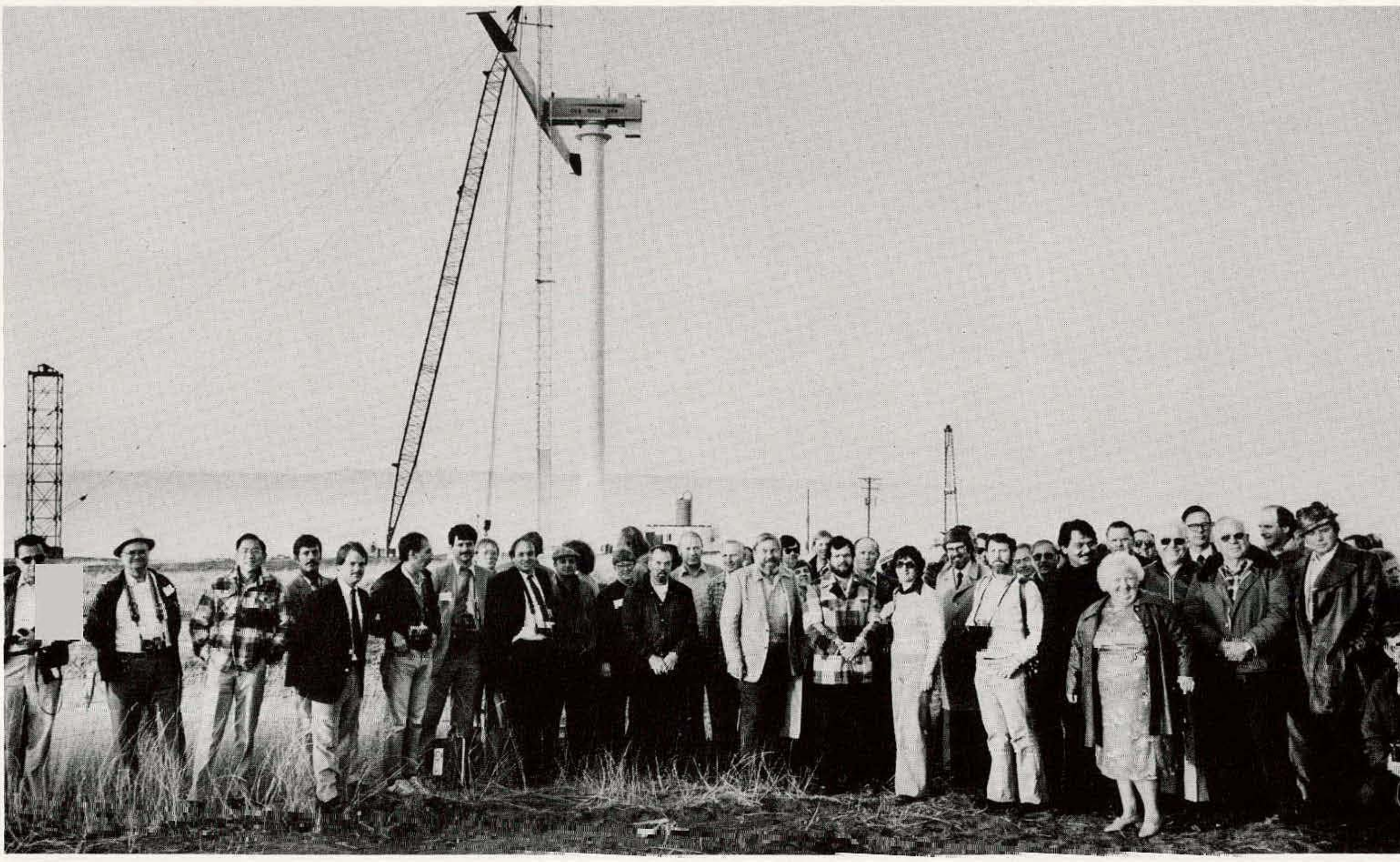
"With tax credits and the savings from installing the system ourselves," says David, "we will be getting years of reduced utility bills. The system will pay for itself in less than five years."

The solar tour was an exciting opportunity to get a feel for what is going on in solar energy in the Portland area. A side benefit was the opportunity for the many people who went on the tour to exchange ideas, talk about solar and exchange information on what they and their organizations were doing to plan for the energy future. The tour members returned to the Red Lion ready for the next two days of conference activities having seen for themselves something of what renewable energy is all about. ▮

GOODNOE HILLS FIELD TRIP

Over 150 conference participants went by bus along the Columbia Gorge to view the three 2.5 MW each wind turbines under construction outside Goldendale, Washington. The Boeing Engineering and Construction Company provided background information and slides at the Klickitat PUD. The participants were also able to see from the bus two small (2kW) wind machines which were operating that day. Along the entire route there were opportunities to observe many energy-related and natural features of the the Gorge.

To conclude the trip, Representative Al Ullman of Oregon addressed the group at a dinner in the town of Hood River. ▌



An Energy Future We Can Count Upon

Sterling Munro
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Sterling Munro, appointed Administrator of Bonneville Power Administration in 1978, earned a degree in political science and journalism at George Washington University in Washington, D.C. and completed two years of study at its law school.

After one term on the staff of the Washington State Legislature, Mr. Munro moved to Washington, D.C. and served in staff capacities with the Library of Congress and the U.S. House of Representatives. In 1953 he joined the office of Senator Henry M. Jackson as an administrative assistant, involved in conservation and natural resource legislation. Mr. Munro serves on the Board of Directors of the Electric Power Research Institute (EPRI).

As I contemplated my message today on alternative and renewable energy resource development, I was reminded of the man of the cloth with the reputation not only for holiness and wisdom, but also for great diplomacy. He was often sought out by people with problems. One day he was approached by two fellows in heated debate. After they had explained what they were arguing about, he turned to the first fellow and said: "Tell me your side of the story."

Upon hearing the fellow's reasoning, the wise and diplomatic man of the cloth replied with earnestness, "You know, you're right."

He turned to the other fellow and, when he had heard the other side of the argument, said with equal earnestness: "You know, you're right."

Meanwhile, a bystander observing all this was perplexed and, after the two debaters went off each convinced of his rightness, demanded to know from the man of the cloth: "How could you do that? Here these two fellows took opposite sides of the argument, and you told them they both were right. They both can't be right."

Reflecting for a moment, the wise and diplomatic man of the cloth looked the bystander in the eye and told him, with all earnestness, "You know, you're right."

Well, as I stand up here and tell you that we in this region are going to lead the nation in accomplishing conservation and renewable resource development, I'm also going to tell you: You know, Munro's right about that.

And as I stand up here and tell you that we're going to have a hard time getting a significant amount of conservation and renewable resource development accomplished in this region in the next few years, I'm also going to tell you: Y'know, Munro's right about that.

But if you try to convince me—like that bystander tried to convince that man of the cloth—that I cannot be right on both counts, I will not respond in the fashion of the story and tell you that you're right. No, I will insist that Munro is right on both counts. We can accomplish a lot! It will not be easy!

We will be able to accomplish a lot because of the growing determination of the people in this room . . . and the growing determination of the region's Congressional delegation, Governors and other state officials . . . and the growing determination of the region's utilities . . . and the growing determination of the region's ratepayers and the public at large.

We will accomplish so very much because it appears certain that the Congress is about to give Bonneville the authority to invest heavily—on behalf of the entire region—in conservation, and heavily in renewable resources, as well. We will be able not only to acquire the output of renewable resource projects, but we will be able to provide the upfront money for feasibility studies and preliminary engineering of potentially worthwhile renewables.

I speak only of renewable resources in detail because it and not conservation is the principal subject of today's conference. It will be difficult to complete construction of any appreciable amount of renewable resource development in the next few years. There are several reasons why this is so. One is planning time. Another is licensing time. A third is that because renewable resource projects typically are small in size it will take many successful individual projects to add up to one Bonneville Dam, or one Trojan nuclear project, or one Centralia coal project, not to mention one Grand Coulee Dam.

As for planning, we will soon have a new Regional Council to assess the region's power requirements and develop a plan for meeting the needs. The plan must give priority to renewable resources as well as to conservation. But the governors of the four states will have six months in which to appoint the council, and the council will have two years after formation in which to assemble a staff and hold the public hearings and develop and adopt a plan. After the plan is in effect, BPA may acquire only such new resources as are consistent with the plan, unless otherwise specifically authorized by Congress.

But the region will not have to wait for adoption of the plan to move ahead in the development of renewable resources, and BPA will not have to wait for adoption of the plan, either, to help the region get going on renewable resource projects of 50 megawatts or less. Not only will BPA not have to wait to make such contribution as it can to small renewable resource development, the Act will **direct** BPA to move forward immediately with whatever it can help accomplish in the way of the priority options—conservation and renewable resources—prior to development and adoption of a plan. These include consumer-installed individual applications of renewables such as solar hot water heaters and family-sized windmills that either produce electricity or substitute for it. The Congress will not say that we **may** do this. It will say that BPA **shall** do this. The Congress, of course, will require BPA to follow normal budget procedures. We are self-financed, as you know, but we still must present our proposed expenditures to the Office of Management and Budget and to the congressional appropriations committees before we can expend funds for these worthwhile purposes. But we are preparing to fast-track our conservation and renewables efforts just as the new law will require.

In that vein, I want you to know that we have already written letters to all of BPA's utility customers, and to each of the governors of the four Northwest States, inviting their recommendations as to what should be included in the way of conservation and renewable resource project funds in the budget amendments for Fiscal Year 1981 which we are now preparing—assuming the bill passes next month—and what might be included in our Fiscal 1982 budget, as well. If we are going to spend funds in this Fiscal Year, the latest time at which amendments to our budget can be submitted is in January, less than three full months away. I hope others will start planning immediately, too, for what they will recommend to the Regional Council.

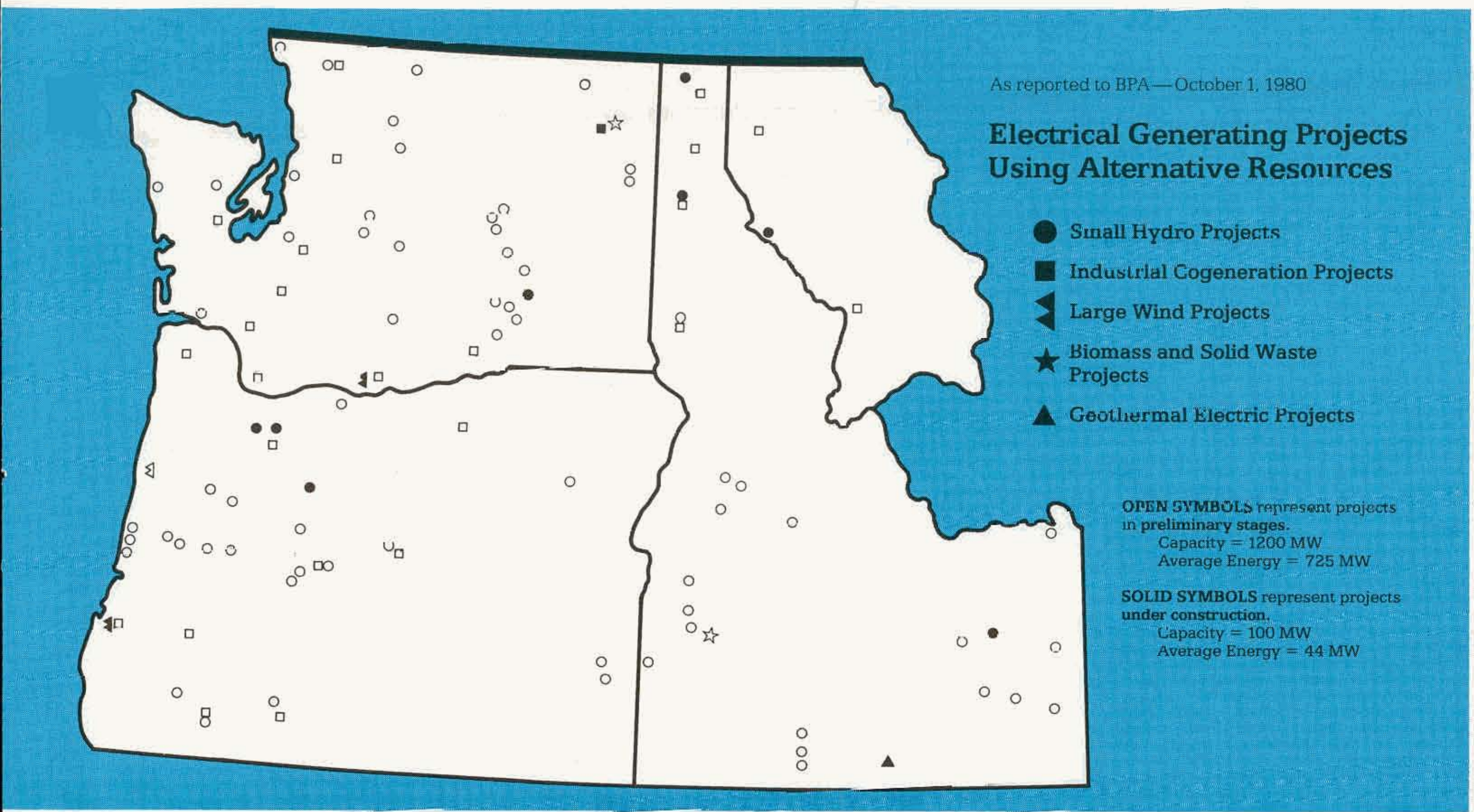
It is absolutely necessary for BPA to work closely with all interested parties in the region if we are to help get new renewable resources projects built. For the Act will not allow BPA to undertake renewable resource projects or any other generating projects on its own. Just like BPA conservation programs must be accomplished by working through our utility customers, renewable resource projects must be built by others. The Act will not authorize Bonneville to build or operate or own any power generating resources. For renewables, we can provide upfront money for potentially cost-effective projects, and this is likely to be our very important contribution in the first several years—money for preliminary site analysis, feasibility studies and pre-construction investigations. To the extent that projects utilizing renewable resources reach culmination, we will purchase the capability of the projects built by others. But, as is the case now, we will not be allowed to construct or own any projects ourselves.

Now, I don't want to appear a pessimist, but I must be a realist, and the big map behind me tells the real story on renewables in our region at the moment. Renewable resources projects already in existence, other than the Federal and non-Federal hydro projects large and small—the original great renewables—add up to only about 200 megawatts of average energy. That's not a whole lot either in terms of the region's present total resources of 16,000 average megawatts or forecasted needs of double that, about 32,000 average megawatts, by the year 2000.

In any event, the map shows only renewable resources projects including small hydro under 50 average megawatts that are under construction or in various stages of planning—and only to the extent we have been able to learn from others what they presently have in the works. There may be more going on than we know about, and if so, we'd like to know about it. On the other side of the coin, it is not at all certain that **all** of these projects will actually get built. Nevertheless, the map shows eight small hydro projects under construction and 64 in one or another stage of planning. If all those under construction and planned are, in fact, completed, they will add 560 megawatts to the region's hydro capacity—about the same capacity as the second powerhouse at Bonneville Dam or the new Boardman coal-fired project. The energy from these small hydro projects will be less than half their contribution to peaking capacity because there simply will not be enough steady streamflow behind them to produce energy more than 50 percent of the time, as a general rule, and often no more than 30 or 40 percent of the time.

I am comparing the output of these renewable resources to some large existing projects only to emphasize my earlier point that it takes a large number of individual small renewable projects to make a dent in overcoming the shortages in the decade ahead, which could range from equivalent of two to four large thermal plants. And, of course, we all know that you can't start one new thermal project of that size now and expect to get it on line in this decade. We have to do the job in this decade with the means available in this decade—and that means mainly conservation and renewables in addition to completing as rapidly as possible the large thermal projects under construction or scheduled.

The map shows one cogeneration project under construction and 24 planned. If all those under construction and planned are completed, they will add to the region's supply capacity equivalent to a little more than a Boardman coal project or the second powerhouse at Bonneville. The fall-off between capacity and energy is not so great with cogeneration as with small hydro. We



expect about 75 percent plant factor from cogeneration, so the cogeneration projects shown on the map, if all are in fact completed, could add as much energy, too, as the Boardman coal plant.

And so it goes. All of the renewable resource projects shown on the map, if completed, will add about 1,250 average megawatts of capacity to the region's supply and about 700 average megawatts of energy. We need three to six times that much in this decade to head off the projected deficits.

In the past year, not one new small hydro project has been completed in the region, but one retired small hydro plant has been reactivated with capacity of three—count 'em: one, two, three—megawatts. Since we met a year ago, actual construction has begun on three—count 'em: one, two, three—average megawatts worth of large and small wind projects, including the three MOD-2 windmills at Goodnoe Hills. Their 2½ megawatts **capacity** each make them the world's largest windmills ever. But the available wind—the most favorable wind conditions in our region—will allow them to operate only about 35 percent of the time. Hence only about one average megawatt of energy for each 2½ megawatts of capacity. We know of only two other windmill projects totalling eight megawatts of capacity on which construction has been started within the past year, and only one wind project with one-half of one megawatt of potential on which the site-specific licensing process has begun.

Bonneville's resource assessment people tell me there may be no more than five renewable resource projects of any kind—other than individual homeowner applications—that are far enough along in development so that Bonneville might actually be able to acquire their capability in the next 12 months. That's renewable resource projects of all types—wind, solar, small hydro, biomass, cogeneration, geothermal, whatever—that might add one megawatt or more to the region's supply.

So it goes. High hopes. Low numbers.

In the case of geothermal, in our region there is not a single **commercial** geothermal electric generating project **built or planned**. The main reason is that the hardware for producing electricity from geothermal resources has been built for higher temperature geothermal resources than those so far identified in our region. We have no known geothermal resources that can be put to work producing electricity with available technology. So the one geothermal electric project underway in our region is a **research** project in Idaho, sponsored by the Raft River Co-op with participation by DOE and others. Its purpose is to develop technology that can produce electricity utilizing the moderate-to-hot thermal reservoirs in our region. Of course, there are other applications of geothermal that may prove to be energy-efficient, but BPA's involvement is limited to electricity.

Development of commercial geothermal projects in this region faces other problems, as well. One is the difficulty for developers to obtain leases on Federal land. Another is water rights. Geothermal does not conform to either water or mineral definitions. As a consequence, several states have elected to treat it as a water resource. In this region, where water is so important to agriculture, many water rights already exist and the present holders of those rights want to hold onto them. Inasmuch as the Raft River pilot plant is recognized as a research project, it has avoided the water rights issues a commercial plant would have to face up to. For example, the Idaho Department of Water Resources decided to allow an agricultural water right to be applied to this 5-megawatt pilot plant. However, under the agreement, if the plant were to be used for commercial operations, a change in the water agreement would be required. And just recently, the Supreme Court ruled that anyone entering into a change-in-use agreement will lose those water rights.

Each renewable resource has its own peculiar problem or set of problems when it comes to translating electric energy potential into reality. We must not let that deter us, but neither can we afford to duck the problems and talk only about the potential. What we need in the region is energy resources we can count upon. The starting point is to identify and investigate all the potential and get cracking on what can be developed. The ability that the new law will give BPA to provide upfront money should assure the necessary studies getting underway, and the authority the new law will give us to acquire renewable resources should assure renewable resources projects actually getting built that otherwise—because of the risk—might never get built.

So, while only a handful of renewable resource projects may be available in the near-term for acquisition by BPA under the new law, we expect to be doing other things in the coming year to help others move more projects to the acquisition stages once we hear back from the Governors and the region's utilities—things like funding preliminary siting analyses and feasibility studies and other preconstruction-preacquisition activities.

There are other hoops to test us on the way to acquisition of renewable resource projects. Under the forthcoming Act, BPA not only must identify the sponsors of potential projects, but we must make some preliminary findings that each proposed resource would likely meet the standards of the Act—that is, that they would be cost-effective, needed, compatible with our existing system, etc.

Unless BPA can make an initial determination that there is no way there could be a significant environmental impact, an environmental assessment leading to either a Finding of No Significant Impact (FONSI) or an EIS must be prepared. Now, I am not talking about a one-time assessment or a one-time EIS. I am talking about assessments for project after project, even the smallest of them, over and over again—adding up not to tens or twenties, but literally hundreds of assessments—no matter what the renewable resource might be or how many projects of that type might previously have been approved. This is because the impacts on air, water and land must be judged on a site-specific basis.

And if you think winning all the necessary approvals will be easy, you haven't been reading the same newspaper headlines I have. Here are a few headlines from just the past month or two: "Rexburg Geothermal Drilling Terminated," "Dam Would Hurt Eagles, City Light Studies Show," "Montana Rejects Kootenai Dam Application," "Goods for Energy Conservation Hard to Find," "Building Codes Slow Solar and Windmill Plans." Well ... that's just a few.

Each assessment for renewable resource projects proposed for BPA acquisition is expected to take somewhere between a few weeks and a few months. An EIS likely would take an additional 6 months to 12 months, depending on complexity and controversy, possibly longer, and would include a hearings process. Even with a FONSI—a Finding of No Significant Impact—we might decide we need to hold a hearing in the community most immediately impacted before finally deciding.

Subject, then, to a letter of intent, we would make a purchase by contract and at the same time complete the record of the decision. This record would be subject to judicial review. It would have to establish that the acquisition met the standards of the Act and other applicable laws. The acquisition would have to be cost-effective. It would have to be compatible with the environment. It would have to take into account fish and wildlife protection, mitigation and enhancement. It would have to be compatible with our system. And so on.

There are variations on this acquisition theme. An experimental, pilot or demonstration project would not have to be cost-effective. Though the technology would have to have the potential for eventual cost-effectiveness, there are certain kinds of direct application renewables for which we could give grants and make loans without going through the long process I have just described. I'm now speaking of the kind of renewables that can reduce electric demand in a residence or commercial establishment. We also will be able to give billing credits to a utility which on its own undertakes and utilizes a resource that reduces the demand on BPA for supply.

After the regional plan is in effect, the test of consistency is with the plan, which would tend to simplify the findings respecting need and cost-effectiveness.

But none of this will be easy.

And yet it must be done. There is no higher purpose to be served in our area of human endeavor—electric energy supply—than to put conservation and renewable resources to work in ways that will provide the people of our region with an energy future they can count upon.

If I have sounded pessimistic, it is only because I have ed to be realistic about the size and difficulty of the job ahead, and am trying to encourage energy people to get going. Obviously, nothing gets done unless **somebody** does it. There are some things we at Bonneville can do. There are some things others must do. There is a lot for all of us to do.

I am confident that knowledge exchanged here today and tomorrow will make it easier for us all to get the job done.

I am confident that Munro will be proved right on both counts — not only that it will be difficult to get any appreciable amount of renewable resource development achieved in the next few years, but also that we in this region **will** lead the nation in the application of conservation and renewable resources. In the process we **will** give the people of our region an electric energy future they can count upon. ▌

Renewable Energy Resources: Boon or Boondoggle?

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René Malès has been director of the Energy Analysis and Environment Division of the Electric Power and Research Institute (EPRI) in Palo Alto since February 1976. Before joining EPRI, he worked in the financial, economic, and operation divisions of Commonwealth Edison Company of Chicago, where he was successively director of economic research, assistant to the vice-president of division operations, and manager of general service.

Mr. Malès has chaired the advisory committees of the Oak Ridge National Laboratory's Energy Division and of the Brookhaven National Laboratory's Center for Analysis. He has served on the Edison Electric Institute's Energy Analysis Division's advisory committee and on the Technical Advisory Committee of Project Independence for the Department of Commerce, for which he chaired the Finance Subcommittee.

Mr. Malès graduated from Ripon College, studied mathematics at the University of Chicago, and obtained an MBA from Northwestern University.

Assembled here for the next two days are some of America's leading authorities on renewable resources; wind and solar enthusiasts; water and wood experts; geothermal and biomass technologists; conservation and cogeneration proponents. The question I would like to pose is whether renewable resources are the boon of our society or the boondoggle of our decade?

To avoid any misunderstanding, this question does not minimize the importance of the energy problem we face today or the importance of the role that renewable energy resources will have to play in solving that problem. So that we are speaking in common terms, let me take a moment to review our current situation and the outlook for the next several decades.

Energy Outlook

Currently the U.S. is using 79 quads of energy per year (a quad is 10^{15} Btu or roughly a rate of 40 million barrels of oil per day). Nearly three-quarters of this energy is fueled by oil or gas. Coal contributes about twenty percent and hydro and nuclear about 4 percent each. Solar, wood, and geothermal in total represent just over 1/10 of a percent. Recycled wastes, primarily in the paper, oil, and steel industries contribute less than 1 percent.

The energy mix in the Northwest is now considerably different than that of the nation as a whole. This region has been blessed with abundant hydro resources. However, additional energy will have to be drawn from the same stock as the rest of the country now that most acceptable hydro sites have been used.

In the next two decades energy use will increase, most people would agree, at a substantially slower rate than in the past. Forecasts of energy use in the year 2000 tend to end the region between 100 and 120 quads, although one can find a few quite a bit lower and some a bit higher.

However, there is no disagreement that oil and gas will play a diminishing role because we are beginning to reach the bottom of the well. That is being reflected in ever increasing prices for these resources. Coal is counted on to fill part of the gap. But it too is a limited resource and intensive use of coal will not be easy for all kinds of reasons. Nuclear energy will have to play an important role, especially if energy demands turn out at the high end of the forecast. While with the breeder uranium and thorium can be made to yield substantially more energy than from a once-through cycle, these fuels are also finite.

Conservation—or more correctly, increased efficient use of resources—will have to play an important role in controlling our appetite for raw fuels. All current forecasts of energy use reflect substantial improvement in the efficiency with which we use energy. We can see this process taking place all around us now: purchase of smaller automobiles, use of increased insulation, development of more efficient appliances.

But, even more important, we must begin to develop a long-term balance between our resource endowment and the rate at which we use it. This emphasizes the potential role for renewable energy resources.

Renewable Energy Resources—Defined

What are the renewable energy resources? Virtually all fuels are renewable; oil, gas, and coal are being formed right now. Yet these are not usually considered renewable since our rate of use is many times the rate at which they are being formed. Wood, in this country, is usually thought of as renewable. In parts of India and Africa, however, wood resources for fuel are being depleted more rapidly than nature can produce it, a situation which parallels the early industrial development years in Europe. In such economies, substitution of other fuels for wood is as important as our getting free of our oil dependence. Even water and solar energy resources can be utilized more intensively than their rate of availability. We are now close to that point with water resources but solar energy is far from its maximum potential.

The essence of the definition of "renewable" then has to be the balance between utilization and availability of the resource. A number of energy resources have much greater availability than their current or prospective use. We usually term these as renewable resources: direct solar forms—active and passive thermal solar systems and photovoltaic devices. Also included are indirect solar forms—wind, water, ocean thermal gradient, biomass. Other renewables include geothermal, biological wastes and garbage. Except for the direct solar sources and possibly geothermal sources (if we include systems beyond the reach of today's technology), none of these resources could alone replace oil and gas energy sources. And even solar and geothermal, under the most optimistic scenarios are unlikely to replace even a major fraction of such scarce energy sources for many decades, if ever.

Renewable energy resources, or any energy source for that matter, cannot be meaningfully assessed on the basis of whether it can carry the whole energy load on its own. The important issue is long-run energy sustainability. This means a transition to a balanced mix of energy resources used at a rate that avoids rapid depletion.

On this basis it is clear that we have a major opportunity in the U.S. and, more specifically, here in the Northwest to develop a number of energy resources which are far from being utilized at their replacemer rate. These could play an important role first in diminishing the rate at which we are using depletable resources and second, in arriving at a long-term sustainable energy system. It is in this sense that I think we should be focussing on renewable energy resources.

Renewable Energy Resources—Issues

Today, our economy is recognizing the importance of making a transition from the fuels which appeared abundant in the past and on which we became dependent. The price we are paying for not having accepted this fact sooner is soaring energy prices fueling a general inflation and economic stagnation. If economic growth is to continue and if a global conflict over dwindling resources is to be avoided, then we must promptly begin to move toward a sustainable energy system.

Why then are there such problems in getting renewable energy resources readily accepted? Why is there a need for this conference if everyone agrees on the importance of this transition? I would like to suggest that there are four principal issues involved.

The first issue is what I call "Cost and Metrics." On the cost side, most renewable energy resources turn out to be more expensive than traditional energy resources when measured in conventional ways. There are important exceptions: certain geothermal applications, the use of wastes, some solar applications, etc. But there are many more that are far from ready to compete with the traditional alternatives, even with oil at $30 a barrel.

In part, the problem is the metric we use to measure costs. The system we use has built in a structure of tax laws, calculations of future values, averaging of old and new costs which favors existing processes over new ones. It is important, therefore, that in making decisions on renewable energy resources we identify and adjust our metric to assure an unbiased evaluation.

The second issue is what I call "Change and Institutions." Our economic system is set up to favor existing ways of doing things. This has lots of advantages such as providing continuity, assuring that investments will continue to have value over their physical life, and avoiding excursions into unproductive byways. But it also has some major disadvantages. Change, when it is necessary, is harder to effect. New institutions are difficult to bring into being and remain viable.

For renewable energy resources to make a significant contribution, we are going to have to find efficient ways to change our habits. These changes run the gamut from the type of heating system we install in a new house to the type of generating facilities considered in utility plans. As well, institutional habits of who furnishes what will have to be remolded to fit the new energy system For example, how can we assure the maximum use o. waste material from a paper plant or who should service homeowners' more complex energy systems?

The third issue is one of technical development. New systems are competing with mature, reliable, cost-effective, traditional systems. Part of technical development is the invention and proof of scientific feasibility. While we can always use more scientific progress, we are making good headway now in this area of developing renewable energy resources. But the next step, application and trial of new systems is the area in which our progress has been less than ideal. For example, we have installed nearly 100,000 solar collectors in the U.S. But the feedback system on cost of operation and maintenance, performance characteristics, and reliability is still not in place. The valuable lessons we should be learning to assure that the next generation is even better are not being collected. In our enthusiasm to utilize renewable resources we are locking into a first generation technology.

The fourth issue is one of "information dissemination." In part this relies on the information we have not been getting from the demonstration process. Information which the general public, manufacturers, utilities, and government units need to make informed judgments. But there is more than mere technical performance characteristics which need to be conveyed. The public needs to know, understand, and believe what is at stake in their energy future. We have been so busy blaming the oil companies, OPEC, the federal government, or whatever favorite boogeyman that we have confused the issue. Similarly, some of us have become so enthusiastic over a favorite technology that we have misled others as to the difficulty of achieving the transition.

I am always perplexed when I consider how efficiently our existing market system introduces new ideas. We differentiate, where little difference exists, between soaps, cereals, cigarettes, and cars. A new product gains national attention and acceptance, if it meets with public taste. Somehow, we seem to believe that introduction of a new energy system will need less product push, less marketing muscle than other goods and services.

These issues imply that renewable energy resources will have to compete just like any other commodity looking for its share of the consumer's preference. The competition must come on price, even if we have to calculate costs more completely than we have in the past. The product will have to overcome the inertia toward change and we will have to build or adapt existing institutions to deliver and service the product. Technical development, particularly the trial and error of application, will have to be orchestrated to assure the rapid transition we are looking for. Finally, the consumer will have to be informed and convinced of the rightness of his choice.

Roles for Various Institutions

In this period of change there are obligations and opportunities to go around. Federal, state, and local governments have to take on the responsibility that renewable energy resources can be utilized. This means assuring that regulations, laws, and administrative process do not create impediments. For some government units, this also means getting involved in the development of the technologies to assure their availability as rapidly as possible. Whether enough has or is being done in these areas is a value judgment which needs review. I would like to focus on two areas where I believe enough has not been done.

The first area is one of clearing impediments from existing legislation, regulation, and tradition. By this I mean such as reconsideration of utility regulation, zoning ordinances, environmental regulations, and building standards as to how they effect the adoption of renewable energy resources. For example, could a utility owned, garbage fueled, cogeneration plant be built in your city? If not, should it be possible to do so?

The second area is one of assuring commercial adoption of new renewable energy systems. This is particularly acute for government developed technologies. It is my bias that most renewable energy systems will eventually have to be viable as privately developed and privately owned systems. There are significant exceptions, as is, for example, most of the development of hydro resources here in the Northwest. But, it seems to me that solar collectors, waste-using systems will do best if they can be part of the commercial economy. This transfer from public sector development to private sector deployment has always been a difficult step.

The next set of actors in the renewable resource game are the research community, the entrepreneurs, and the manufacturers. Their combined role is to identify the energy opportunities and develop them from laboratory to market place.

It is my impression that in our complex and highly automated economy that the most efficient development, production and delivery of goods occurs in large, centralized facilities. It is for this reason that I see a good sign in a number of the U.S.'s largest firms investing in the solar business. But the very nature of most renewable energy resources, implies local application, whether on a roof top, at a cement plant, or in the center of a city.

It is the connection to every customer which identifies the possible role for utilities. Not only are they an institution with a contract with every user, but also with the technical capability to provide the installation and maintenance of such systems. In any case, by most state laws, they also must stand ready to provide the back-up reliability. Not only are these opportunities for utilities but also problems on the questions of fair pricing of services. Unfortunately, this option is limited by federal law.

Finally, there is a role for the public to become informed on both the issues involved and the options that exist. In this context the media has an important obligation to inform and educate. With all the conflicting arguments, with all the difficulties of separating fact from fiction, it will not be an easy role. Moreover, since the outcome of the transition from our present energy system to a sustainable one will occur only slowly, there will be little opportunity to check guideposts along the way. It's not like reporting on a sports season which ends with the World Series or the Super-Bowl Game. If we do not adequately plan for future energy sources, the need will not be apparent for a decade. If we do not shift to a sustainable mix, the consequences may not be clear for several decades. But just like the sports team that does not assemble and apply the best players, our economy will not be able to compete if we do not develop a sustainable energy system while other economies do.

Caveats and Cajolings

The answer to my original question, as to whether this conference is the subject of a boon or boondoggle, should be clear. The need for a transition to a long term sustainable energy system is very great. Renewable energy resources (those resources not being used as intensively as they ocurr) are one important element in this transition. But there are a number of issues to be faced.

Now that we are all convinced that we are working on the boon to our society, it is equally important that we not get carried away with our mission. Enthusiasm for our particular endeavor is needed to overcome the difficulties, disappointments, and set-backs which will inevitably occur. However, the enthusiasm must be tempered by realism. In the long run, the consumer is going to demand the most cost-effective system based on his metric. If we can't deliver, he will ignore our advocacy.

We are in a period of change. The Cassandras have always forecast the future as a linear extrapolation of the past. Clearly, a continued dependence on oil and gas to meet future energy requirements would spell disaster. Equally clear, renewable resources provide the opportunity of contributing to an energy future which is sustainable.

In the past in such periods of transition, it has been man's ability to think, to innovate, to grapple with his problems that have led to new periods of growth and success. You have the solution to part of our energy problem within your grasp. But it will take the application of your mind and the sweat of your brow to translate these opportunities into realities. ■

Collecting Energy End-use Data: an Overview

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After many decades of stable energy supplies, the country has entered a period of instability of supply. Energy stability depends upon an assured fuel supply and equally upon a reliable energy production, transmission and distribution system. A transition to energy stability is a transition to a sustainable energy system. In all likelihood, a sustainable energy resource base will be composed in large part of renewable energy sources converted by application of small-scale technology deployed in a relatively decentralized infrastructure.

Assuming the transition to a sustainable energy system is called for, attempts to achieve the transition will be less than optimal. Many mistakes and failures are probable. Consequently, conservation of the existing stock of non-renewable fuels is essential. Because conservation can significantly decrease the demand for energy, freeing energy for new demand, conservation may also be treated as a supply source. Numerous economic analyses conclude that most conservation is substantially cheaper than any new energy conversion facility.

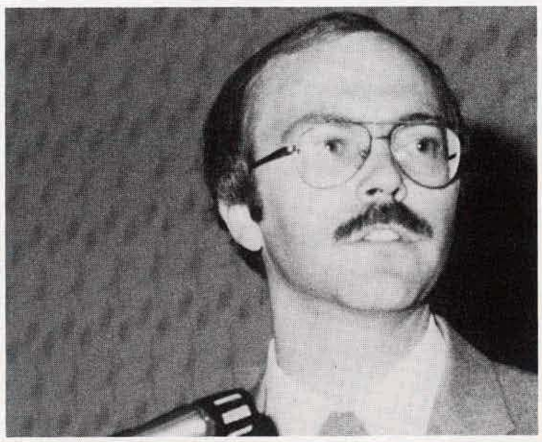
Traditionally, power planning by electric utilities and other electric power supply agencies and firms focus exclusively upon bringing new generation on line to meet projected demand. In so far as the projected demand for energy is demand for electricity, planning for new generation required little or no data about specific energy use within the service area. Because the successful application of conservation measures and non-electric renewable energy systems generally requires a specific thermodynamic match between the energy demanded and energy supplied, traditional power supply planning methodologies are not adequate. Planning for the implementation of conservation and renewables requires a fairly sophisticated energy-use data base.

Simply stated, the rationale for obtaining energy end-use data is to enable the utility or power planning agency to obtain an accurate assessment of both the renewable energy potential and conservation potential in the service area. For power planning purposes, this assessment is useful only if it specifies the opportunities available at specific times, specific costs, and specific locations. Determining the conservation and renewable energy potential is a prerequisite for planning for systematic implementation of conservation measures and renewable energy systems.

There are two major considerations involved when obtaining end-use data: the type of data to be collected and the method of collection. Experience in collecting end-use data is limited. Methodologies developed at laboratories such as Oak Ridge to collect data at the national level are of limited value to planners at the local, state, or even regional level. During the past few years, some utilities, energy consulting firms and public power agencies have initiated energy end-use data collection efforts in Northwest service areas. As a result of these initial efforts, valuable experience has been gained which enables ongoing refinement of data collection methodology.

The following papers discuss methodological considerations when obtaining end-use data in the residential, commercial and industrial sectors. These papers reveal that data gathering techniques appropriate to one sector are not necessarily appropriate to another another sector. Moreover, although some methodological considerations apply to each sector, there are some unique to each sector. ▮

Development of the PNW Residential Energy Survey



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Somewhat over two years ago, several utilities with a common problem banded together under the auspices of the Pacific Northwest Utilities Conference Committee to form what is now called the End-Use Data Subcommittee. "End-use data" is what is referred to among energy analysts as information about how energy is used at the point of actual consumption. That is, it is concerned at the most minute scale about where the electricity ultimately goes, and how much of it goes there, and at what time it goes there. Of course, electricity in today's society is an all-pervading energy source, to be found just about everywhere, so developing this "end-use data" was, and is, a very large undertaking.

It is my purpose here to describe some of the experiences that this group has had in developing this data base, because what we have learned can, I think, be applied generally to any new information or data gathering system. I have generalized the lessons we have learned into eight rules, which are described later.

PNW Residential Energy Survey

As every energy analyst is aware, more is known about how energy is used in the residential sector than in the other sectors (commercial, industrial and agricultural). For one thing, we all have personal experience with how energy is used in the home.

All households have to be concerned with providing some heat to the living space, and heating water, and refrigerating and cooking food, and so on. In the other sectors, that is generally not true. There are very large aspects of energy use in the commercial and industrial sectors that are very diverse and with which we are not familiar. So knowing this, it is easy to pick which sector we tackled first: the residential sector. It may sound anomalous that we began with the sector about which we knew the most, but it is also the sector that was the center of attention for a wide variety of decisionmakers. All kinds of questions were being asked about residential energy use, and we didn't have the answers to those questions. To develop those answers, we decided that we needed to develop a new detailed data base by conducting a household survey. The PNW Residential Energy Survey turned out to be a personal interview survey of 4,030 households in the four-state region of Oregon, Washington, Idaho, and Montana. This sample size permitted data tabulations not only for the entire region, but also for the four states individually and for four climatic zones that we defined based on heating and cooling degree days. The sample was taken from the customer records of electric utilities. This sampling frame is ideal since it is complete (virtually every household has electricity) and up-to-date (demolitions and new constructions are almost immediately reflected in those customer records). Thirty-seven utilities in the region participated in drawing the sample.

The questionnaire we ultimately developed after several drafts was quite lengthy; it had 105 questions, some with several sub-parts, and the average interview lasted about 45 minutes. The subject areas covered in the interview included dwelling characteristics, appliance ownership, economic and demographic factors, conservation practices, and household energy consumption and cost. The last item was obtained by gaining the household's permission to go to the fuel suppliers directly (electric and natural gas utilities and fuel oil companies) in order to obtain that information.

That is a very brief background on the survey; additional information can be obtained from the Executive Summary which has now been published. I think you will find the results extremely interesting, since there is something for everyone in there.

The Eight Rules of New Data Systems

As mentioned previously, the experiences we have gained from this survey, and from talking to others who have also conducted similar surveys, has led me to develop a list of eight general rules that can be applied to the subject of this panel discussion: establishing an energy end-use data base to determine conservation and renewable energy potential in an electric utility's service area. Data has never had a very good reputation. Two quotations from about one hundred years ago serve to illustrate this. The first one is well-known from Mark Twain, who said, "There are three kinds of lies: lies, damned lies, and statistics." The other one is from an Englishman, Sir Josiah Stamp, who said, "The government is very keen on amassing statistics. They collect them, add them, raise them to the nth power, take the cube root, and prepare wonderful diagrams. But you must never forget that everyone of those figures comes in the first instance from the village watchman, who just puts down what he damn pleases." I'm afraid that mo- people's opinions about statistics haven't changed mu since then, and so our job is clearly laid out for us in developing our end-use energy data base to avoid those pitfalls. Now, I'd like to get into those eight rules I mentioned previously.

1. **The Rule of Purposes**— The most important rule of all is this first rule: it is absolutely necessary that there is a clear idea of what the data is going to be used for. As we approach the 21st century, it is clear that we are now well into the Age of Information. We gather all kinds of detailed data on all possible subjects. Yet amidst this great blossoming of knowledge, there is a sign of discontent, primarily among those who have to provide that data in the first place. You see increasing resentment against filling out government forms, for example. People are apparently beginning to wonder why all that information is needed, and whether it is really being used in important ways. Therefore, the first job in developing a new information system is to clearly define its purpose—what is it trying to accomplish—and the definition should be in as much detail as possible. These purposes must be defined at two levels. At a very broad level, you must ask yourself why you are collecting the data in the first place. In our survey, we had several purposes: We wanted to be able to determine the potential for energy conservation in the residential sector. We wanted the data to permit us to evaluate which conservation programs will be most effective. As with conservation, we wanted to determine what the potential is for renewable energy sources. the data should contribute to regional forecasting efforts, and we wanted to be able to evaluate potential load management programs. That was a pretty large order, and we found that we had to make occasional sacrifices in that list. At a more detailed level, it is necessary that you define the purpose of each and every question that you might include in a survey. If something doesn't have a clear and direct application, don't include it. Too often we are tempted to include a question that sounds generally interesting; as a general rule, don't.

2. **The Rule of Limits**— In the first step of defining our purpose, we essentially laid out our list of wants. However, the rule of limits says that we can't have everything that we want, and we'll have to be constrained. There are basically four kinds of limits. First is money; everyone is familiar with that. You will be interested in knowing that a personal interview survey will cost about $50 to $70 per completed interview; a telephone survey will cost somewhere around $5 per completed interview; while a mail survey can cost as little as $1. You will have to compare the tradeoffs of tl__ increased data reliability you gain from personal inter-

views against the lower costs of telephone or mail surveys. A second limit may be manpower: in-the-home interviews or telephone interviews are more labor intensive than mail surveys. A third limit is time or space: In our case, we felt that 45 minutes was close to the limit of toleration for most respondents, and while we could ask a lot of questions in that time, we still had to pare our entire wish list down in order to fit into that time limit. Mail surveys have space limits: If the questionnaire runs too many pages, the first reaction of most people will probably be to chuck it in the waste basket. The fourth limit may be physical constraints. For our survey, we were very interested in getting as reliable data as was possible. For example, we did not entirely trust the average homeowner to know what levels of insulation they had in their attic or crawl space, and so we wanted our interviewers to physically inspect those areas for insulation. The rule of limits restricted our ability to do that, though. Twenty percent of the respondents told us that no access to their attics existed, and another thirty percent could not provide our interviewers with a ladder to climb up into the attic. We wound up having to ask these people for that information.

3. **The Rule of Involvement**— If other people might be interested in or affected by the survey, it is best that those people become involved in it at an early stage. You will find that whatever data is collected will have a much higher probability of being used, and there will be a lower probability that the data you are collecting hasn't already been collected by somebody else. At the local utility level, this means that the office developing the survey consult with other offices that might be interested: I know of more than one instance where, for example, the conservation office planned and implemented a survey without ever talking to the rates people or the forecasting people. Some utilities are small enough that all of those functions are performed by one person, but for all the rest, be sure to talk to each other. In our case, we wanted to get historical energy consumption data from the natural gas and fuel oil companies, so we made sure to involve representatives of those interests at an early stage.

4. **Rule Four is to Be Like a Child**— That is, ask lots of questions and don't assume you know anything. Thinking things through will save you from making mistakes. In one case, the people who were putting the questionnaire together wanted to know about daily patterns of energy use, and how lifestyle might affect the amount of energy consumption. So they included a question about whether anyone was home during the daytime. It was the secretary who was typing the draft that pointed out that many people might be reluctant to answer such a question, since they might figure they will be setting themselves up for a daytime robbery. Every question you want to ask should be similarly examined to see what might lie hidden below the surface.

5. **The Rule of Complexity**— Nothing complicated works. Simplifying things will greatly increase the chances of success. This especially pertains to the ways in which questions are worded. If there is any possible way that a question can be misinterpreted, it is amazing how people will figure that way out.

6. **The Rule of Thumb**— Related to the previous rule is the rule of thumb: If the data are thicker than your thumb, they are not likely to be comprehensible to very many people. For our survey, we really didn't adhere strictly to this rule. With that many questions, we can compile the data into a million different ways. But we did keep the summary volume down to a manageable size, and I hope that people's interests are stimulated by the information gathered there; if a question is of particular interest, then the backup information is available. But for the general audience, keep the size of the report down.

7. **The Rule of Anticipated Anguish**— Also known as Murphy's Law, we know that most of the things that can go wrong will. This means in practical terms that you should prepare for the worst, and schedule more time for the project than you might first think you need. In retrospect, I think our survey went amazingly well, but it did have its problems. For example, the cover on the Executive Summary is dated July 1980, but actually it didn't come out of the printshop until the first of October.

8. **The Rule of The Known Evil**— The eighth rule applies when the information finally becomes available, which is the rule of the known evil. People are used to working with what they have, however inadequate or limited that might be. They know what fudge factors need to be applied to a particular problem. When your new data becomes available, they will have to reestimate all those relationships under a new information system, and because of that, the new data may be met with some resistance or skepticism. I don't want to play this rule up, because if the previous seven rules were followed, there shouldn't be many problems in having the data become quickly adopted, and probably by more people than were originally anticipated. End-use energy information is really scarce at this time, and we have found a great deal of interest in it. One source of interest that we didn't expect, for example, was a state welfare agency, which wanted to know how much money poor people are spending on energy. In another case, there is a Ph.D. candidate in economics that will be using the data base in the development of his dissertation.

It is clear from this list of eight rules that there are many hazards involved in developing utility-specific end-use information. I certainly hope that it doesn't scare you away, because I think you will find from the discussions during the second panel this morning that the uses of end-use data are very important.

In order to assist utilities and governments that might be interested in developing their own survey of residential customers, the End-Use Data Subcommittee has had developed a 16-page Mail Survey Manual. It provides step-by-step instructions on how to select a sample, on preparing the survey materials, handling the mailing, and tabulating the results. Perhaps the most important part of the Manual is an example of a two-page questionnaire that can be adopted wholesale by an interested utility, or perhaps be used as the basis for your own questionnaire. It was designed to be both effective in soliciting a high return rate and to be compatible wit' the region-wide personal interview survey. If you are interested in getting a copy, they are available at all the local BPA Area and District offices, or you can write to me directly. I think you will find it very useful. ■

Industrial Energy End-use Data Acquisition

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The ease of acquiring industrial energy end-use data spans the continuum from extremely tedious to comparatively simple. This range of effort may be experienced within a single plant, as well as from plant to plant. A number of factors contribute to this observation, including the type and level of detail of data being sought, industry attitudes, individual management practices and policies, and past and present industrial design practices. Other factors often involved are plant age, past and present plant experience with providing data to outsiders, the prevailing regulatory environment including pending legislation, data acquisition planning, personnel background/training, level of plant participation, plant operation cycles including planned and unplanned events, and others.

This commentary represents a compendium of experiences resulting from on-site surveys of 150 industrial plants in the Pacific Northwest conducted by Rocket Research Company and several university subcontractors. The work was sponsored by the Pacific Northwest Regional Commission (PNRC) and Bonneville Power Administration (BPA) in two interrelated studies. The PNRC study evaluated the potential for recovering industrial waste heat and utilizing it in the surrounding communities. The BPA-sponsored study assessed the Pacific Northwest industrial cogeneration potential.

DATA ACQUISITION METHODOLOGY

The overall plant data acquisition process may be characterized by the following basic steps:

a. Data acquisition planning
b. On-site data acquisition
c. Data analysis and storage

Both technical and nontechnical aspects must be considered in each step, as may be inferred from the aforementioned factors. The impact of these factors will be discussed following a brief review of the basic data acquisition process.

Data Acquisition Planning

Data Acquisition planning begins with development of an understanding of the plant processes. This understanding must be sufficiently complete to identify the data required for the analysis being performed. At the same time, criteria are developed which fix the study boundaries and which establish the internal consistency for the subsequent analysis. A data-logging format is necessary to ensure complete and efficient data collection, and to provide consistency in multiple-plant surveys. The selection and training of field personnel in this step is of paramount importance to establish credibility with plant management and engineering contacts, as well as to instill the discipline of the study.

Nontechnical preparations proceed in parallel with the technical preparations. A critical element of the entire process is securing plant permission for the survey. Telephone contact with senior plant or corporation management, followed by a letter request, is sufficient in many cases. In other cases, a presentation to the same management level may be necessary to secure the required permission. Where the energy manager can be identified, contact should be made. A brochure describing the project is a useful, and perhaps necessary, enclosure to the letter.

On-Site Data Acquisition

On-site data acquisition is frequently frustrated by lack of available information at the unit process level, or even at the level of major plant subdivisions. The most accessible plant energy information is the monthly overall plant utility bills, sometimes available for individually metered plant elements. Information on stack flows is also generally available due, in part, to air quality monitoring requirements. Data on plant operational cycles usually can be obtained at a gross level, i.e., planned shutdowns for vacations and maintenance, but is often affected by market factors and other unplanned events which are difficult at best to forecast. Many times, the only clues to a unit process energy flow are indirect, such as nameplate or burner ratings and material flows.

Data Analysis and Storage

Analysis of raw data to derive the required energy information will make use of the criteria determined at the beginning of the study to provide internally consistent results. The volume of raw and derived data obtained from a broadbased survey may be expected to require some form of automated handling for ready storage and retrieval. This will also facilitate development of data summaries and parametric information.

FACTORS AFFECTING DATA ACQUISITION

Perhaps as important as the basic methodology, is an awareness and appreciation of the impact of factors affecting the data acquisition process. Not all factors noted are present at each plantsite, and each will assume a different significance from plant to plant. The general nature of their affect, however, can be described.

Type and Level of Detail

The type and level of detail of data being sought will influence the ease with which it is obtained. For example, technical data which does not infringe on proprietary information is more readily determined than financial data. Even energy cost information may be considered sensitive in certain highly competitive industries. For a variety of reasons, energy flow information is usually unavailable at the unit process level. An exception to this is high demand equipment, such as an arc furnace or boiler, which may be individually metered. Overall plant energy consumption for each type of fuel is usually readily available through the medium of monthly utility bills. Other purchased fuel data, such as for coal or hog fuel, are also usually available. Internally generated fuels, such as hog fuel or refinery gas, however, may be more difficult to assess.

Industry Attitudes

Attitudes within a given industry may also influence the ease of data collection. Plants within industries that are highly competitive may find it difficult to cooperate with data collection unless some assurance of anonymity is provided. One way of accomplishing this is to aggregate the data so that individual plant identities are protected. Of course, when working on behalf of an individual plant on an internal study, such a concern should not apply. Industry attitudes may also be affected by the current public relations, political or regulatory environment which in turn may inhibit individual plant involvement in energy analyses that are to be made public.

Management Policies

Individual management practices and policies may similarly prevent a plant from cooperating in a study of energy utilization. Such policies may result from industry-level considerations as mentioned above, or from past experiences, legal factors, or proprietary considerations. Individually owned or closely held corporations may also be less willing to participate in energy studies than widely held corporations accustomed to operating under public scrutiny.

Plant Design

With some exceptions, industrial design practices of the past have not included lavish plant instrumentation. In certain industries, this may be true even of newly designed installations. Notable exceptions to this practice are boiler-room installations and refinery operations where process control and automation are the rule rather than the exception. In tracing plant energy flows and deriving energy balances, it will often be found that either special instrumentation must be installed for critical measurements or the data must be derived by indirect means.

Plant Age

Plant age may be a factor in some cases in obtaining the desired data. Older plants, in general, will have less installed instrumentation and metering than plants of newer design. Also in older plants, design records of individual process installations may be incomplete or unavailable, thus requiring extraordinary means of securing the desired information. Plant age may influence the willingness of the industrial organization to become involved in a survey if the plant closure is an active consideration.

Past Survey Experience

Past plant experience with providing data to outsiders may or may not have been successful. In some cases data, provided in good faith and in a more relaxed regulatory climate than prevails today, have been used in a punitive context from the plant's point of view to develop new restricting regulations. The net effect of these regulations usually has been to add cost to the plant operations and to deprive the plant ownership of certain control of its operation. Where such has been the prior experience or where the threat of such an action pertains, obtaining data may be extremely difficult.

Regulatory Environment

The prevailing regulatory environment will influence data acquisition in several ways. Where an industry is under considerable demand to provide information to a multiplicity of agencies, their willingness to provide yet another set of data may be at a minimum. Pending legislation may cause the plant to take a wait-and-see attitude during the time period in which the desired data are needed. Overall, current regulations and new legislation being contemplated are having the effect of requiring industrial plants to become more energy conscious. Rising energy costs are having a similar effect. At the same time, these same forces are acting to increase the sensitivity of plant management to outside influences on their operations. These outside influences are not generally perceived as either desirable or productive and may act in some cases to inhibit a plant or a corporation's willingness to cooperate.

Data Acquisition Planning

The old adage of "There is no substitute for good planning," is certainly true of the data acquisition process. Highlights of these planning effects were noted in the preceding section. A major effect of good planning will be to economize on the time required by both plant and survey personnel, a fact which has been found to be important to the plant operations management. Development of a basic understanding of the plant processes prior to an on-site survey has also been found to be a much appreciated factor which together with economizing on the plant's time, will maximize their willingness to cooperate.

Survey Personnel Selection and Training

The selection and training of field or on-site survey personnel is particularly important. Eliciting a plant's permission to participate in an energy survey is quite literally a technical sales job. Relating to the plant operations personnel in the data acquisition process requires elements of both process design and human relations. The background and supplemental training of selected personnel must therefore be carefully examined to assure that these elements can be properly satisfied in order to maximize the data obtained and its reliability.

Plant Participation

Plant personnel will normally know and understand the operation and idiosyncrasies of their facility better than the survey personnel. The depth of insight that a surveyor may have on individual or generic processes cannot be allowed to obscure the objective statements that the plant personnel may make regarding the plant operations. While there may be exceptions in certain plants and industries, in general, the best data will be obtained where the level of participation of plant personnel is a maximum.

Plant Operating Cycles

The determination of plant operating cycles often presents a dilemma and can have a significant influence on derived energy flow data. Planned events such as plant shutdowns for vacation and maintenance are straight-forward considerations. Unplanned events of widely varying impact, such as market vagaries, weather influences, strikes and equipment breakdowns, are effects that are only semipredictable. Determination of what constitutes "normal" operations may thus be difficult where a series of such unplanned events has occurred in recent years.

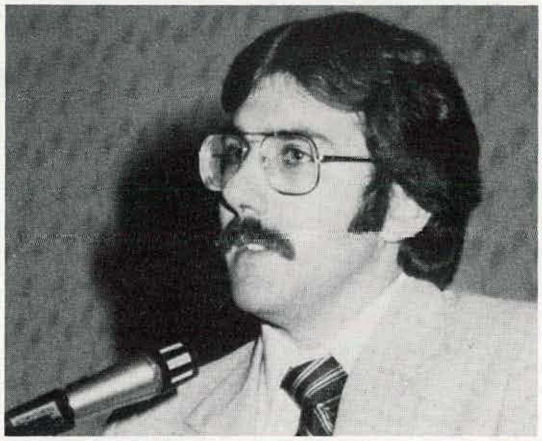
Summary

The factors reviewed in this section must be considered an inherent part of the data acquisition process in the "real world." Ignorance of these factors can adversely affect the data obtained and its reliability. Conversely, when proper attention is paid to these and any other site specific factors which can be identified, a successful data acquisition experience can be expected and confidence can be placed in the information obtained.

CONCLUSION

In summary, every plantsite is unique and will present a challenge to surveyor and analyst alike. Considerable planning and analysis is required to secure the desired data acquisition result. Even the best of these efforts will frequently be complicated by lack of accurate raw data, but thorough planning, trained personnel, persistance and an understanding of the pitfalls of the process will aid in producing a successful result. ▮

Establishing a Commercial End-use Data Base



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This paper deals with the establishment of a commercial end-use data base. It reflects the present experience of Portland General Electric Company in this type of endeavor. To be consistent with the stated topic of interest, this paper will concentrate on methodological and data collection issues. Some findings from analyzing available data are included to highlight possible applications.

End-use analyses are not new to Portland General Electric Company. For the last several years, PGE's official load forecast has consisted of an end-use approach for the residential sector. Comparatively, an econometric approach has been used in the forecast of the commercial and industrial sectors. One major benefit of the end-use methodology is that it has facilitated the assessment of residential conservation potential. The impact of such programs as appliance efficiency standards, building codes, home weatherization, and solar space and water heating applications can be more readily determined.

Sectoral Analysis

As a first step to analyzing commercial end-uses, PGE undertook a special project this last summer. The primary objective of the project was to explore different methodologies and applications of end-use analyses. This included a search for any existing data and an effort to acquire additional data where easily available. The project did not attempt to establish a comprehensive commercial data base. PGE is presently involved in a couple of survey efforts which will yield considerable end-use information when completed. These will be discussed later on in the paper.

Before attempting to identify specific end-uses, some basic questions first need to be answered. They are:

1. How much homogeneity exists within the commercial sector?
2. What information is critical in determining a particular building's energy consumption?

To answer these questions, PGE commercial accounts were disaggregated by major group category. PGE's definition of major groups closely parallels the Standard Industrial Classification (SIC) categories. There is only one major difference: PGE has added a classification entitled Office Buildings where a building is occupied by more than one firm's offices. With this disaggregation available, the summer project proceeded with special attention given to the groups which were prime energy consumers.

Seven major groups, which account for about 40% of total commercial consumption, were selected for examination. They are:

Food Stores	8.9%
Educational	6.6%
Eating and Drinking	6.1%
Office Buildings	5.8%
Hotels and Lodging	5.1%
General Merchandise	4.1%
Government	3.5%
Total	40.1%

The disaggregation of commercial accounts into these groups was done using the coding from the Company's computer customer master file. Before simply proceeding with an analysis of this data, a necessary preliminary step was to verify its accuracy. Consequently, a sample was drawn from each group and the recorded coding checked. Generally, the results were positive. The accuracy ranged from 83% to 99% for these seven groups. This included a weighting given to each account corresponding to its level of energy consumption. In every major group category, the percentage of accounts accurately coded was greater for the higher use accounts.

As a side note, in the process of performing this check, the wide distribution of energy consumption in the commercial sector became highly apparent. For instance, approximately one-half of PGE's commercial accounts consume less than 1,000 kWh per month and result in 3% of total commercial consumption. Comparatively, 14% of the customers, with monthly consumption in excess of 7,000 kWh, consume 80% of total commercial load. Consequently, one evident conclusion is that any conservation program will need to focus on high use customers if it is to have any appreciable impact.

After testing for accuracy, the next step was to determine the level of homogeneity within these groups and to identify the factors most affecting individual energy usage traits. This was done via a regression analysis on a sample selected from these groups. To date, this regression has only been done on the educational and office building categories. The other groups will be similarly analyzed within a couple of months upon the completion of a short survey of about 200 PGE accounts. This survey consists of a mail questionnaire with potentially two follow-up contacts.

The educational sample consisted of 19 all-electric schools (schools with electric heat) which had previously participated in an end-use submetering study (this study will be discussed later in the paper). Subsequent analysis indicated a strong similarity in total energy consumption when viewed in relation to each school's floor space. Simply regressing total consumption versus square footage alone yielded a 98% coefficient of determination (R^2). This indicates that for all-electric schools, square footage is a good predictor of total energy consumption. Included as Graph 1 is a plot of the actual data values and predicted values from the regression equation. As illustrated, in general the large schools used more on a per square footage basis.

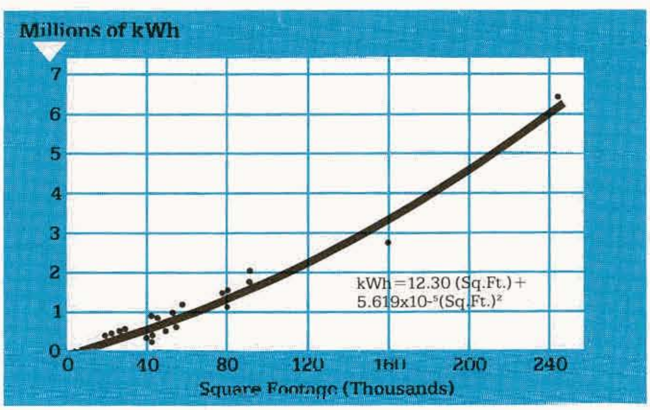

Figure 1: **Energy Consumption in Educational Buildings**

The office building sample consisted of 20 buildings in the Portland downtown area. Data on these offices was obtained from the Building Owners and Managers Association (BOMA), as well as from a few brief customer interviews. Once again, a very strong correlation existed between the size of the building and energy consumption. The best-fit equation contained only two independent variables—square footage and heat type. With these two variables, a correlation of 99% was obtained. Of the two variables, square footage had the primary impact. A correlation of 96% was obtained with square footage as the only independent variable. Similar to the schools, predicted use per square foot increases in relation with the size of the building. A plot of the regression of total energy consumption versus square footage is shown as Graph 2.

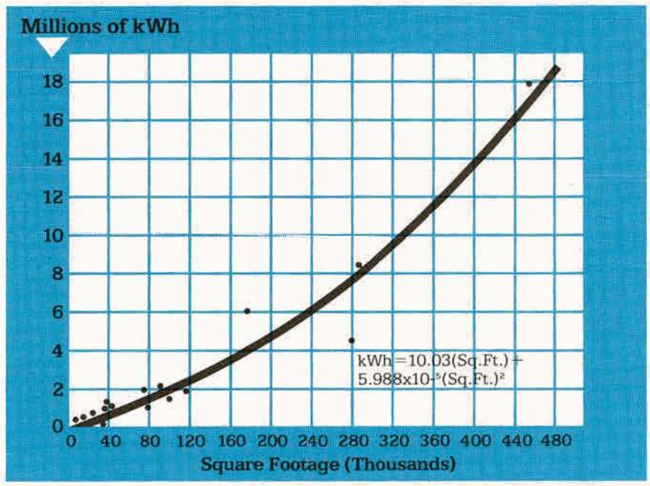

Figure 2: **Energy Consumption in Office Buildings**

The results from these two samples were enlightening. At a glance, it appears that there is considerable diversity within the commercial sector. Structural characteristics, space conditioning systems, and lighting levels were considerably—at least in relationship to the degree of variety in the residential sector. This perspective has previously lead analysts to feel more comfortable in dealing with the residential sector. The results of this analysis, however, indicate that in fact, from a statistical perspective, there is significant similarity within major commercial groups—at least for the educational and office building categories. This degree of homogeneity in energy consumption should enhance the value of future end-use analyses.

In comparison, statistically there is actually greater diversity in the residential sector; yet it is this sector where historically most end-use analyses have been aimed. To identify the degree of homogeneity in residential energy consumption, a similar regression analysis using a sample of 380 PGE electric heat residential customers was performed. It did not yield nearly the same degree of correlation. In the regression analysis, there were three significant variables which entered the equation:

- Square footage
- Household size
- Income level

The correlation (R^2) was only 43% — much lower than for the two commercial categories.

End Use Analysis

Once having gained confidence that sufficient homogeneity exists in the commercial sector, it is possible to progress to the actual collection of end-use data. There are two fundamental approaches to gathering this data. The first is essentially a quantitative approach utilizing submetering. It involves selecting a sample of accounts and installing special metering equipment on a customer's premises to record actual energy consumption from different types of end-use equipment.

Some PGE data is presently available from past load research activities. Several years ago, PGE submetered 19 all-electric schools (the same ones discussed previously). Of these, 11 were elementary schools and 8 were secondary schools. Unfortunately, the aggregation of end-uses in the submetering varied considerably between schools. In each case, the HVAC (heating, ventilating, air conditioning) system and lighting usage were separately metered. In some cases, the cooking, water heating, and various components of the HVAC system were split out as well. Because of the overlap in metering, it is difficult to draw any precise conclusions from the data. The data does indicate, however, that about 60% of the usage in these schools went toward space conditioning (HVAC), while about 30% was consumed by lighting. Elementary and secondary schools had similar proportions of end-use consumption, although the secondary schools generally consumed more per square foot.

This kind of data is not currently available for any other sectors. A main deterrent to undertaking additional submetering is the cost. It is estimated that the installed cost of the submetering equipment alone would be about $3,000 to $5,000 per site. In addition, there would be meter reading and processing expenses. To submeter a sample of about 200 accounts would result in capital costs alone of $600,000 to $1,000,000. Because of the high cost and budgetary constraints, PGE is not presently planning to undertake a major submetering program. Within a couple of years, however, once sufficient data has been collected to satisfy initial PURPA (Public Utility Regulatory Policies Act) load research requirements, PGE may begin to do some limited end-use submetering.

This method is the most accurate means of measuring end-use consumption. Because of the variety of equipment used in the operation of commercial buildings, it is very difficult to estimate end-use consumption without actually metering. The drawback of simply relying on submetering, however, is that it cannot identify the conservation potential. Energy consumption is simply measured without any knowledge of building or equipment characteristics and how they can be modified to conserve energy.

There is a second fundamental approach which can be used. It is more qualitative in nature. This consists of conducting building surveys. In this process, a questionnaire is used to identify major end-uses and activities. The questionnaire can be administered through the mail or in person. Particular items of interest might include:

- Structural characteristics
- Hours of operation
- Number of occupants
- Lighting characteristics
- Type and operation of HVAC equipment.

With this type of information, an estimate of the end-use consumption can be constructed with the conservation potential also identified.

PGE is presently participating in a federal DOE/BPA pilot project of this nature. Information is being gathered using a detailed questionnaire. The questionnaire is about 40 pages long and has approximately 200 questions. Interviews are conducted in person, typically with the building manager. There are 400 sites in the PGE service territory which are included in the project. Following the initial interviews, 100 of these buildings will be selected to receive an engineering audit. This audit will test the veracity of the data obtained in the interviews. Similar interviews are also being conducted in the Seattle, Tri-Cities, and Boston communities, as well as other parts of the Portland SMSA area outside the PGE service territory.

Two procedures are being used to select survey sites. One, draws the sample from the utility's customer master file and then attempts to find the corresponding physical building. The other procedure does the inverse. It selects physical buildings from partitioned geographical areas and then attempts to find the matching utility accounts. In each procedure, utility records are needed to obtain energy consumption figures. One problem prevalent to both procedures is that utility accounts do not always correspond to actual building structures. Frequently, there is more than one account for a particular building. In addition, some accounts are not actually buildings but, instead, provide service to telephone booths, outdoor area lighting, or some other activity. Consequently, this problem slows down the data collection process and requires careful scrutiny to ensure that the energy consumption figures obtained from the utility precisely correspond to the building surveyed.

The disadvantage of this type of approach is that it is only an estimating procedure. It cannot measure actual end-use energy consumption. This approach, however, has one distinct advantage. It can identify specific conservation actions for the buildings surveyed. This information is valuable, assuming that the sampled buildings are representative of the general population.

An action with considerable promise would be to pursue these two approaches—surveying and submetering—in conjunction. For instance, submetering a subset of the 400 interviewed buildings in the DOE/BPA project would provide a cross-check to the survey estimating procedures. The ability to estimate end-use consumption and identify conservation potential would therefore be enhanced.

Summary

In summary, preliminary analysis indicates that significant homgeneity exists within commercial major groups. The similarity in energy consumption traits is sufficient to justify pursuing the development of an end-use data base.

There are two basic approaches which can be used in gathering end-use data. The first consists of end-use submetering and measures actual consumption. The second utilizes a questionnaire to identify major uses of energy. An effective alternative in establishing a data base would be to undertake these two approaches jointly. ■

The Consumer-Based Planning Approach to Data Development for Renewable Energy Supply Options

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The purpose of this paper is to present a conceptual framework for the systematic collection of data in support of the Consumer-Based Planning Approach to renewable energy supply options. Traditional energy distribution data bases do not include renewable energy considerations. Although renewable energy technologies have an early history, the 20th Century has witnessed technological innovations in the petrochemical industry, which has produced a downward trend in the price of fossil fuel forms, thereby, effectively squeezing renewable energy supply options out of the market. In the past decade there has been a reversal of this trend leading to a re-emerging public acceptance of renewable energy technologies. This earlier concentration in the use of fossil fuel forms has resulted in a void in information on the extent of renewable energy installations, the reliability of the systems, and the capital and maintenance costs of the current technologies.

Data development in support of the renewable energy supply options is needed. This data is needed to provide the foundation for the planning of new applications of an old energy form within the confines of an established economic and political system. The Consumer-Based Planning Approach is a good tool to employ in the development of a data base for renewable energy forms.

Consumer-Based Planning Approach

Consumer-Based Planning is a concept being developed and advocated in this paper as an alternative approach to energy distribution which has as its basis a consideration of the energy needs and demand of the consumer. Consumer-Based Planning is comprehensive problem oriented approach to analyzing, implementing, and evaluating specific energy demands of a target group. The concept has its origin in work done on population-based planning for addressing health needs of a community.* This paper will adapt and modify these concepts as they apply to the distribution of energy needs.

Planning functions in the United States requiring a substantial and viable data foundation are a fairly recent development. The 1970's saw the advent of the large scale data bases. Substantial data development has occurred in the public sector; however, perceived need for reliable data has been predominant in the private sectors of the economy. The private sector has as its goal a profit motive, and as such requires accurate assessment of market potentials. The public sector has an equal need for accurate data, however, placing its emphasis on providing a social good, not strictly limited by cost effectiveness measures. This has resulted in decisions being made which are non-quantitative and/or political in nature.

Planning directed toward meeting private and public goals has been traditionally of a resource-based approach. Resource-Based Planning considers the supply of a service to be homogenous in nature and can be equally demanded by all consumers. Given this homogenous supply, Resource-Based Planning examines the past and present energy demands and projects future demand of existing and potential consumers. Energy generation and distribution systems are then modified to meet the projected requirements. The explicit needs of a target population and the matching of service delivery to meet these needs are not directly addressed by a Resource-Based Planning approach. Consumer-Based Planning is a conceptual approach directed to this end.

Consumer-Based Planning (See Chart A) begins with the consideration of a specific energy related problem. Such problems would include supply distribution limitations the requirement of non-interruptable load, and the relatively high cost of convention fuel forms. Few energy problems have the same degree of impact to all segments of the consumer population. A determination must be made as to which segments of the population will be adversely effected by the problem. This sub-set will be referred to as the Consumer Population.

The Consumer Population is composed of five sectors of the economy. Included are the agricultural, commercial, industrial, residential, and the transportation sectors. For purposes of this paper, data development in support of Consumer-Based Planning will address all but the agricultural and transportation sectors. The Consumer Population is the sector of the economy which is presently effected by the problem and/or which has a high probability of being effected by the problem in the future, and can be thought of as a comprehensive

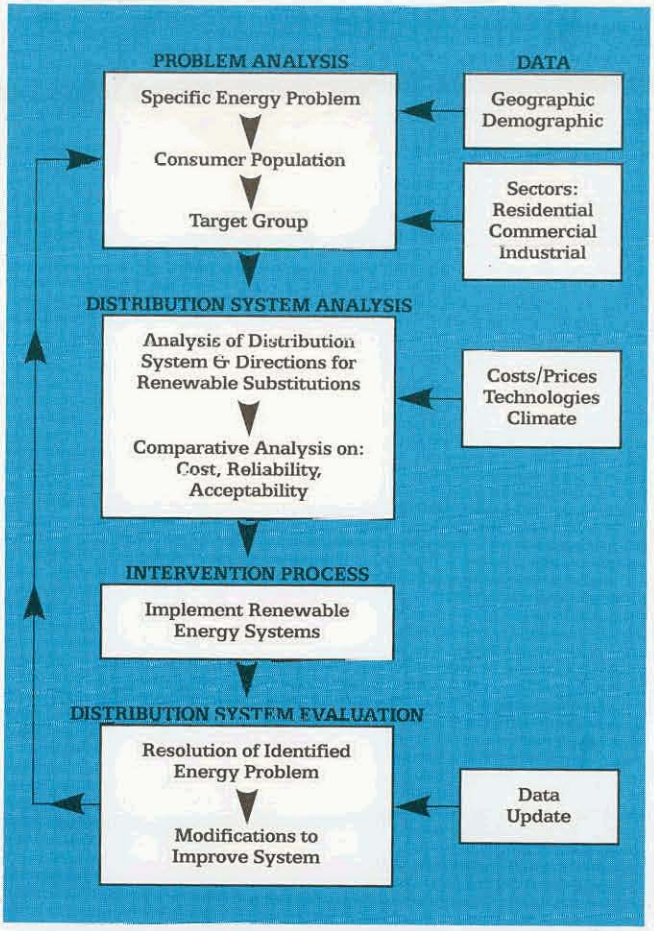

Chart A: **Consumer-Based Planning; A Conceptual Model**

definition of the population of people effected by a specific energy problem.

Data development (See Chart B) in support of Consumer-Based Planning begins with the more refined analysis of the consumer population which is referred to as the Target Group. The Target Group is defined within a specific geographical locality, such as a state, county, or utility service area, as to the demographic characteristics of the population of the locality. The demographic characteristics on which data is analyzed is dependent upon the specific energy problem, however, would include elements of age and sex, household, size, income, employment, and education level. The sector-by-sector considerations of the target group requires data elements which relate to economic and physical characteristics. Considerations of the residential sector pertain to water and space heating and cooling requirements. The physical data to be collected includes; the single family/multi-family housing mix, the age and density of housing, and the present fuel form used in space and water heating. Energy considerations of the commercial and industrial sectors includes space and water heating and cooling requirements for their employees. In addition, this sector will have varying

*Reference is made to work by: Tanner & Leibman (1978), Wennberg & Gittelsohn (1973), Hutchinson (1978), and McCord (1980). Sitings to these references will be supplied upon request.

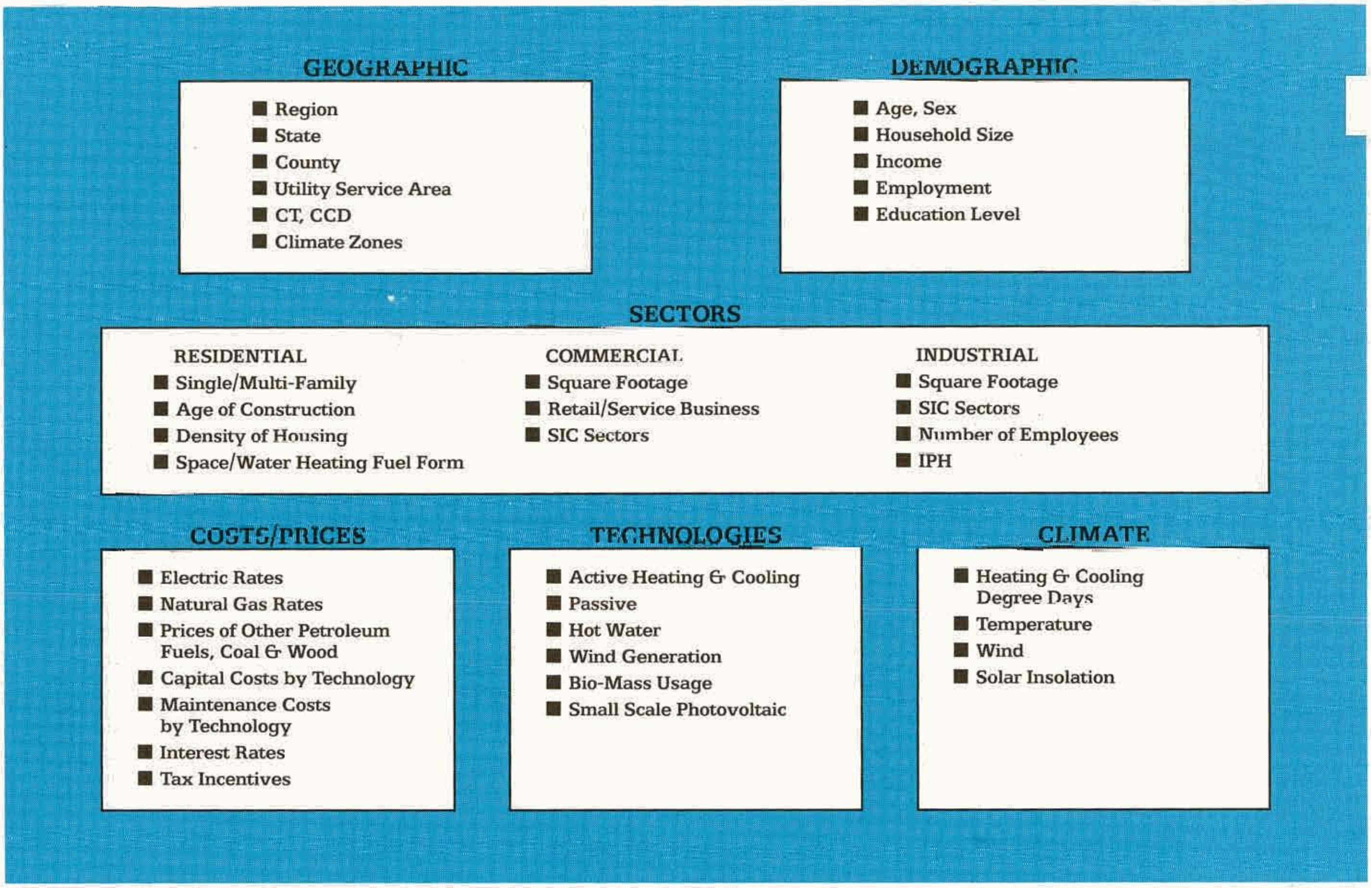

Chart B: **Taxonomies of a Data Base**

energy requirements based upon their type of business and operation. The data elements to be included are; the number of employees, the square footage of work space and some indicator of the use of the space such as retail/service business or Standard Industrial Classification (SIC) codes. The industrial sector in addition to the commercial requirements considers the manufacturing processes and the application of industrial process heat. The majority of data development will occur in the Target Group definition phase of the Consumer-Based Planning process.

The next step in the development of a Consumer-Based Planning model is that of Distribution System Analysis. In this step renewable energy forms are introduced as alternatives for conventional fuel form usage and can be analyzed by considering the cost, reliability, and acceptability of the alternative energy technologies. A systems approach is utilized in which the need of the target group and the potential renewable technologies are developed jointly through feedback mechanisms. Considerations are included for the substitution of appropriate renewable energy technologies for a portion of the conventional energy supplied in existing grids. Such substitution is based upon the contribution of the renewable energy technology and the benefits and costs of this energy form to the target group.

Several data taxonomies can be developed in support of planning for alternative energy technologies. Cost and prices should be collected reflecting utility rates for natural gas and electricity and prices of other non-renewable fuels. This taxonomy of data would also include capital cost and maintenance cost of the renewable energy technologies, as well as loan interest rates and the dollar value of various incentive programs. Data in support of reliability addresses and details the number of specific renewable technologies, including active solar heating and cooling systems, passive solar systems, solar hot water, windmills, small scale photovoltaic, and biomass systems. Renewable energy system reliability also requires a consideration of climatic conditions of the locality. A particular renewable energy technology may prove very reliable in one locality, however, given extreme conditions such as temperature or low solar insolation, may prove unreliable in another locality.

The next step in Consumer-Based Planning is the Intervention Process. In the last step relevant renewab energy technologies were analyzed in light of addressi problems to specific target groups. In this step of

Consumer-Based Planning, those technologies which were found reliable, acceptable, and cost effective to the target group are implemented. Implementation can be accomplished by providing appropriate marketing tools to the private sector, information dissemination and training programs, or through the use of incentives and local regulations. Incentive programs can include financing mechanisms such as low interest or no interest loans, and property and income tax incentives. Regulatory measures include solar access and energy zoning enacted by local jurisdictions.

The final step in this process is the Distribution System Evaluation. In the analysis phase of Consumer-Based Planning, problems were identified specific to a target group. Appropriate renewable technologies were identified and various implementation strategies were used in substituting alternatives to the traditional energy distribution system. The last step in the process is to evaluate the degree of effectiveness in reducing the impact of the problem to the target group. The introduction of new technologies need the initial verification as to benefits achieved. Existing distribution systems need periodic monitoring to determine if they are still relevant and still addressing the needs of the consumer population. This evaluation process will identify problems which have been reduced or solved. It further identifies changes in the consumer population relating to specific problems. A consideration of those elements will point to the modification of existing, and contribute to overall improvement of the energy distribution system.

Typical data bases in support of Consumer-Based Planning would provide a foundation for various energy related problems affecting different target groups. As an example of a data development activity in support of a specific target group, Western SUN has a project in process which addresses the potential markets for domestic solar hot water heating systems. The project has been designed to provide a set of computer generated maps identifying the potential for solar hot water installations on a county-by-county level for the 13-Western states.

Data development for the solar hot water mapping project has been collected in support of one specific project, however, it is illustrative of some of the data elements necessary to undertake a Consumer-Based Planning approach. A definition of the Target Group requires considerations of geographic, demographic, and economic sectors. The geographical region being perused is the 13-Western states. Solar potential is being developed and mapped individually for each state. The analysis for each state will be further spacially investigated at the county level, the smallest geographical area being considered in this project. The target group definition is the residential sector, and as such, the primary demographic variable is income. Characteristics of the residential sector for which data is being collected includes existing housing units by owner/renter occupied, the density of housing units, and the percentage located in urban areas, additions to the housing stock obtained from building permit statistics, and a percentage breakdown of existing water heaters by fuel form.

An analysis of the distribution system requires additional data addressing the cost, reliability, and acceptability of the alternative energy technology. To further specify the analysis for solar water heating potential, the technology has been described by defining five generic types of systems consisting of; thermosyphon, recirculation, drain-down, heat exchange/drain back, and air. Cost/price and reliability data can then be developed covering the generic types of systems. Such data files include; installed equipment cost and annual maintenance costs, a consideration of governmental and utility incentive programs, and electric and natural gas prices by utility service districts. Climate data has been developed on a regional basis providing information on heating degree days, temperature, and solar insolation for monitoring sites throughout the 13 states. Such data will provide a constraining factor to the reliability of particular generic types located in specific geographical areas.

The data in support of this project, for the most part, has been collected for one point in time. The factors considered are representative of many of the considerations using a Consumer-Based Planning approach. The data development process, when completed, will provide a foundation for the analysis leading to the definition of area of high potential for solar hot water heating systems, and will further provide the basis for a broader data base development in support of other energy related problems affecting other target groups.

Considerations in Data Base Development

A data base is a collection of stored operational data which presents a picture of the past, present, and perhaps the future of a subject area. The Consumer-Based Planning Approach is being advocated in this paper as a methodology for the conceptualization of appropriate data base development for renewable energy supply options. The measure of a well constructed data base to address the needs of renewable energies lies in its appropriateness as a foundation for analysis, planning, marketing, and evaluation. The functional requirements of the data base define and limit the categories of data to be collected.

An appropriately developed data base, while addressing all phases of Consumer-Based Planning, should be scaled to the level of analysis required. Given the large spectrum of coverage, scaling considerations include the definition of the geographical area to be covered and the level of subregional analysis required. Resources devoted to data development are historically minimal. If a larger geographical area, such as county level rather than census tract level, will be adequate for the level of analysis the data base is designed to support, the available resources can be devoted to an expansion of the historical data or the number of variables collected.

A second consideration in the scaling of data collection is the identification of the key elements which will be used by various forms of analyses. To identify the key datum, common requirements of the end-users of the data are explored. Those requirements which reoccur are established as a part of the data base. Identifying the key elements is largely based upon those that have been required for current forms of analysis. Consideration should be given to data which not only meets current requirements, but that which will also give some consideration to potential future requirements. Data on substitution potentials must be gathered for analysis leading to long term solutions to energy problems.

Data in support of renewable energy analysis is a sub-set of data development for total energy distribution. As such, the renewable energy data are nested in data addressing overall supply and distribution of energy by the public and private utilities and other fuel form suppliers. Data for renewable energies is not developed in isolation, but rather as an integration of data development activities of traditional fuel forms. The 1980's may be the decade of the gradual transition to integrating renewable with non-renewable energy delivery schemes. The first step in such a transition is the recognition of the appropriate data development scheme to contribute to this end. ▮

The Analysis of End-Use Data to Determine Conservation and Renewable Energy Potential: An Overview

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The papers that will be presented in this panel are concerned with current attempts to estimate the potential for cost-effective investments in conservation and renewable energy within a specified geographic area. While a number of such estimates have been made in the past, including some which have been prominent in debates over the energy future of the Pacific Northwest, the efforts you will hear described today differ in being based upon an analysis of the ways energy is currently being used and of the determinants of those use patterns.

Why is there so much interest in the potential contribution of conservation and renewables? There are at least as many answers to this question as there are participants in the debate. For example, consumers are interested in the assurance of minimum cost, reliable, future energy supplies. Utilities and other energy producers and suppliers need to make profits, attract capital, and satisfy their shareholders; they also must satisfy the utility obligation to provide service. Citizen groups, concerned with potential social and environmental impacts, argue that new energy facilities would not be needed if advantage were taken of conservation opportunities. Siting agencies in examining alternatives to proposed plants, must consider minimum impact, including minimum cost. Public utility commissions have a different regulatory responsibility to ensure the fiscal health of the utility adequate for attraction of capital, and to ensure that rates charged to consumers are just and fair.

In the past, confusion and disagreement over the potential for conservation and renewable energy forms to displace conventional energy supplies have characterized the relationships between these interested parties. Estimates of the size and cost of the potential ha tended to be based on fairly broad, if reasonable, assumptions, and the application of national estimates.

They tended to not be refutable, but neither were they verifiable, conclusive, or implementable within specific ~ographic service areas. The existence of commonly cepted statistics, derived from the operation of a commonly accepted, comprehensive, and detailed methodology, would do much to reduce such conflicts.

The arguments in the past over the quantity and implementability of conservation and renewables have also to a large extent been misplaced, due to the focus on (and overstatement of) areas of conflict among the various parties, instead of the areas of mutual benefit. If there are indeed sizable amounts of low-cost alternatives to the construction of new, conventional energy facilities, then it would be a misallocation of resources to ignore them. The potential savings to society from not misallocating resources represent a sizable incentive, and part of the problem we face is making sure that the proper incentives are present for all parties. These incentives can be provided if the following four conditions are met.

First, incremental pricing should be used to establish the cost of conventional energy from new facilities as well as the cost of energy saved through conservation measures or produced via renewables. This would give users the proper incentive to undertake conservation measures and to gauge the desirability of their own use of energy. While this would by no means assure the immediate implementation of all cost-effective production and conservation measures and the elimination of all wasteful uses of electricity, it would put the cost of failing to do so where it will have the greatest effect—on the energy consumers. The Public Utilities Regulatory Policy Act of 1978 (PURPA) requires Public Utility Commissions to consider the implementation of rate structures based on marginal cost, and it requires unregulated utilities to consider them on their own.

The second condition involves making investment in conservation and renewables as attractive as investment in conventional facilities by allowing the inclusion of all such investments in the rate base. This possibility is at least permitted by the 1980 amendments to the National Energy Conservation Policy Act (NECPA) of 1978.

In addition to these two conditions providing incentives to consumers and energy companies, incentives could be provided to other individuals and innovators in the areas of conservation and renewables by requiring energy companies to buy back energy at their avoided cost. PURPA partially addresses this problem by requiring utilities to buy electricity from certain types of renewable facilities. The problem has not yet been addressed with respect to other forms of energy and conservation, but one can at least envision a solution similar to the PURPA one.

The fourth condition concerns the need for adequate wledge by all participants of their investment opportunities, and it is this condition that is the topic of the papers at this session.

If utilities are ever to have a good idea of the extent to which they should be installing wind systems; if customers are ever to know which conservation and renewable measures to install; if siting boards are ever to have a firm handle on whether facility proposals represent the minimum impact alternative; and if public utility commissions are ever to resolve fully the issue of whether plants are used and useful for inclusion in the rate base, then the issue of the amount of cost-effective investment opportunities in conservation and renewable energy must be satisfactorily resolved.

The resolution of this question at a level of detail sufficient to satisfy the needs of all interested parties requires, first, that we know how energy is being used currently, and what the determinants are of that use. This question is the object of much attention, as you heard in the first panel this morning. The residential end-use data base gathered jointly by BPA and the PNUCC is attracting interest from all over the country, and work is under way on the other sectors in equivalent detail. Given knowledge of how energy is used, we must then know the cost and reliability of individual conservation measures and individual renewable supply technologies. We may then begin, by applying these conservation measures to actual patterns of usage and the actual stock of energy using structures and capital equipment, to estimate supply curves for energy saved. We may also estimate supply curves for renewable technologies installed at optimal locations, using the resources present at those locations. In addition to estimating supply curves, which tell us how fast we use up the lower cost opportunities and proceed on to higher cost ones, we must also be able to specify the timing, as well as the location, of the various investment opportunities. Finally, we must be able to separate those investments which are likely to be undertaken by individually initiated action given current and likely future incentive patterns, from those which will not be taken advantage of even though they have been identified as being cost effective.

When we have accomplished this analysis, we will be able to conduct the debate on the best energy future for the region on issues suitable for debate: questions of policy rather than questions of fact. We will be able to debate the appropriate levels of risk and reliability we wish to have in our energy supply rather than energy to be saved through insulation. We can debate the best role of the state in the energy section rather than the Btu's available in geothermal sources. We will be able to debate the distributional issues of how the costs and benefits of energy should be spread, having some idea that we know what the minimum costs and maximum benefit levels are. We won't have to waste our time arguing over what is or is not of fact. ▌

Modeling Annual Energy Consumption*

by S.L. Schwartz and W.T. Ziemba, University of British Columbia, delivered by W.T. Ziemba.

This paper reviews the strengths and weaknesses of modeling energy consumption to facilitate the analysis of conservation and renewable energy supply potential. Recent trends in the GNP price deflator, oil prices, growth rates in oil consumption and fuel shares for the United States are reviewed. The possibility of substitution away from traditional fuel sources into renewables and conservation is linked to the flexibility of substitution in the economy which may be measured by various elasticities. Elasticity concepts and recent estimates are reviewed. The paper concludes with a review of recent energy demand projections for the period 1985-2030.

1. Background

Since 1973/74 when OPEC quintupled the price of oil from $2.20 to $11.50 per barrel, there has been a deep concern for the future economic development of the developed and the under-developed nations of the world. This concern has been fed by the apparent relationship between GNP and energy utilization in the near historic periods. For example Pindyck (1979a) provides a chart of Btus/GNP for six major industrial countries for 1960-75 which shows that this ratio is virtually constant over this 15 year period. Canada had the highest utilization averaging approximately 68 Thousand Btu/$ GNP, followed by the U.S. at 60, the U.K. at 55, the Netherlands and West Germany at 50 and France with 30. See also Pindyck (1979b) for an extensive review and analysis of such data in many countries.

Energy demand modeling has enabled us to look behind this apparent relationship and investigate the causes. Since 1950 the price of petroleum (using Saudi Arabia light as a base) declined in nominal terms through the 1960's only reattaining the 1949 level in 1972, see Figure 1. During this period the GNP deflator in the U.S. increased slowly through the 1950's and early 1960's and more rapidly in the late 1960's; during the entire period prices tripled. See Figure 2.

It was not surprising then that the total energy usage and particularly petroleum products increased dramatically from 1950-1973 and then tended to level off, see Table 1. An indication of the United States' heavy dependence on oil largely through its inefficient trans-

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Table 1: **Percentage Annual Growth in Oil Consumption**
EIA (1979b; 15)

	1950-1973	1973-1978
United States	4.3	1.5
Canada	7.9	-0.2
Japan	25.0	-0.4
Europe	12.3	-1.7
Developing Countries	6.1	2.0
OPEC	10.4	5.6
Free World	7.1	0.6

Table 2: **Energy Consumption in the U.S. by Fuel Type and Total 1950-1979 in Quads (10^{15} Btu)**
EIA (1979b; 6)

	1950	1960	1965	1970	1973	1976	1979
Coal	12.9	10.1	11.9	12.7	13.3	13.7	15.1
Natural Gas	6.0	12.4	15.8	22.8	22.5	20.4	19.9
Petroleum	13.3	19.9	23.2	29.5	34.8	35.2	37.0
Hydro	1.4	1.6	2.1	2.6	3.0	3.1	3.2
Nuclear	-	-	-	0.2	0.9	2.1	2.8
TOTAL	33.6	44.0	53.0	66.8	74.6	74.5	78.0

portation sector is that the relative share of energy usage from oil continued to increase during 1973-1979, see Figure 3 and Table 2.

In summary the period from WW II to 1973 saw strong, steady growth of energy demand, abundant supplies of fossil fuels and a decline in the real price of energy of 30%. The reversal of relative energy price trends in the mid 1970's with real energy prices increasing about 35% in the period 1973-77 led to a reassessment. If the future were to mirror the past, disaster lay ahead. Predictions about the future began to change based on energy demand analysis and these were borne out by the subsequent drop in the rate of energy demand growth. For example in Canada, the 1973 prediction based on past growth was 5.8% per annum. Hopper's (1975) estimate was in the range 3.7-4.8%. Two years later Brooks (1977) was reporting estimates in the range 2-3%. Meanwhile the United States experienced a decrease in energy usage of 2.5% and 2.8% in the recession of 1974-75. This was followed by growth rates of energy usage of 5.4%, 2.5%, 2.3% and -0.2% in 1976-79; see Energy Information Administration (1979a). Europe also experienced negative growth in the late 1970s. Setting the energy/GNP ratio at 100 in 1973, then by 1979 the U.S. index stood at 91; the Western European index at 93, and the Japanese index at 82 (Business Week, October 2, 1980).

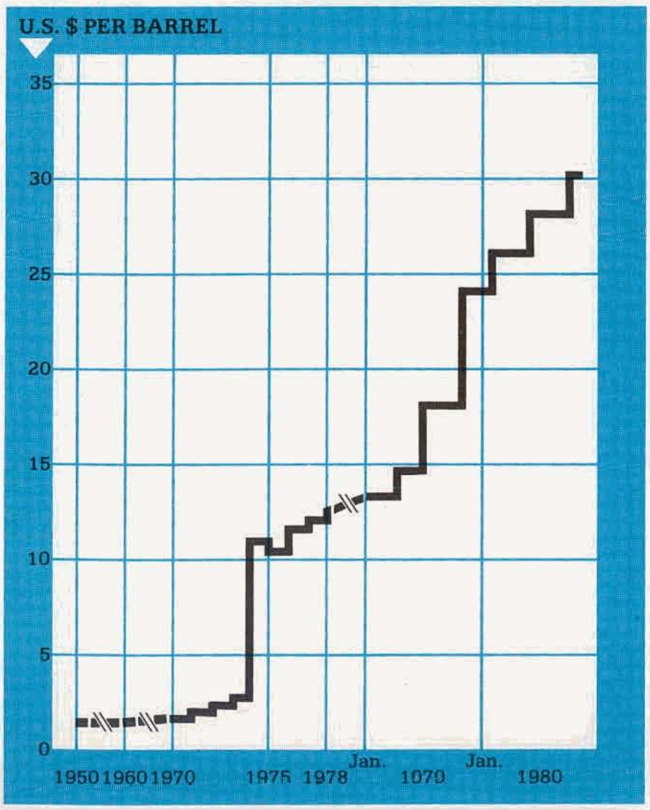

Figure 1: **Price of Saudi Arabian Light Crude, U.S. $/Barrell, 1950-1980**

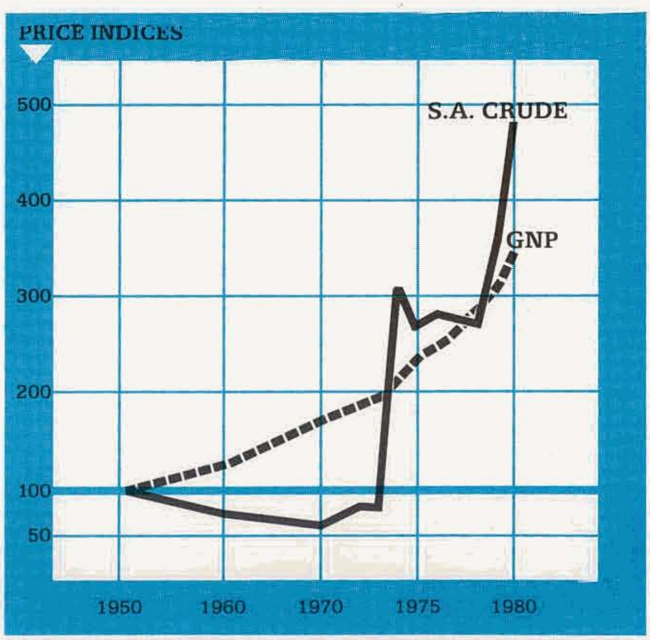

Figure 2: **U.S. GNP Price Deflator and the Real Price of Saudi Arabian Light Crude, 1950-1980**

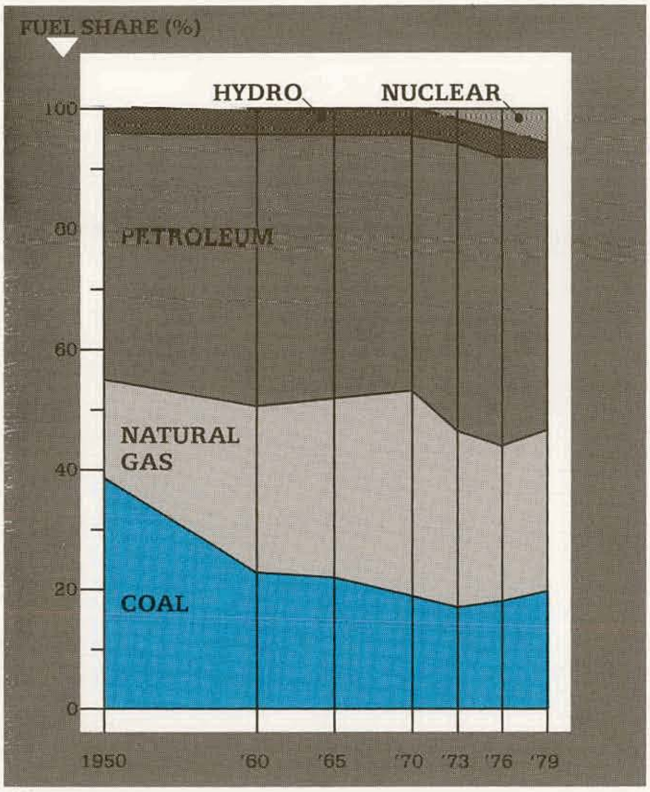

Figure 3: **Fuel Shares in U.S., 1950-1979**
(Source: EIA, 1979 b, 6)

2. Elasticity Concepts

Implicit in the decline in energy/GNP ratios is a flexibility in energy utilization. At issue is the **degree** that the economy can substitute capital and labor for energy to maintain current or provide for increasing levels of GNP. Economists use various elasticities to measure the demand response to changing prices. The price elasticity of demand for a given commodity is the percentage change in quantity demanded divided by the percentage change in the price of this commodity; this and other elasticities are point estimates and are thus defined for infinitesimal price changes. Price elasticities are generally negative. Cross price elasticities provide information on how adjustments are made; for example the cross price elasticity between electricity and oil is the percent change in the quantity of electricity demanded divided by the percentage change in the price of oil. Such elasticities may be positive in which case the two commodities are considered to be substitutes or, negative when they are complements. Except in special circumstances such elasticities are not symmetric: the electricity-oil elasticity usually differs from the oil-electricity elasticity. Elasticities may be aggregate dealing say with total energy or fuel specific. The numerical value of the different elasticities is crucial in the analysis of various policy questions such as the assessment of the impact of different energy taxes and energy technology modifications as well as forecasts of future energy consumption. A formal model of these interactions between energy and the economy is provided by the Elephant-Rabbit Stew analogy, see Hogan and Manne (1977). They utilize the elasticity of substitution between energy and non energy outputs; for values shares of energy about 4% as in the U.S. economy the elasticity of substitution is very closely approximated by the price elasticity. Considering energy as an aggregate the higher the price elasticity, the smaller will be the impact on GNP of a given energy price increase and the lower will be the estimate of future energy consumption with higher energy prices.

For example for an energy usage drop of 40%, GNP drops by 20% if the elasticity is 0.1, by 6% if the elasticity is 0.2, by 4% for 0.3 and by 2% for 0.9. For a doubling of energy prices, energy usage drops by 48% for elasticity 0.9, 19% for 0.3, 16% for 0.2 and 5% for 0.1; see Energy Modeling Forum (1980) for graphs and more discussions.

It is only in cases of extremely low energy price elasticities that we need to place priority on the development of new high cost energy sources and new technologies. Instead the "burden" of transformation is placed on alternative inputs such as labor, on the development of new production processes, and on shifts in the goods produced toward those requiring less energy intensive methods.

Another important aspect is time. In the short run, given fixed capital stocks, elasticities tend to be low and changes in demand are slight. In the long run capital equipment and production processes can be modified and elasticities are much larger. On this basis some argue, and it is current Canadian energy policy, that one should shelter economies from the shock of a sudden movement to the world price of oil by moving to the world price in a series of known and gradual steps.

3. Elasticity Estimates

The economic literature contains a number of papers that provide energy demand elasticities in a wide variety of model situations. Recent reviews of some of these models can be found in Energy Modeling Forum (1977, 1980), Hartman (1979), Pindyck (1979 a,b) and Ziemba, Schwartz and Koenigsberg (1980). The estimates are obtained from a variety of models including econometric models of demand, engineering demand process models and large scale integrative planning models. The econometric models are based on an underlying economic model of optimal economic behavior. A statistical model is then derived from the optimizing conditions relating independent and dependent variables. The model's parameters are then estimated using historical data and consistent estimation procedures. Very often models are estimated with weak theoretical foun ations and investigators simply try to obtain the moc… that best fits the data. In the so-called engineering

Table 3: **Secondary Demand Elasticity Estimates**
(EMF, 1980)

	Estimation Methodology			
	Econometric		Engineering/Judgmental	
Sectors	Low	High	Low	High
All Sectors	-0.3	-0.7	-0.1	-0.6
Residential	-0.5	-1.0	-0.4	
Residential/Commercial	0.5	-0.8	-0.5	
Commercial	-0.5		-0.3	-0.4
Commercial/Industrial	-0.3	-0.7	-0.1	
Industrial	-0.2	-0.5	-0.2	-0.7
All Transportation	-0.2	-0.5	-0.4	
Automobile Gasoline[1] with Efficiency Standards	-0.1	-0.2	-	
without Efficiency Standards	-0.1	-0.5	-	

approach to demand estimation, one simply adds up all the energy "needed" for specific industrial, consumer, residential, transportation, etc. uses to arrive at final demands. Since the engineering approach provides detail about actual end-uses and the economic approach specifically considers price effects, combining them is very desirable in many applications. At present little of this is done; for more discussion see Berndt and Wood (1979) and Ziemba and Schwartz (1980). In the integrative models the elasticities either are indirectly estimated from optimization over time of the interaction of energy supply and demand or are input to the model in a judgmental fashion; see the Energy Modeling Forum (1980).

Caution is advised in comparing the results of various energy elasticity studies as typically the time periods used for estimation as well as the sectoral definitions may vary. Time series studies often provide only short run elasticity estimates as the data base is not sufficiently lengthy to capture fuel adjustments. Cross section and cross country estimates, being representative of a wider range of price ratios, can more closely approximate long run elasticities; see Pindyck (1979a) and Schwartz (1980) for more discussion. An important consideration is the level of aggregation. The Energy Modeling Forum's (1980) extensive study of energy elasticities concluded that estimates based on primary energy supplies are much less useful for planning purposes than those based on secondary energy supplies. Measurement at the point of source as is used in the estimates of primary elasticities does not capture important behavioral incentives of energy demand at point of use as is reflected in secondary energy elasticities. These include transmission losses and choice of fuel mixes, for example, in the case of electricity.

A summary of the ranges of elasticity estimates found in the studies by the Energy Modeling Forum (1980) and the Pindyck (1979a) and the Schwartz (1980) studies appears in Tables 3 and 4, respectively.

As can be gleaned from Tables 3 and 4 the ranges of elasticity estimates are quite wide. It is difficult to provide single best estimates of particular elasticities. This variability in the estimates of elasticities of demand provides a focus on scenario development and investigation of energy demands given economic characteristics rather than a concern with fixed energy requirements. The individual estimates should be used in similar contexts to those in the models from which they were derived.

Table 4: **Econometric Secondary Demand Estimates**
(Pindyck 1979a, Schwartz, 1980)

Sector	Low	High
Residential	-.12	-1.10
single country	-.12	-.56
cross country	-.71	-1.10
Industrial		
aggregate	-.50	-.80
disaggregate	-.30	-2.54
Transportation	-.20	-1.0

[1] Note that the differences with and without efficiency standards are misleading because the imposition of efficiency standards has already captured some of the flexibility in energy use.

Table 5: **Estimates of Agregate Primary Energy Consumption, Quads.**

Model, year	1985	1990	1995	2000	2010	2025	2030
Energy Policy Project, 1974*	93-115			100-185			
PIES, 1974*	94-109						
ERDA, 1975*	97-107			122-165			
CONAES, 1977*		69-113			64-189		
Pilot, 1977**		120-135		150-200	180-270		
DRI-Brookhaven 1977**		95-120		115-170			
Hnyilicza, 1977**		75-120		85-180			
Lovins, 1977				95		60	
EIA, 1978***	91-97						
EIA, 1979***	81-83	88-93	94-102		122-128		
Manne, 1979	84-89	88-98		100-116	118-140		162-203
IES, 1979		68-83				49-108	

Source as given except: *Just and Lave, 1979; **EMF, 1977; ***EIA, 1979b.

4. Aggregate Energy Consumption Forecasts

Aggregate energy demand forecasts are made with the use of scenario analysis of various exogeneous model parameters. Typically forecasters vary several of the key parameters to obtain ranges for their estimates. The resulting forecasts are closely linked to the model structure including elasticity estimates as well as the price and economic growth scenarios. The models are referred to as partial equilibrium models if the GNP growth rate is exogeneously specified and general equilibrium if there is a two-way linkage between the energy sector and the rest of the economy. In the latter case the rate of GNP growth may be affected by rising energy prices. A summary of several forecasts for the period 1985-2030 appears in Table 5. In general the more recent estimates point to a slower growth in energy consumption than the earlier estimates. Two of the studies (Lovins, 1977 and Institute for Energy Studies, 1979) give estimates that allow for a heavy dependence on renewable energy forms and conservation. Generally speaking the criterion for choice among fuels and, ultimately, total consumption of energy is minimum discounted cost, maximum discounted GNP, or some related concept. Consult the cited studies for estimates of fuel shares.

A major conclusion of several of the studies, see in particular Manne (1979), is that conservation policies will be difficult to implement unless the domestic price of petroleum is allowed to rise to world level or energy-standards are mandated. The effect of differing elasticity of substitution estimates is clearly borne out in these studies. This may be illustrated with results from Manne (1979). With other things equal such as 4% real OPEC price increase from 1980, one has a substantial drop in energy consumption for $\epsilon = -0.5$ versus -0.3. For example in 2000 with $\epsilon = -0.5$ primary energy consumption in quads and electricity generation in trillion kWh and 100.1 and 4.08, versus 115.0 and 4.49 with $\epsilon = -0.3$. By 2030 the difference is even more significant with $\epsilon = -0.5$ one has 161.8 and 7.60 versus 201.7 and 9.41 with $\epsilon = -0.3$. This is still a substantial increase from the 1975 values of 70.6 and 1.98, respectively. Despite the lower consumption of energy with $\epsilon = -0.5$, GNP is substantially larger. Discounting at 5%, the difference in cumulative aggregate GNP is $0.34 and $1.26 trillion by 2000 and 2030, respectively. Manne also provides calculations concerned with the cost of a nuclear moratorium. In this case the major differences, assuming

$\epsilon = -0.3$, are a large drop in electricity generation (3.29 and 5.48 in 2000 and 2030 versus 4.49 and 9.41, respectively), a substantial drop in primary energy consumption (105.2 and 170.4 versus 115.0 and 201.7) and a slightly lower GNP (-$0.04 and -$0.80 trillion by 2000 and 2030, respectively). The paper by Manne and the other cited studies contain many analyses of these and other important policy questions. An important consideration is the believability of the results from various model scenarios. In this light there has recently been extensive study of model validation (does it do what it is supposed to do?), verification (does it do what is appropriate?), and ventilation (use by others), see e.g. Energy Modeling Forum (1977), Gass (1979), Greenberger and Richels (1979), and Ziemba and Schwartz (1980). Surveys of model structures and results appear in Berndt and Wood (1979), Brooks and Hollander (1979), Energy Modeling Forum (1977, 1980), Fuller and Ziemba (1980), Hitch (1977), Just and Lave (1979), Manne, Richels, and Weyant (1979), Ziemba, Schwartz and Koenigsberg (1980), and Ziemba and Schwartz (1980). Two important recent studies of energy conservation are Griffin (1979) and Rosenfeld, Goldstein, Lichtenberg and Craig (1980). ∎

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Forecasting Energy Demand by End-use

End-use demand forecasting is a method of estimating future energy use by adding up the use by individual energy-using devices. In principle end-use forecasting can be done for any sector, but most work to date has concentrated on the residential sector.

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End-use Forecasting Compared with Econometric Forecasting

It is useful to compare end-use forecasting to an alternative forecasting technique, econometric demand forecasting. Econometric energy demand forecasting is widely used, and in many cases can provide an adequate forecast. An econometric forecast for the residential sector typically takes variables such as population, per capital income, price of each energy source, and other variables to explain total energy consumption. Using past observations, equations are developed to estimate consumption as a function of the chosen input variables. Given forecasts of the input variables, a forecast of energy consumption is developed. Such a forecast will give useful information about future consumpton levels. However, such a forecast is unsatisfactory in several ways.

An econometric model gives little explanation of why patterns of consumption change. There is a difference in paradigms between aggregate econometric forecasting and end-use forecasting. An example comes from the trend in Oregon residential natural gas consumption. Oregon residential natural gas consumption has declined by about twenty-five percent per customer since 1970. About a year ago, I talked to an economist at a gas company, wondering if he had any explanation for this decrease. His explanation was "price elasticity of demand." He pointed out that gas prices have risen dramatically during the seventies, and due to price elasticity, consumption per customer has declined. However, he was not at all sure how this reduction has been achieved, whether through weatherization, thermostat setback, better furnace maintenance, or other actions. It is as though there is some abstract demand for natural gas, and customers just decide to use less of it when the price goes up. The end-use modeling pardigm argues that people do not have a demand for natural gas, electricity, or oil as such. A person gets no satisfaction from the consumption of electricity. Instead, there is a demand for things such as warm homes, refrigerated food, lighting, hot water, and television. The demand for energy is a secondary demand due to these primary demands. If I weatherize my home, it is because I can satisfy my desire to stay warm at a lower cost; I am still deriving the same amount of satisfaction. End-use forecasting attempts to project the amount of activity that uses energy, and total the energy used by these activities.

In addition to an econometric model's lack of explanatory power, there are some cases in which an econometric model does not function well as a forecasting tool. The effects of changes which are not reflected in the data used to develop the econometric equations are hard to forecast. For example, the effects of a new residential code are hard to predict. Similar problems occur with technology shifts to new methods of meeting energy demand, such as solar or heat pump water heating. If the demand for space and water heating are explicitly modeled, the effects of such changes are easier to estimate.

Developing an End-use Forecast

An end-use forecast is conceptually very simple: determine for each future year how many of each kind of appliance will exist and the average annual use of each appliance. Adding the use by all the appliances gives total demand. In practice, carrying out this process poses formidable data requirements. It is necessary to have data for some base year detailing number of homes b structure type, insulation characteristics, and applian(saturations. In addition, it is necessary to know the energy use of each type of appliance. Some of this information is available from the census, other government sources, and utilities, but gathering the necessary data usually requires a survey. Periodically, additional surveys are advisable to provide a check on the forecast.

The process of developing an end-use forecast is outlined here. For each future year, the number of appliances of each type is necessary. The number of appliances can be forecasted by projecting the number of households and the saturation (fraction of homes having that appliance) of each appliance type. This poses the problem of developing a housing forecast. Because appliance ownership is different between housing types, it is desirable to forecast the number of households by structure type, rather than just the total number of households. A reasonable way of projecting housing is to use a relationship between total population and number of housing units. In addition, the average use of each individual appliance needs to be forecasted, including any changes due to increased efficiency. Thus a possible process of forecasting end-use demand may be summarized as:

1. Get a population forecast.
2. Using the population forecast, derive a housing forecast.
3. Forecast saturation of each appliance type by housing type. Multiply the appliance saturation by total homes to get the number of each appliance type.
4. Project the average annual use of each appliance. Multiply this use by total number of appliances, and add the use by all appliance types to get total demand.

Population forecasts can be developed by the forecaster, or taken from the forecast of some other organization. In Oregon, the Bonneville Power Administration and Portland State University both make population forecasts. In addition, other agencies and some private firms forecast population. The Oregon Department of Energy (ODOE) uses the BPA forecast.

The BPA population forecast includes a forecast of number of households by age of the head of household. Using data from the U.S. Census, the age of the head of the household is used as a determinant of the type of housing chosen. The age of the head of household is used to represent differences in lifestyles, income, family size, and other factors of housing choice. Past trends in housing choice in the past are projected into the future and multiplied by the BPA forecast of households, giving number of housing units by dwelling type. This forecasting technique does not account for business and interest rate cycles, but is assumed to represent long-term trends.

The saturation of each appliance type can be forecasted by trending past saturations to some ultimate saturation, or by econometric techniques if sufficient data is available. In many cases, the saturation of an appliance is known in only a few years. For several appliances, the ODOE model assumes an ultimate saturation for that appliance, and fits a logistic (S-shaped) curve to the past data to forecast saturation. If sufficient data is available, it might be appropriate to forecast saturation econometrically; as a function of per capita income, for example. However, if saturation of an appliance is more of a market penetration phenomenon than a function of income, a logistic fit may be quite appropriate.

A different approach is taken with space and water heating. In the case of many appliances, a household can acquire the appliance at any time, and it is appropriate to forecast the overall saturation. In the case of space heating, the type of heating fuel is less easily changed once the original choice is made. Thus, the variable forecasted is the fraction of new homes connecting to each heating fuel. In the ODOE model, the number of new homes that have solar heating is also an input variable.

Energy use by appliance in the base year can be estimated from manufacturer data, metering analysis, regression techniques on a sample of homes, or engineering calculations (e.g., heat-loss equations). Surveys can be valuable in estimating the consumption of different appliances. Using a sample of homes with a varied pattern of appliance ownership, statistical techniques can be applied to consumption data from each household to compute the average consumption for each appliance. If more accuracy is necessary, appliances can be individually metered. This may be desirable in the case of new appliances that might not appear in a general sample. Examples are metering of hot water heat pumps, solar homes, and super-insulation homes.

For future years, the use per appliance may be modified due to changes in appliance efficiency. In the case of many appliances, reductions in use are forecasted because of federal appliance efficiency standards. Use for space heating changes as a result of weatherization, solar retrofitting, or behavioral actions such as lowered thermostat settings or more frequent maintenance of furnaces. For new homes, code changes cause changes in annual energy use. Estimates of implementation rates of these actions must be made, as well as estimates of the amount of energy saved by each action. Similar estimates must be made for decreases in energy use for heating water, because of solar or heat pump water heaters.

Problems of an End-use Forecast

An end-use model is generally better suited than an aggregate econometric model in forecasting changes due to factors other than price. However, a disaggregated model has the problem of accounting for price changes that an econometric model easily takes into account. For example, it is difficult to find data to use for forecasting the amount of weatherization done as a function of the price of energy. Thus, forecasts of the amount of weatherization done tend to depend on the judgment of forecasters. This problem occurs with weatherization, solarization, number of homes built better than code requirements, and similar factors. Thus, although an econometric forecast lacks explanatory power, an end-use model poses the difficulty of forecasting the explanatory variables.

Applications of an End-use Forecast

Possible uses of an end-use forecasting model are as an aggregate demand forecasting method, or a policy analysis tool.

Given a set of assumptions about future trends, an end-use model will produce a forecast of total demand. Sensitivity analyses can be done to test for the importance of various assumptions. For example, it might be assumed in a forecast that twenty percent of single family homes in the year 2000 have solar or heat pump water heat. As a sensitivity analysis, the model could be run using fifteen and twenty-five percent saturations, and the change in total demand determined. In this fashion, the end-use model is being used in manner similar to an aggregate econometric demand model. The total demand forecasted for future years can be used in decision making: for example, in determining the need for electricity generation.

An end-use forecast model is also a natural policy analysis tool. When presented with a demand forecast one of the first things that comes to mind is "what if" type analyses. Scenarios may be projected by changing the input assumptions to the model. The ODOE residential end-use model was used to do analyses for the Oregon Alternate Energy Development Commission. Scenarios included the potential impact of a new building code, full weatherization of existing stock, and a high saturation of solar or heat pump water heating. The model has also been used to estimate the impact of a ban on electric resistance heating in new homes.

When used for scenario analysis, a forecasting model incorporates a time dimension not present in, for example, a simple calculation of total savings from solar or heat pump water heaters in a large fraction of homes. A reasonable implementation schedule must be included in the scenario. When addressing the need for new generation, the question of how soon savings will occur is important. ▮

Calculating Annual Energy Conservation Savings

Robert Spencer
Puget Power and Member,
PNUCC's End-use Data Committee

I appreciate the opportunity to participate in this Second Annual Pacific Northwest Alternative and Renewable Energy Resources Conference and to share with you some of my ideas concerning the estimation of conservation savings. Rather than concentrating on a detailed description of methods currently available for assessing conservation potential, however, I will take this opportunity to share with you some of my perceptions with regard to the problems of the major analytical techniques and ideas that I have concerning the direction future research and analytical activities should take. I hope that in presenting my ideas you can sympathize with my interests which emanate from responsibilities I have at Puget Power for designing research projects which might, in part, provide the utility with a greater understanding of conservation and the capability to use alternative and renewable energy technologies as an electricity resource. Throughout my presentation I will use the term "conservation" as synonymous with alternative and renewable energy resources.

Having worked in the utility industry in the Pacific Northwest for the last several years, I have been impressed with both the interest in and commitment to conservation electrical utilities have made. Clearly, the energy audit and weatherization services offered by most major electrical utilities have provided their customers with a substantial amount of support in their conservation efforts. Further, it is not uncommon now to find utilities with staff with specialized knowledge of solar and other alternative energy resources and highly motivated to see the proliferation of these technologies.

It is important to note, however, that utilities have r been greatly rewarded for their interest and investmer in conservation. Rather than resolving problems and concerns utilities have had, their efforts have tended to make conservation more problematic and difficult to harness as a legitimate energy resource. Results, for example, of weatherization programs often vary widely throughout the region, with one utility realizing only a 30 percent reduction in project consumption while another realizes 130 percent reduction in projected consumption. Utility power planners faced with providing energy in future years justifiably pull out their hair when faced with such potential variation because the consequences of error may be power blackouts, radical increases in rates, or both.

There are presently several efforts underway to make regional assessments of the conservation potential we have, but we should not delude ourselves into thinking that the results of these studies will be definitive. During the next fifteen months, there will be a preliminary assessment of the conservation potential for residential households performed by the Pacific Northwest Utilities Conference Committee and this will be followed by a more rigorous study in the Pacific Northwest funded jointly by the PNUCC and Electric Power Research Institute. Also, the PNUCC will be jointly funding another assessment of the conservation potential in all sectors with the Bonneville Power Administration and several local utilities. Although these studies will be based upon and should contribute significantly to the advancement of state-of-the-art end-use and econometric methodologies, there is a substantial amount of behavioral phenomena that must be explored and better understood before conservation can be harnessed as a reliable alternative to traditional forms of electricity generation.

It is useful to review some of the behavioral limitations in existing models and techniques to better understand the problems we will face in estimating conservation potential. This brief review will focus on three of the more prevalent techniques available to utility analysts: statistical end-use and/or econometric models, structural models, and relatively simple before and after measurements.

End-use and econometric models have been used with a fair degree of success to statistically estimate appliance utilization and price response phenomena. When time series data is available, these models can be particularly useful for estimating general trends. It is interesting to note that models with both end-use and econometric elements are becoming increasingly common and are more useful for measuring the sensitivity of a wider range of conservation policy options. Still, despite these improvements, these statistical models require a substantial amount of data and still may not be able to predict changes in consumption which may be related to broad social or perceptual changes. For example, radical increases in the use of wood stoves appear to be less related to price phenomena than to a general social interest in self-sufficiency. These end-use and econometric models may also be incapable of detecting subtle differences in appliance energy usage among central city, suburban and rural populations, yet such social phenomena may intervene to depress or increase the energy savings potential of different conservation and alternative resource actions.

Structural models can be very useful for estimating potential energy savings, but can also yield problematic results due to behavioral complications. Assuming a utility can select and calibrate a realistic structural model for its service area, it may still be impossible to reliably predict energy savings related to weatherization and other forms of conservation. Consider, for example, a household that has kept its thermostat at 65° and then substantially upgrades its insulation. The energy savings which might be realized can be estimated fairly precisely with a good structural model, although the savings may not be fully realized if the household increases its thermostat setting to 68° or 70° or greater savings may be realized if, for example, the household later installs a wood stove also.

Finally, simple before and after comparisons of weather-adjusted consumption can be made, although the deviations frequently observed in such results tend to raise more questions than are answered, especially related to long-term behavioral phenomena.

To summarize to this point, it appears to me that analysts are faced with three challenges in developing an assessment of conservation potential which will be useful to forecasters and planners in identifying future electricity resource requirements. First, we must be capable of estimating the reliability and stability of various conservation actions, especially if conservation is to be used instead of traditional forms of generation. This will require the development of a typology to allow us to distinguish among different conservation actions to direct our research and analytical activities. I will discuss one possible approach to such a typology in just a moment.

Second, we must assess the acceptability of various conservation actions and policies. If our focus is upon alternative regional or even service area policies and programs, we must identify differences among different populations and social groups. Finally, we must explore the interrelationships which exist among potential conservation actions so we can anticipate where countervailing trends might serve to reduce consumption savings. For example, wood stoves may lead to a reduction in electricity consumption for homes with electric heat, but if homes with oil space heating acquire wood stoves and additionally install electric baseboard units to heat peripheral rooms, electricity requirements may actually increase. Clearly, the interrelationships among many potential actions need to be identified to assess the conservation potential which exists.

As I have already indicated, I am of the opinion that a great deal of basic behavioral research needs to be done

Figure 1: **Conservation Typology**

Permanent Resources	Temporary Resources	Uncertain Resources
Net Capacity/Energy Gain	Contributing to System Stability	Creature Comfort Dependent
Net Energy Gain/Capacity Loss	Contributing to System Instability	Social Change Dependent
Net Capacity/Energy Loss		Economic Dependent

to develop realistic conservation assessments. To guide these efforts and also better structure our models, a basic typology is necessary to distinguish among qualitatively different kinds of conservation actions. In the time remaining, I will outline one possible typology and try to indicate some of the research, as well as model, implications which follow from such a schema.

To begin, it appears as though when we discuss conservation we may be referring to three qualitatively different resources representing either permanent, temporary, or uncertain energy savings. These possibilities are depicted in Figure 1 along with the basic resource attributes of each. When we discuss permanent conservation resources, we are generally referring to long-term changes in the electrical energy and capacity requirements of structures or appliances. Some examples of changes which would represent a net energy and capacity gain are increased weatherization of an electrically heated home or the replacement of an electric water heater with a solar water heating system with an oil or wood-fueled backup unit. Conversely, an example of a permanent resource representing a net energy gain but capacity loss for an electric utility would be a solar system with an electric backup unit. In the Pacific Northwest, solar systems could easily have this effect if backup electrical units are used during periods of system peak load, i.e., on the coldest and cloudiest days of the year. Finally, examples of permanent resources which might lead to net energy and capacity losses would be additions of electric backup of peripheral room heaters associated with the installation of solar or wood heating systems in homes where these units replace gas or oil space heating. Similarly, any electric space or water heating conversions stimulated by householder desires to take advantage of zero-interest or other weatherization programs of electric utilities would also represent a net capacity and energy loss. Please note that I do not mean to suggest that solar and other weatherization or conservation actions may necessarily have the attributes I am describing; instead, I mean to suggest only that we should identify what attributes these systems and actions may have to help us both better design conservation systems and programs and more appropriately account for impacts of conservation in our resource assessments.

The second class of resources are temporary in nature and these can either contribute to or detract from the reliability of our electrical generating systems. Many of the load management and typical wintertime conservation appeals of utilities can best be classified as yielding temporary resources. It is important to note that these are resources which may be tapped in an emergency or to control loads during peak periods. These may range from voluntary, short-term reductions (e.g., lighting reductions or deferring the turning-on of self-cleaning ovens to off-peak periods) to periodic controls, such as the cycling of spare and water heating loads.

It is important to recognize, however, that temporary resources represent "the first line of defense" for any utility in the case of an emergency, such as the loss of a generating unit or whole plant during a system peak period. If temporary resources are used too often, the utility runs the risk of inducing a permanent behavioral change. While this may be desirable from the standpoint of reducing overall capacity requirements, the conversion of temporary resources to permanent resources may create profound system instability resulting in rolling outages or similar phenomena.

By identifying those temporary resources available to utilities, these can be monitored and important behavioral trends and changes can be followed. This should improve our ability to plan for emergencies and may also enhance our ability to develop creative load management and curtailment plans.

Finally, there are a whole set of uncertain resources influenced by standards of creature comfort, social change, economic and other factors. These factors tend to be related to one another, but are most important because they can influence gains and losses relative to permanent and temporary resources. The kinds of actions which might be considered to represent uncertain resources are water and space heating thermostat setbacks, flow restrictors, appliance efficiency standards and possibly even the impact of wood and other alternative heating resources. These resources may be classified as uncertain when they rely in large part on a host of behavioral changes which may be subject to reversal at some future time.

Thermostat settings are creature-comfort depende... and temperature requirements obviously change as people develop from infancy through middle age to old age. While these creature comfort standards may vary with the age of an individual, they may also vary with changes in the perceived efficiency of living structures, and this variation may manifest itself as thermostat increases following an upgrade in weatherization.

Social change-related phenomena may also manifest itself in a number of ways. In a global sense, society may unilaterally decide some things are desirable, like increases in appliance efficiency. Whether such policies lead to energy savings or losses needs to be the subject of future research. While increased efficiencies should lead to savings, we should not forget our physics and the fact that energy is ultimately converted to heat. In this sense, savings of more efficient appliances could be offset by increased space heating requirements. On a more individual level, and keeping with the same example, more efficient appliances may be used more intensively by households.

Finally, economic factors may make some alternative resources more uncertain. In this regard, a household may obtain a wood stove and initially use wood scraps from their yard. However, once the household must purchase wood and finds it more expensive than the electricity for its central furnace, the wood stove may be used substantially less, if at all.

The principal reason why a conservation typology is useful is for revealing what it is that we need to measure to assess the potential of any particular conservation strategy. If we consider what it is that we need to measure (see Figure 2), it becomes clear that permanent resources are more amenable to direct physical measurement, although there is still some behavioral component that needs to be assessed even here. As we advance to uncertain resources, the measurement of the behavioral component becomes increasingly important, though there are still some physical measurements to be made. If we take a purely economic view, the resource typology I am discussing captures long-term economic phenomena in the permanent side of the resources spectrum and short-term phenomena more in the uncertain side. However, the point I am laboring to make is that physical, economic, and behavioral phenomena all need to be explored and understood to assess the potential of conservation as an energy resource.

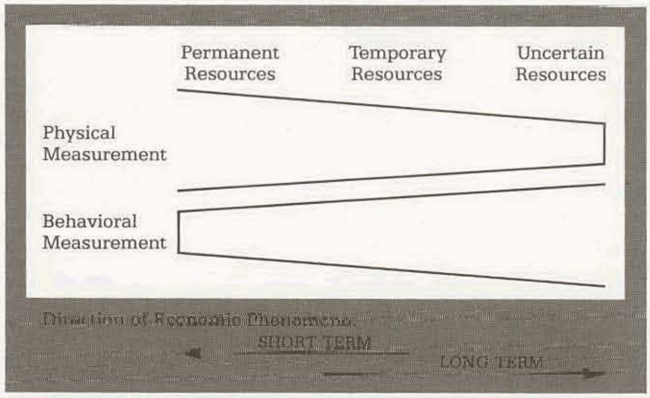

Figure 2: **Measurement of Conservation Phenomena**

To be even more exacting with the measurement implications of the typology I am discussing, it is useful to consider a very simplified conservation decision-making model (see Figure 3). Any individual household can be subjected to three kinds of messages, appealing to physical, economic, or social interests. For example, a utility can launch an advertising campaign appealing to its customers to conserve, noting that they will (1) be more comfortable (a physical appeal); (2) save money

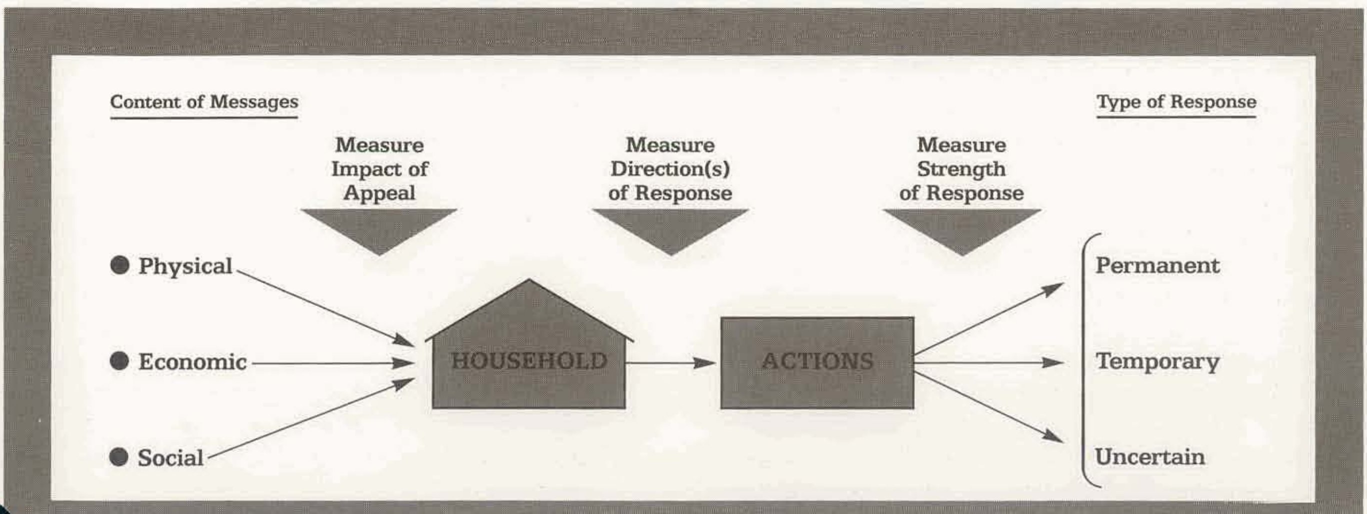

Figure 3: **Content of Messages**

(an economic appeal); and/or (3) be better citizens (a social appeal) if they conserve. Obviously, these messages need not emanate from a utility, but may be experienced by a homeowner sitting in a drafty living room on a winter night. The point is, the first step is to measure the content and impact each of these different messages may have.

Next we need to discern how households (or firms) might respond to the messages and what the direction and strength of each action might be. The conservation typology may be particularly useful in making this assessment. For example, a household reacting entirely to physical discomfort in a drafty home may be led to install weatherization and increase thermostat settings simultaneously. Similarly, a person interested in becoming more energy self-sufficient may be led to install a wood stove, although without an immediate need to actually be energy self-sufficient, the wood stove may be improperly maintained and represent only a very uncertain long-term resource.

Although there is room for differences of opinion concerning the appropriateness of the conservation typology I have suggested and the illustrations I have employed, I believe the important point to be made is that we must move to develop a way of classifying and distinguishing among qualitatively different forms of conservation while at the same time expending a significant effort to understand the underlying behavioral phenomena, including all the attitudes, opinions, and beliefs that may apply, and influence how much conservation can be reliably harnessed as a surrogate for new generation. In making this appeal for more behavioral and social research, I do so in the hopes that our conservation assessment efforts may be constructive and more truly representative of what is possible. In emphasizing the behavioral, I am taking my lead from Alfred North Whitehead and I will leave you with his admonition that "When one is lost, one should not ask where one is but rather where the others are." Thank you. ▮

Evaluation of Renewable Energy Sources in the Pacific Northwest

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As a staff engineer for JBF Scientific Corporation, Martin Goldenblatt has responsibility for evaluating the impact of dispersed and central station alternative energy sources on prospective users. He is project director for a study which has as an objective determining the value of solar generation to Seattle City Light. Mr. Goldenblatt also has project responsibility for determining the impact frequency of wind speed data acquisition on the economic evaluation of wind turbine units for utilities. Prior to joining JBF, Mr. Goldenblatt evaluated power plant dynamics by means of computer simulations for Stone and Webster Engineering Corporation. He is the author of several papers on wind energy systems and computer simulation. Mr. Goldenblatt received his B.S. in mechanical engineering from the City College of New York and his M.S. in mechanical engineering from Northeastern University.

The Department of Energy and the Solar Energy Research Institute are sponsoring a series of six regional assessment studies (covering the entire country) aimed at identifying both the potential for solar electric technologies and applications that represent the best potential markets with opportunities for early commercialization. The objective of the studies is to identify opportunities for demonstrations and follow-on large-scale use of wind, photovoltaic, solar thermal, ocean thermal, and biomass (direct combustion) in the 1980 to 2000 time period.

JBF Scientific conducted the study which analyzed the potential for the above solar technologies in what was defined as the Northwest Region of the United States: North Dakota, South Dakota, Montana, Nebraska, Idaho, Wyoming, Oregon, Washington, Alaska, and Hawaii.

This paper will focus on the central station analysis and evaluation that was performed for utilities in the Pacific Northwest only, that is: Oregon, Washington, Montana, Idaho, and Wyoming.

The methodology, which was uniquely developed to analyze the performance and economics of solar electric generation for utilities whose capacity is predominantly hydroelectric, will be described first. Following that, the input data and the study results indicating the econom[ic] potential of central station solar electric generation t[o] the year 2000 will be presented.

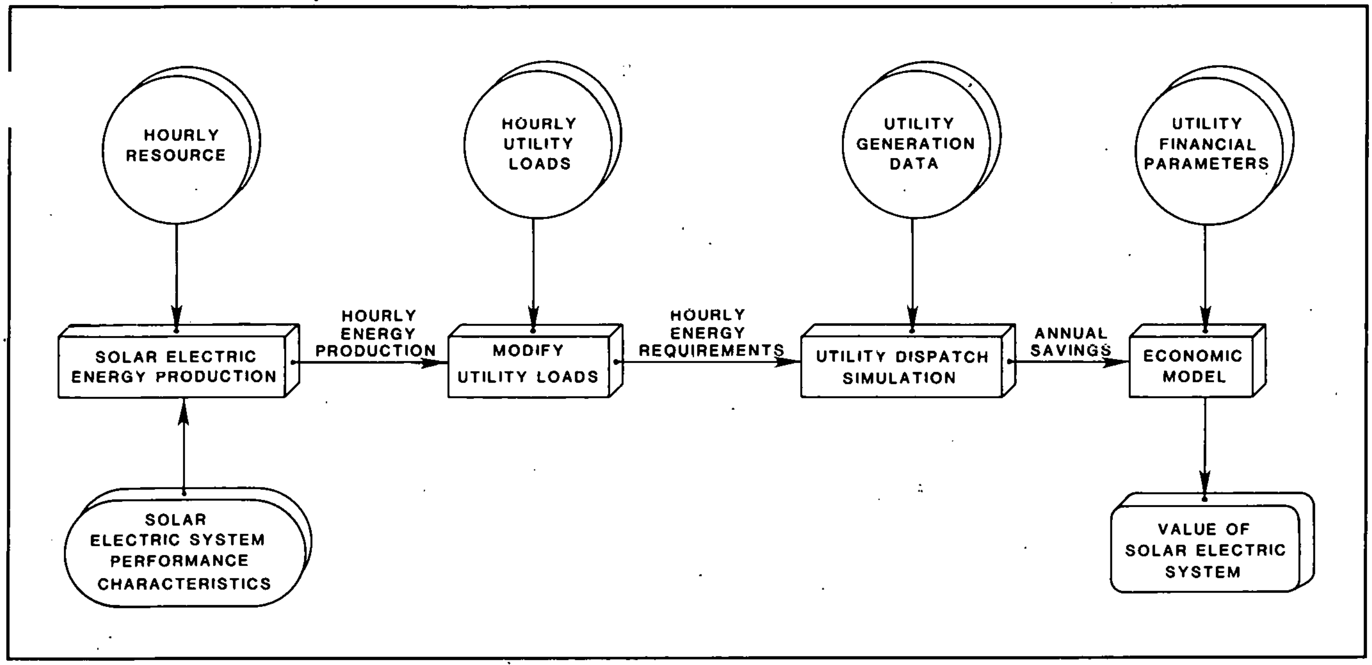


Figure 1: **Central Station Value Analysis Flow Diagram**

METHOD OF ANALYSIS

An overview of the methodology used to develop the value of solar electric systems for the utilities selected for the analysis in the Northwest Region is shown in Figure 1. The methodology is based on techniques used in the utility industry to compare the relative economic values of various alternatives for expanding generation capacity to meet a growing demand for electricity. These methods include computer programs which simulate the dispatch of all sources on an economic basis to meet the projected system load requirements.

Traditionally, the conventional generation sources examined in this generation expansion process have been load driven systems. These units can be dispatched up to full capability to meet the load requirements of the utility customers. Solar electric technologies such as wind and photovoltaic systems are, on the other hand, resource driven systems. Output at any instant of time is dependent upon the resource at that moment and independent of the load being served. This resource dependency requires use of a modified approach to develop the value of solar electric technologies to a utility.

The modified approach used was to first determine what it costs (without solar electric machines) to produce or purchase the electrical energy required for one year. Then, solar electric machines were added to the system and, again, a year's economic operation was simulated with a computer model. The reduction in utility production costs that resulted from adding the solar electric machines was an annual savings that was used to derive their value. Through application of an appropriate present-value analysis, a marginal breakeven value was calculated which was defined as the amount that could be paid for each machine such that there would be neither loss nor gain over the machine's life. This breakeven value was then compared to projections of estimated machine costs in order to estimate when the machines might begin to be economically viable.

A salient feature of the methodology was that solar machine cost was not necessary in defining the value of a solar electric option. As a consequence, it was not necessary to repeat the value analysis to see the effect various cost incentives might have on a particular solar electric device's economic viability.

The first step performed in the value methodology was to calculate expected solar energy generation by modeling the performance characteristics of the solar electric devices. Figures 2 through 6 present schematics of the systems analyzed for wind (WECS), photovoltaics (PV), solar thermal (STEC), biomass (direct combustion) and ocean thermal (OTEC) generating systems.

These systems were modeled using hourly resource data (wind speed, insolation, etc.) to define the expected hourly electrical output of the solar electric systems. The resulting solar electric generation was then used to modify expected utility loads in order to define the net hourly load that had to be satisfied by conventional utility generating equipment. Since solar electric generation was assumed to have zero incremental cost, it was logically the first generating source used to meet load requirements. Net loads were then applied to a production cost model, which simulated the economical dispatch of utility generation, and computed the cost of

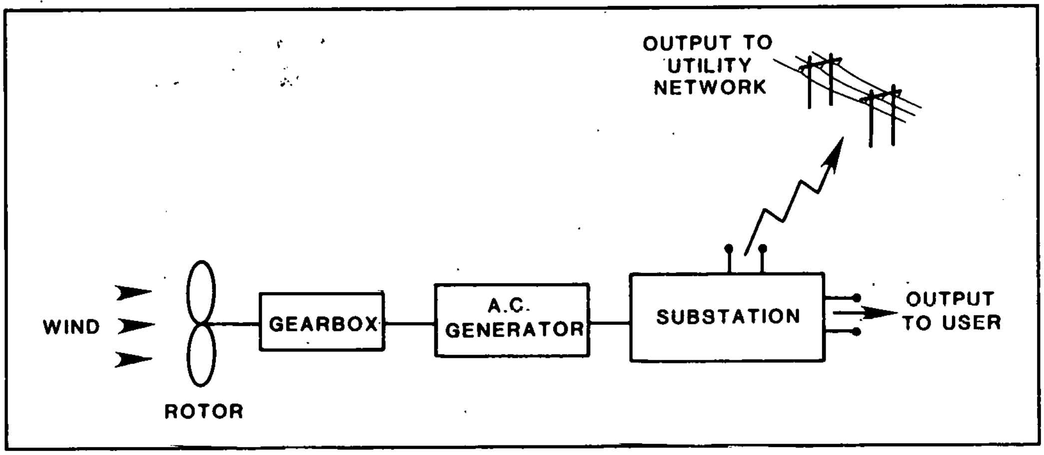


Figure 2: **Wind Energy Conversion System Schematic**

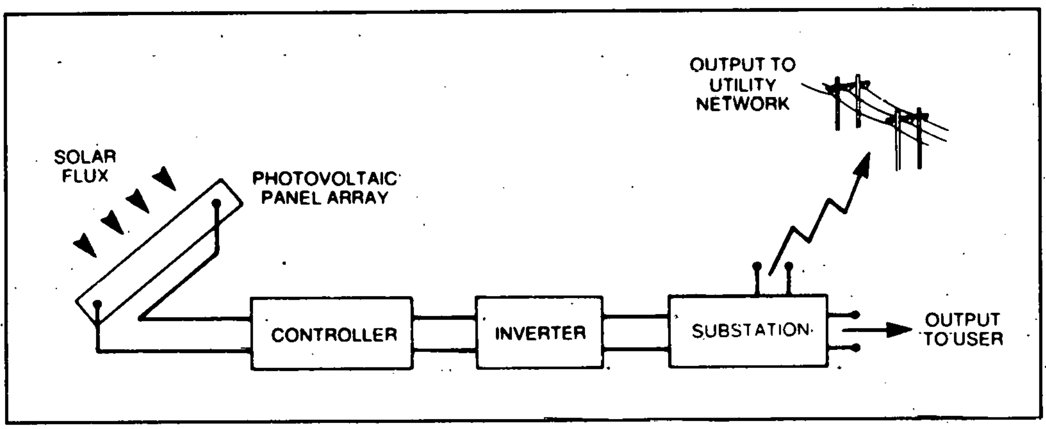


Figure 3: **Photovoltaic System Schematic**

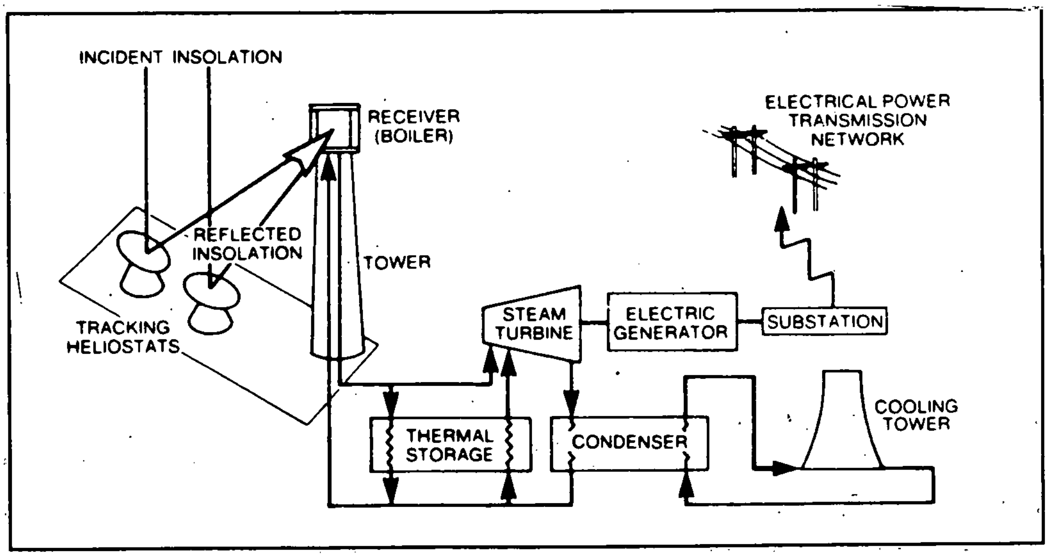


Figure 4: **Solar Thermal System Schematic**

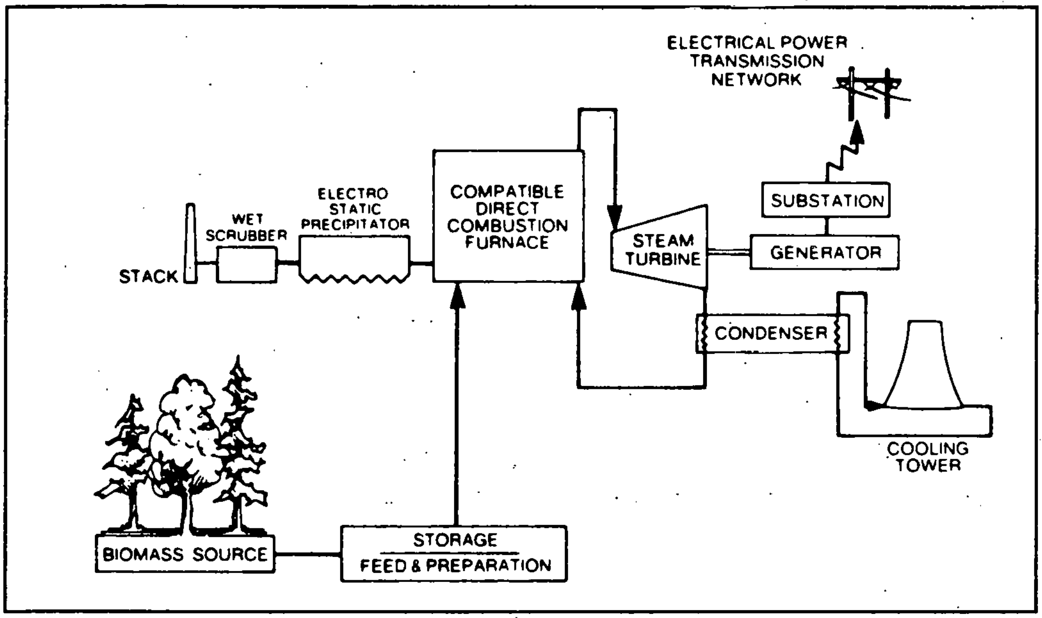


Figure 5: **Direct Conversion—Biomass System Schematic**

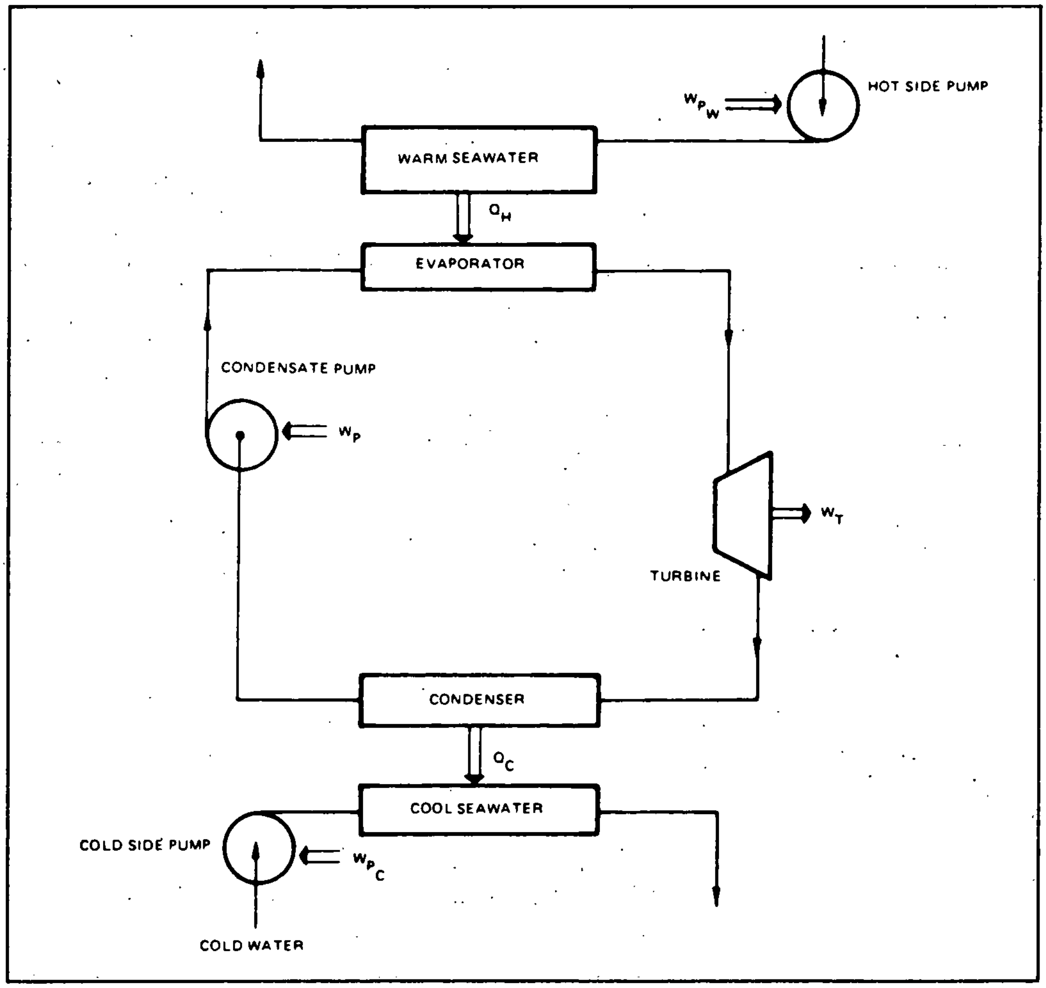


Figure 6: **Ocean Thermal System Schematic**

satisfying load requirements.

In the Regional Assessment Study, the central station value analyses were performed for the utilities that comprise the West Group. The West Group is a consortium of utilities (Table 1), which voluntarily operate their systems on a coordinated basis. The area serviced by the West Group can be seen in Figure 7. In performing the analyses, JBF worked closely with the Pacific Northwest Utility Conference Committee (PNUCC) in defining the

Table 1: **West Group Member Utilities**

West Group Member Utilities Private Utilities
- Pacific Power and Light Company
- Portland General Electric Company
- Puget Sound Power and Light Company
- The Washington Water Power Company

West Group Member Utilities Public Agencies
- City of Seattle, WA
- City of Tacoma, WA
- City of Eugene, OR
- City of Forest Grove, OR
- City of McMinnville, OR
- City of Milton-Freewater, OR
- The Montana Power Company
- Central Lincoln People's Utility District
- P.U.D. No. 1 of:

Chelan County	Franklin County
Clallam County	Grant County
Clark County	Grays Harbor County
Cowlitz County	Kittitas County
Douglas County	Klickitat County
Ferry County	Snohomish County

- Washington Public Supply System

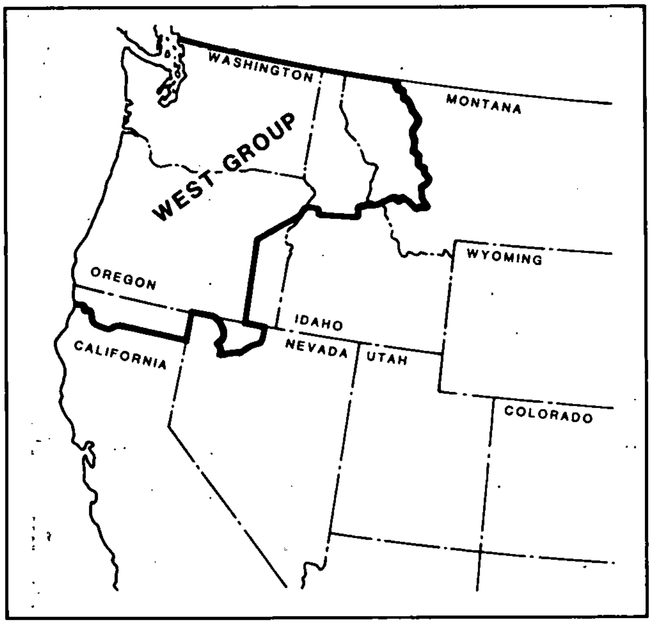


Figure 7: **West Group Service Area**

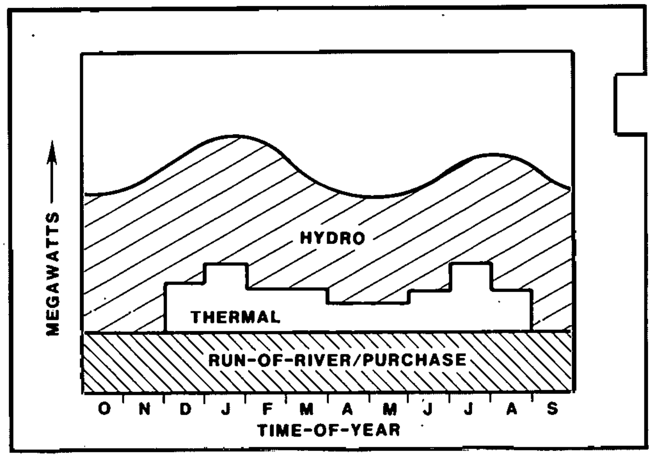


Figure 8: **Typical Monthly Dispatch Schedule**

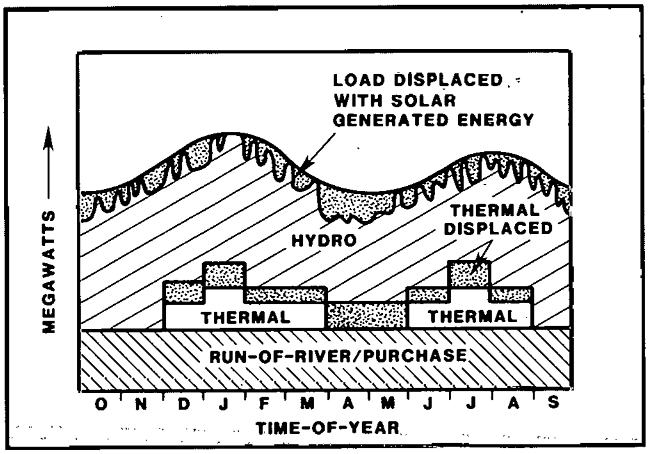


Figure 9: **Typical Reduction in Thermal Dispatch Schedule Resulting from Solar Generation**

projected monthly dispatch schedule for the West Group's thermal generation. Assuming that the hydro system can follow variations in solar power, models were used to determine the impact solar electric generation would have on the monthly dispatch of the thermal units. The resultant reduction in variable costs were calculated and applied in defining the value of the solar generation. (A schematic of this procedure can be seen in Figures 8 and 9.)

Because of the variability in stream flow from year to year, it is impossible to anticipate the amount of generation available for any specific year. Therefore, the

Table 2: **West Group Summary Data**

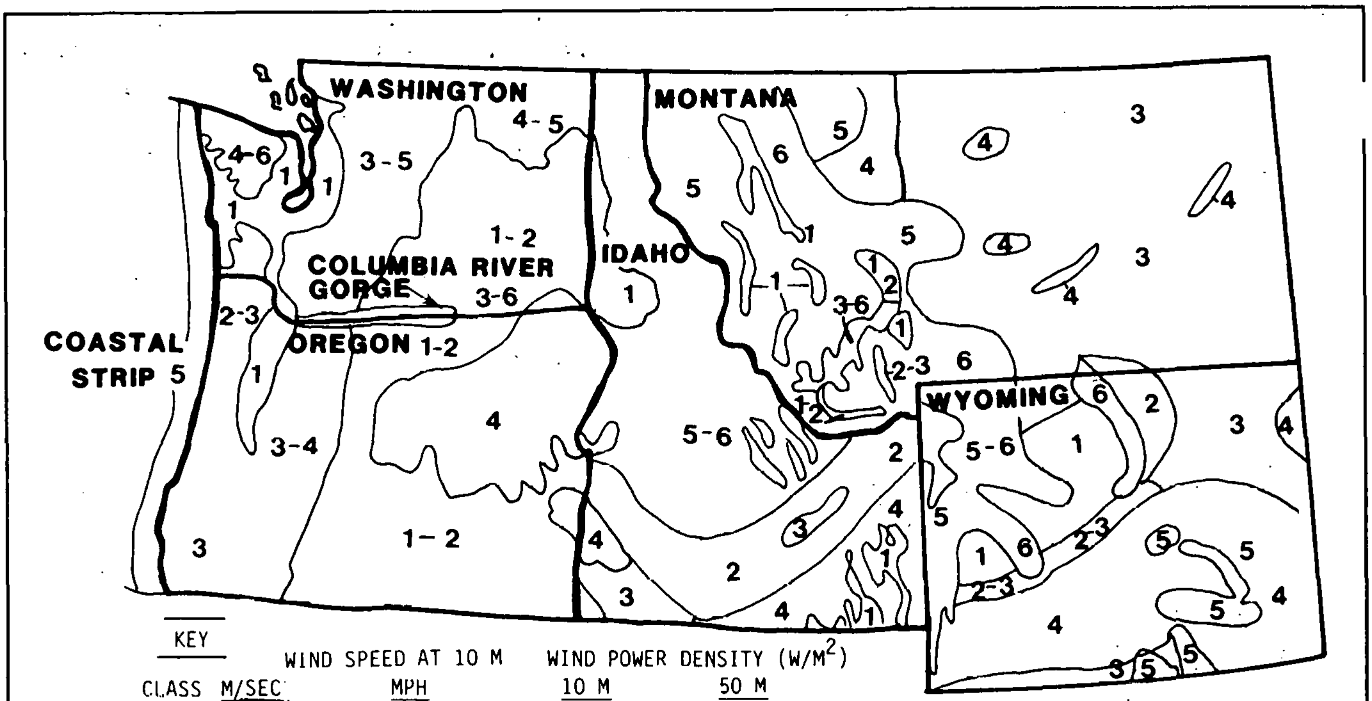
	1980		1990		2000	
	Capacity	Energy	Capacity	Energy	Capacity	Energy
Load (MW)	29500	18200	40400	25600	57900	35700
Installed Resource (MW)	35700	16400	48500	25600	57900	35700
Equipment Mix (%)						
■ Hydro	82	71	64	50	54	35
■ Nuclear	3	8	25	37	21	31
■ Coal	6	8	8	9	13	17
■ Oil/Gas	5	4	2	1	2	1
■ Miscellaneous (Including Purchase)	4	9	2	3	10	16
Incremental Energy Costs (Amount Yr. $/MWh)						
■ Hydro	—		—		—	
■ Nuclear	2.6-6		8-22		16-42	
■ Coal	2.0-9		7-31		13-59	
■ Oil/Gas	53-73		101-140		121-250	
■ Miscellaneous	66		126		225	

thermal and hydro dispatch schedules specified were for "good", "average", and "below average" hydro years. In performing the analysis, the necessity for seasonally transferring the hydro resource as a consequence of including solar generation in the utility mix was examined, and, when necessary, available hydro generation was redistributed accordingly.

By comparing the cost of utility operation with and without the availability of solar electric generation, the reduction in West Group production costs, caused by each solar option was determined. These savings were then used to estimate the total savings that would be generated over each solar electric option's lifetime. This analyses was performed for various levels of solar penetration. Applying the total savings to a model which calculated the value of these savings to the West Group, each solar unit's total life-cycle value was determined as a function of penetration. Comparing these values to projected system costs, the economic viability of each of the solar options was determined.

Input Data

The West Group generation mix and fuel costs used as inputs to the model are summarized in Table 2. The West



KEY

CLASS	WIND SPEED AT 10 M M/SEC	MPH	WIND POWER DENSITY (W/M²) 10 M	50 M
1	4.4	9.8	100	200
2	4.4 - 5.1	9.8 - 11.5	100 - 150	200 - 300
3	5.2 - 5.6	11.6 - 12.5	150 - 200	300 - 400
4	5.7 - 6.0	12.6 - 13.4	200 - 250	400 - 500
5	6.1 - 6.4	13.5 - 14.3	250 - 300	500 - 600
6	6.5 - 7.0	14.4 - 15.3	300 - 400	600 - 800

Figure 10: **Pacific Northwest Wind Speed Classes at 10M**

Source: Barchet, W.R., and Elliot, D.L., 1979 "Wind Energy Resource Atlas—Northwest," Pacific Northwest Laboratories, Richland, Washington.

Group economic input parameters used are shown in Table 3. It should be noted that because the West Group comprises both municipal and private (investor-owned) utilities, two sets of values were used for cost of capital and effective income tax rate.

The wind resources in the Pacific Northwest vary considerably over the region (Figure 10). For the Northwest study, Columbia Gorge winds were assumed to be representative of the more superior wind resources that exist in the West Group service area. The solar insolation resource is less variable than the wind resource (Figures 11 and 12) in the Northwest. Since the insolation resource is much greater east of the Cascade Mountain Range, it was assumed that central station photovoltaic and solar thermal plants would be located east of the Cascades. (Their output could be wheeled through the Bonneville Power Administration transmission system, if necessary.) Table 4 summarizes the wind and insolation resources used on the study.

The average temperature of the ocean surface water during the summer in the Pacific Northwest does not exceed 6°F within 100 miles of the Oregon and Washington coasts. The ocean temperature at the 2500 to 3000 foot depths associated with an ocean thermal

Table 3: **Nominal West Group Economic Parameters**

Economic Parameter	Value
Growth in Fuel Prices (%)	0.09
Overhead and Maintenance Costs Growth Rate (%)	0.06
Undeveloped Land Growth Rate (%)	0.06
Interface Cost Growth Rate (%)	0.06
Developed Land Growth Rate (%)	0.06
General Rate of Inflation (%)	0.06
Growth Rate in Local Taxes (%)	0.00
Cost of Capital (%)	0.06*
Effective Income Tax Rate (%)	0.00*
Operating Life (Years)	30
Ratio of Annual Insurance Premiums to Capitalized Costs	2.5×10^{-3}
Ratio of First Year O&M Costs to Capitalized Costs	0.03
Ratio of Property Taxes to Capitalized Costs	0.02

*Assumed for a typical West Group municipal utility. For a typical West Group private utility, cost of capital and effective income tax rate were assumed to be 12% and 52%, respectively.

plant is approximately 40°F. Thus, in the Pacific Northwest, the temperature differential of approximately 40°F that is necessary for an OTEC plant to be considered for economic viability does not exist, and a value analysis was not performed.

For the Northwest study, the direct combustion of biomass was considered as an alternative fuel source to coal or oil. Consequently, biomass was studied for its resource potential and will not be reported on in this paper.

The wind turbine modeled in the study was representative of the Boeing MOD-2. The machine modeled had a peak capacity of 2.5 MW, a cut-in wind speed of 14 mph, a rated wind speed of 28 mph, and a cut-out wind speed of 53 mph. The central station photovoltaic and solar thermal plants were modeled with capacities of 100 MW. The photovoltaic plant modeled had fixed axis arrays and did not include storage. The solar thermal plant modeled had a solar multiple of 1.67 and 6 hours of low-quality steam storage.

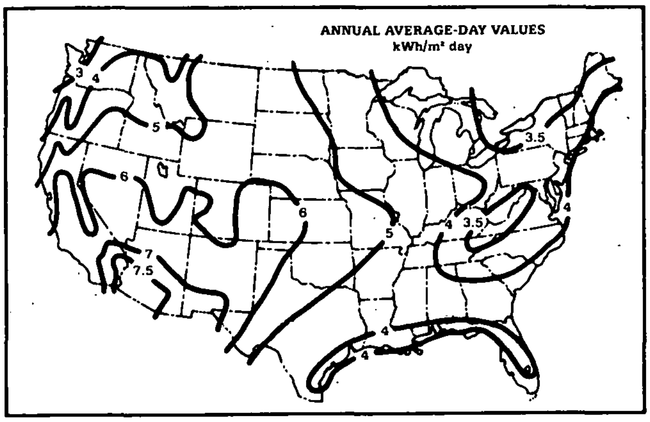


Figure 11: **Solar Radiation Direct Normal Term Annual Average-Day Values kWh/m² Day**

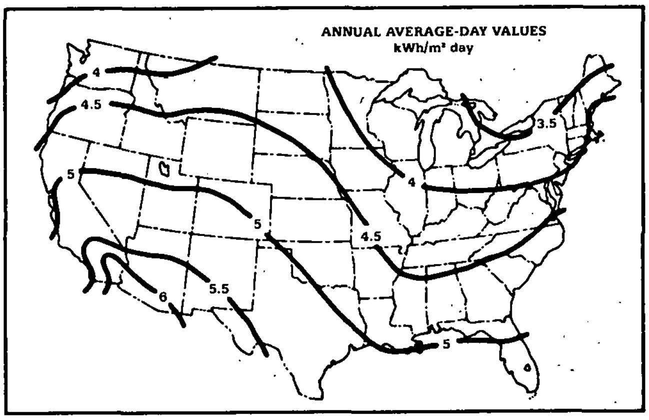


Figure 12: **Solar Radiation Total Horizontal Annual Average-Day Values kWh/m² Day**

Table 4: **Representative Resource Data Sets**

Resource	Resource Station	Period of Record	Average Annual Resource
Wind	Columbia Gorge	1976-78	18.1 mph (hub height)
Insolation	Omaha, NE	TMY	
■ Total Horizontal			4.21 (kWh/m²)
■ Direct Normal			4.59 (kWh/m²)

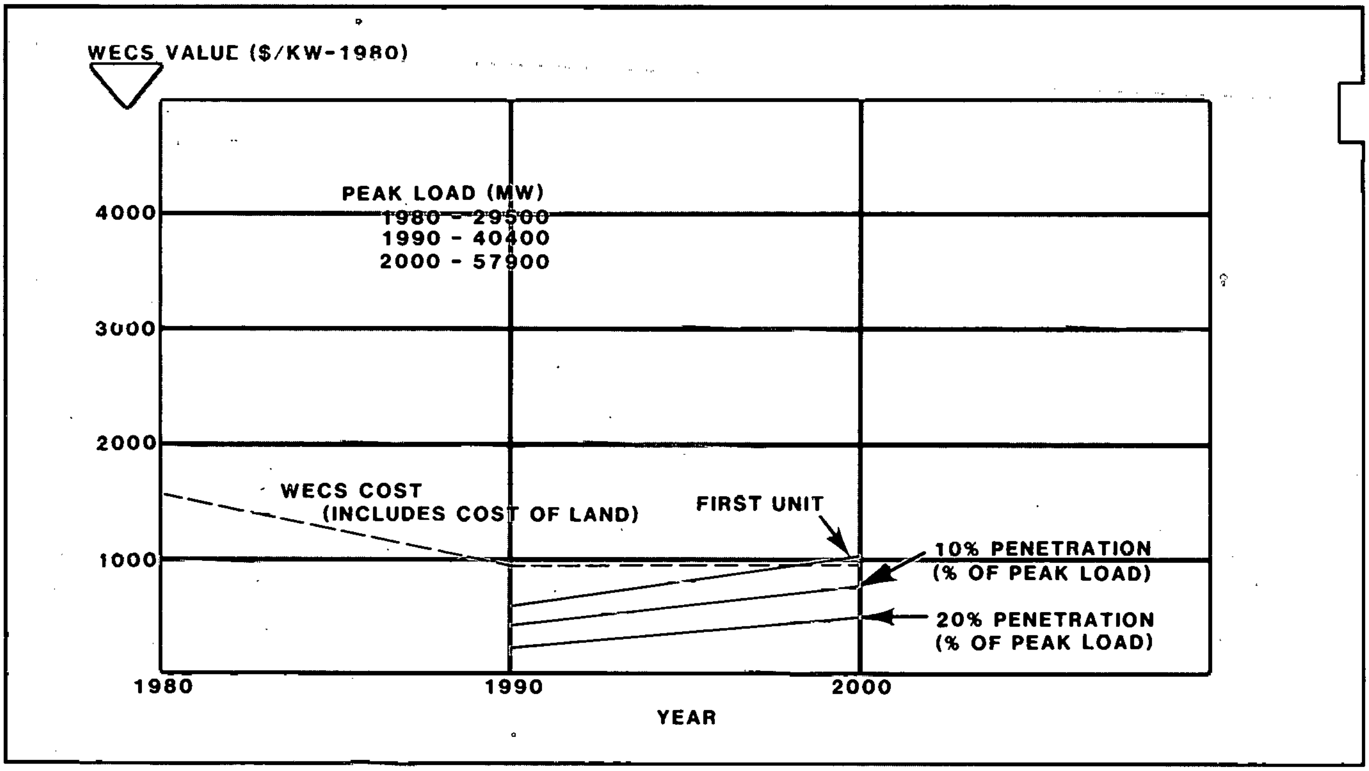


Figure 13: **WECS Value to West Group (Private Utility) Assuming Critical Hydro Conditions**

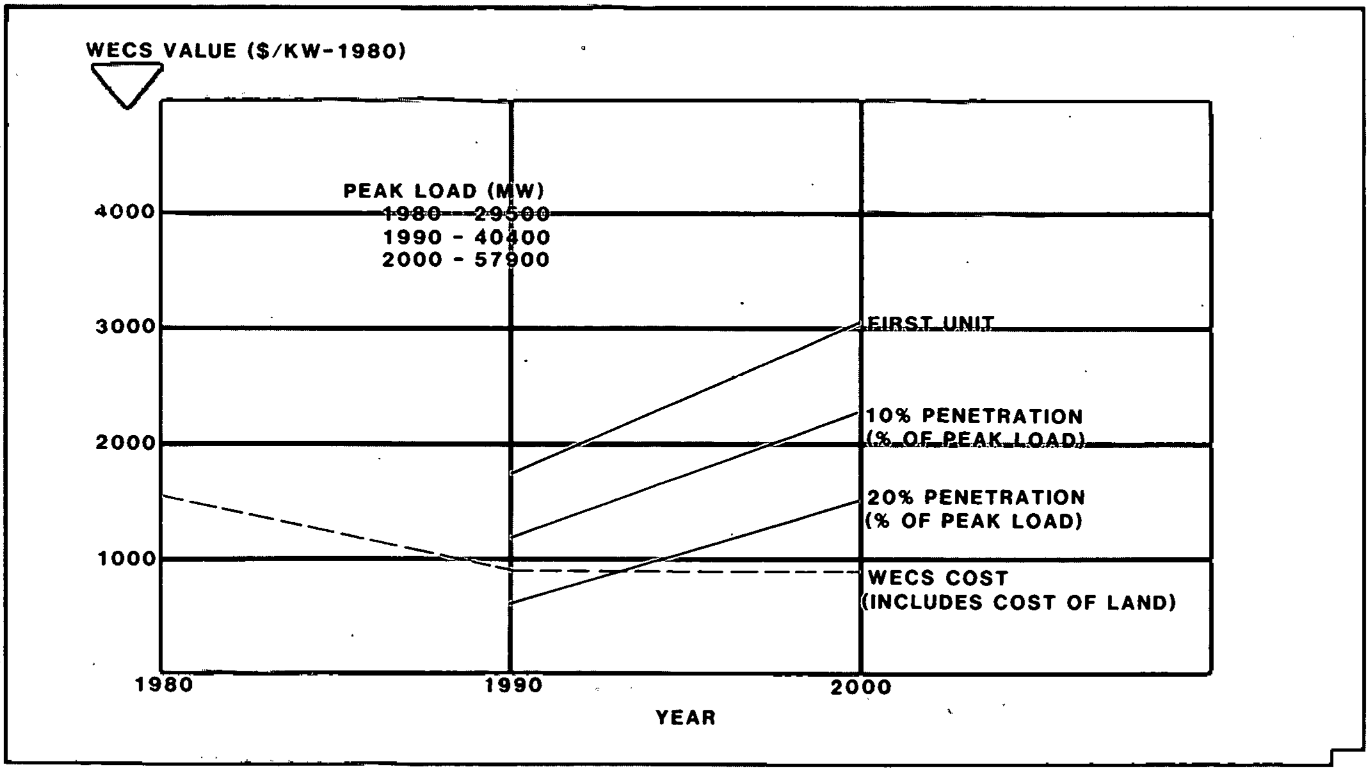


Figure 14: **WECS Value to West Group (Municipal Utility) Assuming Critical Hydro Conditions**

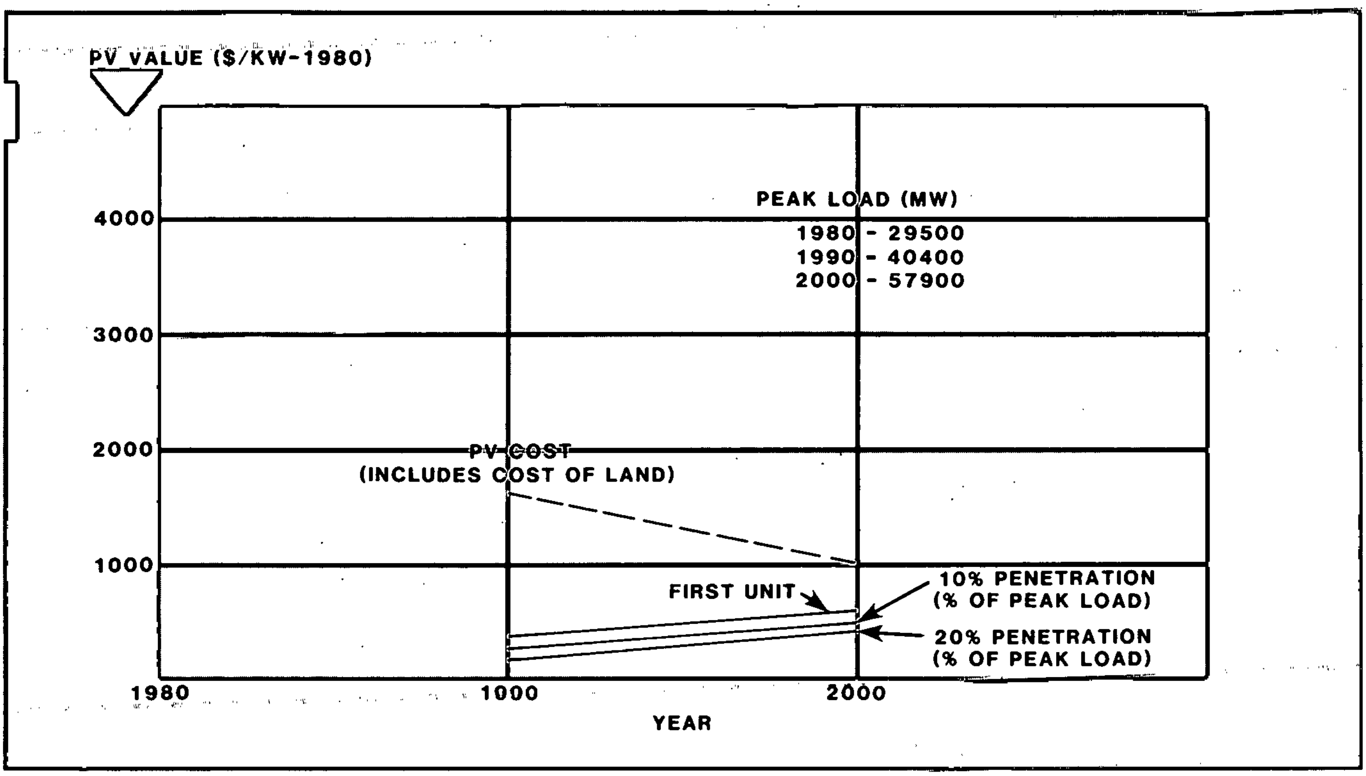


Figure 15: **PV Value to West Group (Private (Utility) Assuming Critical Hydro Conditions**

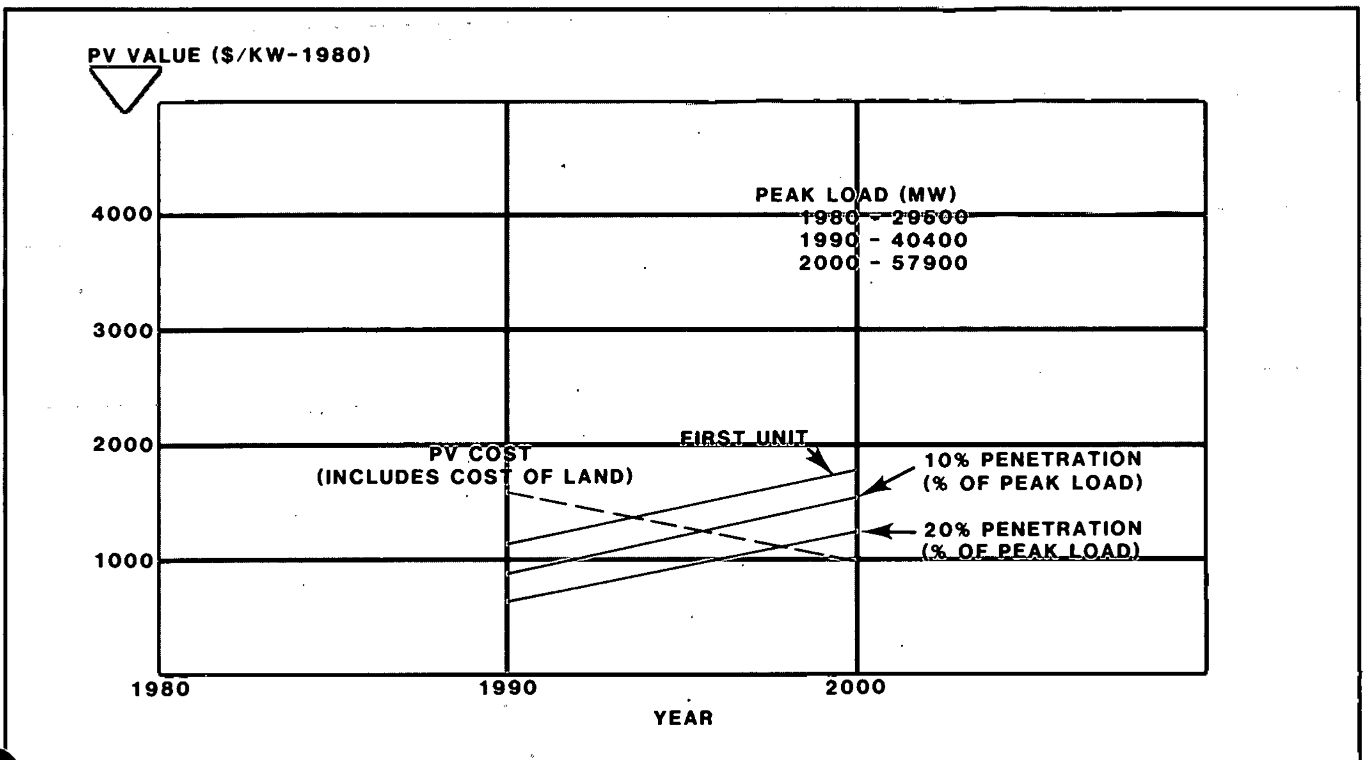


Figure 16: **PV Value to West Group (Municipal Utility) Assuming Critical Hydro Conditions**

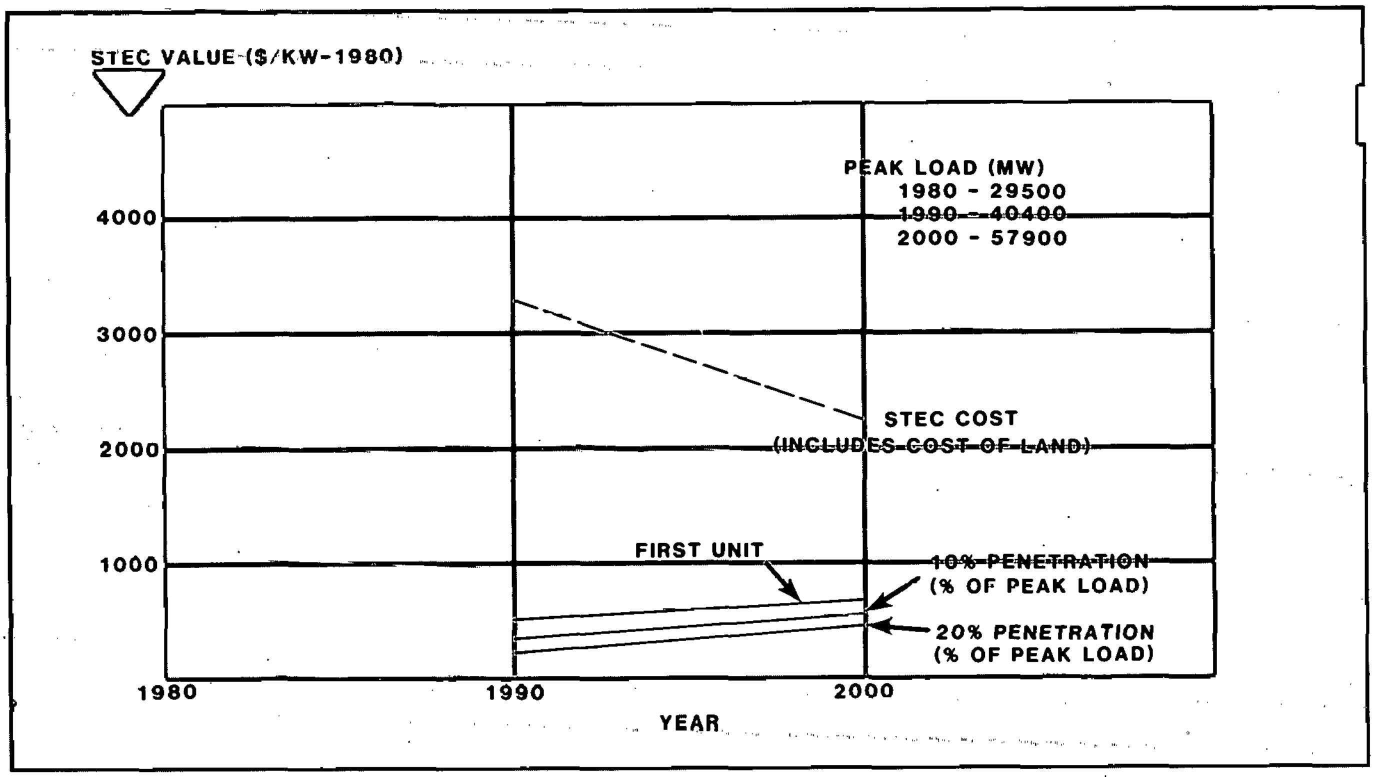


Figure 17: **STEC Value to West Group (Private Utility) Assuming Critical Hydro Conditions**

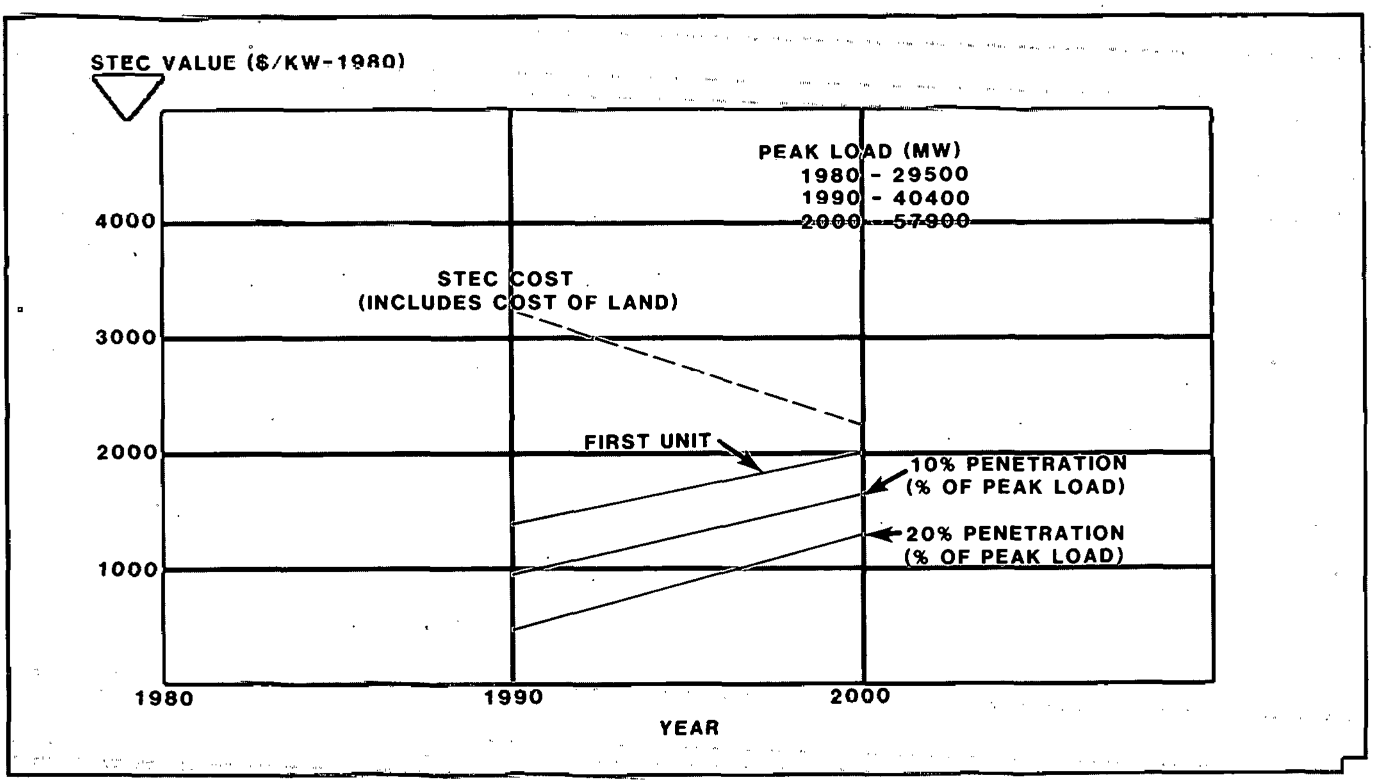


Figure 18: **STEC Value to West Group (Municipal Utility) Assuming Critical Hydro Conditions**

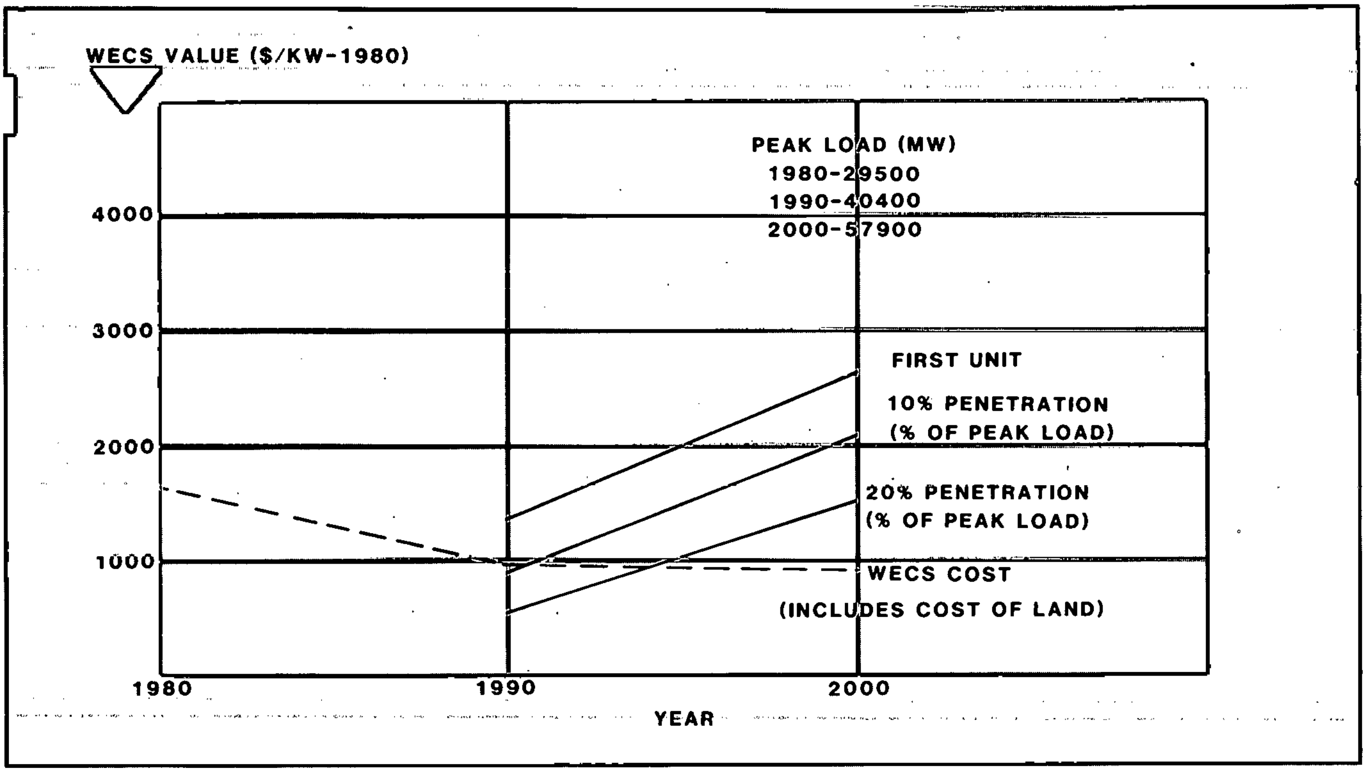


Figure 19: **WECS Value to West Group (Municipal Utility) Assuming Average Hydro Conditions**

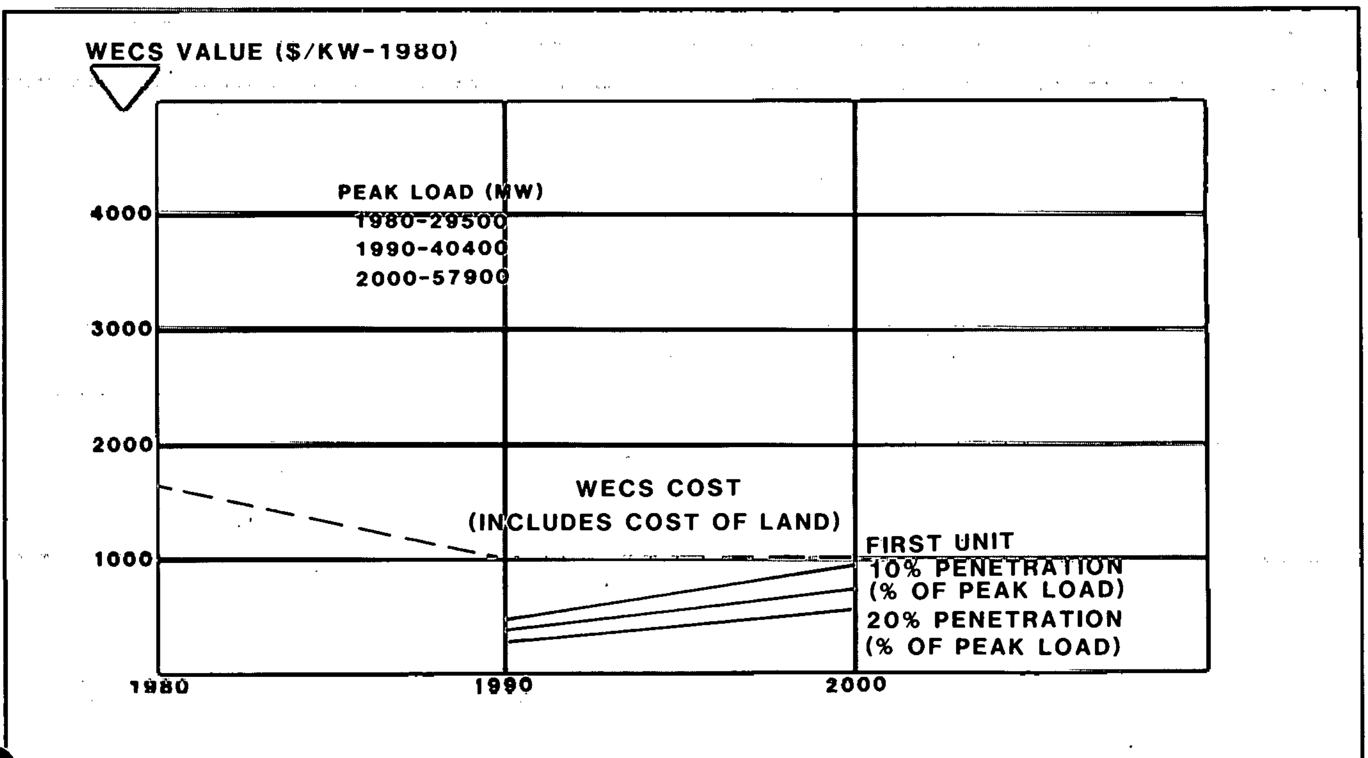


Figure 20: **WECS Value to West Group (Private Utility) Assuming Average Hydro Conditions**

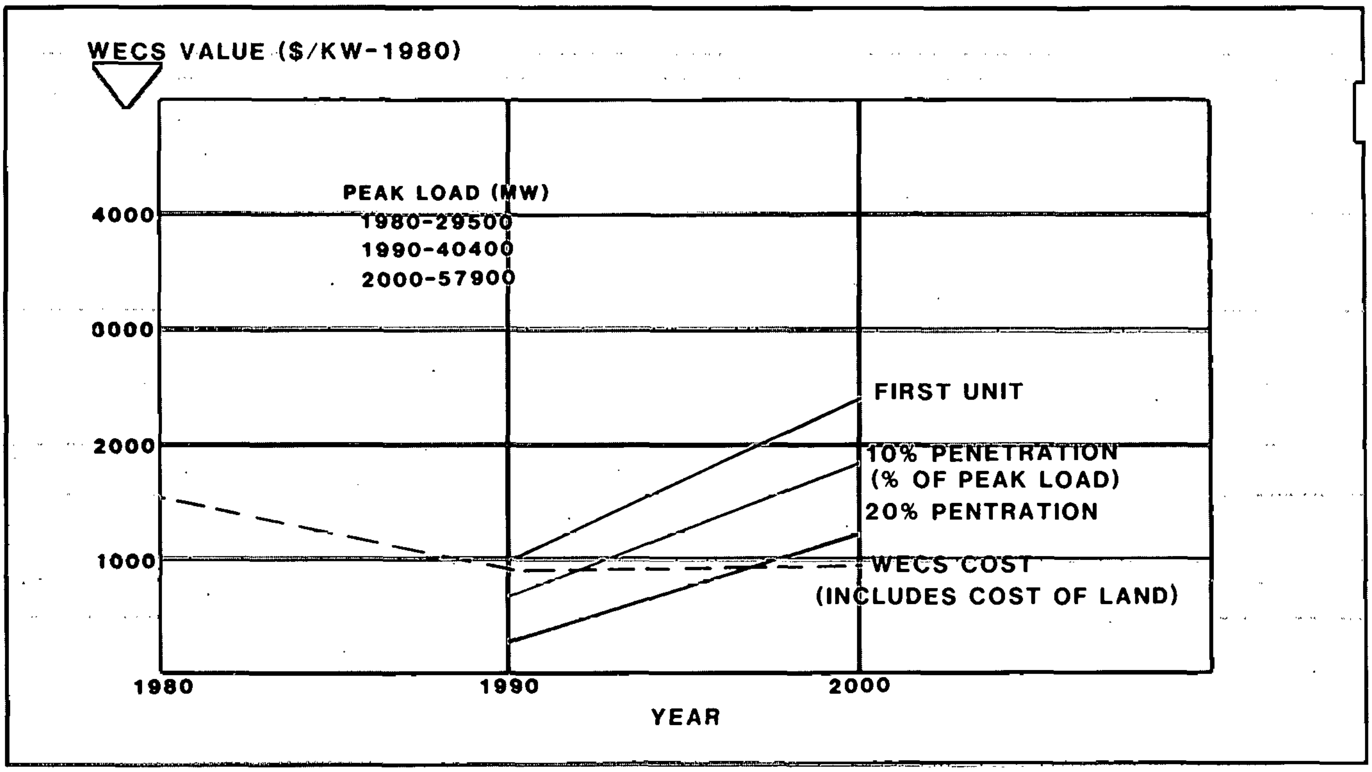


Figure 21: **WECS Value to West Group (Municipal Utility) Assuming Above Average Hydro Conditions**

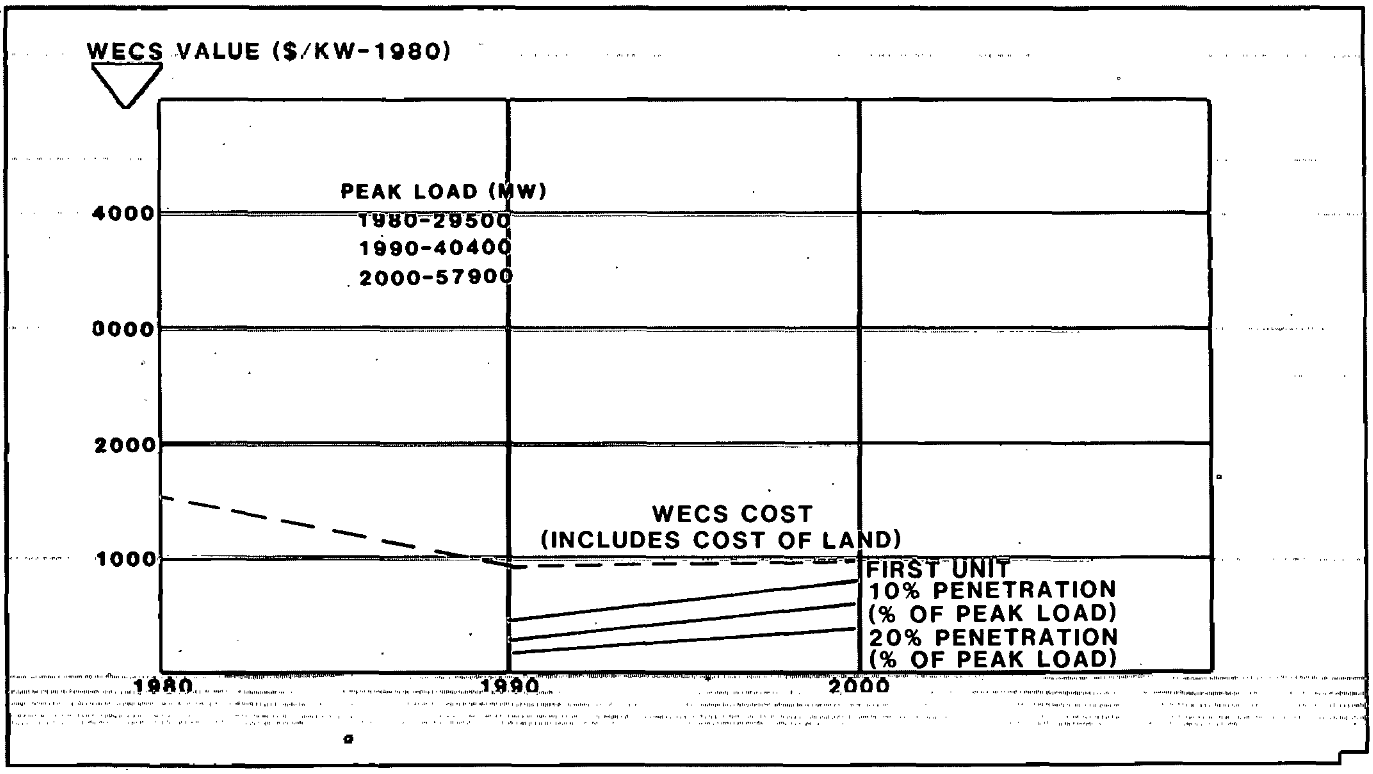


Figure 22: **WECS Value to West Group (Private Utility) Assuming Above Average Hydro Conditions**

Table 5: **Central Electric System Costs in 1980 $**

System Type	1980	1990	2000
WECS	1600	860	860
PV	—	1600	1000
STEC	—	3400	2400
OTEC	—	3200	2200

Results

Figures 13 through 18 show, as a function of penetration, the life-cycle value of central station WECS, PV, and STEC systems to the West Group in the 1980 to 2000 timeframe. These results are shown for both representative municipal and investor-owned utilities, and are based upon low (critical) hydro conditions.

Superimposing the Department of Energy projections for central station costs shown in Table 5 upon the value curves, an estimate of the timeframe in which central station WECS, PV, and STEC will become economically viable was established. As seen in Figure 13 for the baseline assumptions made on the study, WECS economic viability may occur sometime in the late 1990's for a representative West Group investor-owned utility. By changing the financial parameters to reflect a representative municipal utility (Figure 14), economic viability can be accelerated to the late 1980's.

Photovoltaic economic viability occurs in the 1980-2000 timeframe only for a municipal utility (Figure 16). Solar thermal does not show any potential in the 1980-2000 timeframe primarily because of its high projected costs.

To obtain an understanding of the sensitivity of economic viability to hydro conditions, the value of WECS was also conducted for average and above average water conditions. These results can be seen in Figures 19 through 22. As would be expected, increasing the amount of available hydro generation decreases WECS value, thereby delaying the period in which the solar option would become economically viable.

In summary, for the parameters used on the study, central station WECS showed the earliest potential in the Pacific Northwest. This was primarily due to WECS' relatively superior output performance and low cost, as compared to central station photovoltaic and solar thermal generation. Depending upon hydro conditions and type of utility, WECS economic viability could occur as early as the late 1980's to beyond the timeframe of the study. Central station photovoltaics showed a potential for becoming economically viable in the mid-to-late 1990's, while central station solar thermal did not show any potential in the 1980 to 2000 timeframe. ▮

Luncheon Address

It is a distinct honor for me to join you here today at this Second Annual Pacific Northwest Conference on Alternative and Renewable Energy Resources.

My congratulations and thanks go to Sterling Munro and the people at Bonneville Power Administration. You have obviously worked very hard to bring us a dynamic, imaginative and—if you will, an ecumenical gathering of energy expertise.

On behalf of my fellow Oregonians, I want to welcome those of you from our sister states of Washington, Idaho and Montana, and to extend our best wishes to our guests from British Columbia.

We are very pleased to be your host state for this conference. You have come to talk about and hear about old new ideas in developing sustainable energy resources.

And you have come to the right place.

Governor Vic Atiyeh

Vic Atiyeh was elected governor of Oregon in 1978, after representing Washington County in the Oregon Legislature for twenty years. His comprehensive conservation and alternate energy proposal passed the 1979 session of the legislature nearly intact. As a legislator, Mr. Atiyeh had an important part in drafting much of Oregon's landmark environmental legislation.

Governor Atiyeh is vice-chairman of the National Governor's Association's Committee on Natural Resources and Environmental Management, and a member of the association's International Trade and Foreign Relations Committee and of the Republican Governor's Association Finance Committee. He serves as the liaison representative between the Western Governor's Conference and the Western Interstate Commission for Higher Education.

Governor Atiyeh attended the University of Oregon.

I am very proud—and very fortunate—to be governor of a state that is breaking away from some "great American traditions."

I am talking about the **tradition** of wasting energy ...

- the **tradition** of wishing for easy answers instead of tackling the tough problems and making the difficult decisions ...
- the **tradition** of blaming "the Feds" or the OPEC countries—or each other—as the ominous sounds of the energy crunch get closer and closer ...
- and the **tradition** of hoping that **somebody** will do something before it is too late.

Somebody does have to do something. And it might as well be Oregon. After all, we have a head start. We have already begun to design our transition from old energy traditions to an era of new energy ethics.

It was just a year ago that this conference first convened. And, it has been just a year and a day since Oregon's Alternate Energy Development Commission set about to find "new" energy from "old" resources.

The amazing amount of effort that the commission and its task forces invested in this unprecedented assessment of renewable resource potential has produced a remarkable set of resource development strategies.

"Future Renewable," the commission's report, addresses squarely the intricate problems, issues and choices that must be resolved **today** if our social and economic systems are to be sustained and strengthened for **tomorrow**.

The first question the task forces asked was "how much?"

- How much energy can we get from conservation and solar?
- How much from geothermal and wind?
- How much from small-scale hydro, alcohol fuels and biomass?

The second question was "how do we get from **here** to **there**?"

- What stands in the way of resource development? How can we remove those barriers? What can we do to mitigate the financial risks of exploration and development? What is the best way to resolve the inevitable policy conflicts between energy development and natural resource management?

The task forces hammered out basic agreements on resource potentials ... On identifying constraints and barriers ... On the relative effectiveness of different incentives ... And, when state government should step in and push—as well as the point at which government should step back and let free-market forces shape resource development and use.

- Incidentally, by the time the six task forces were ready to submit final reports and recommendations to the commission, more than 1,000 Oregonians in ten different communities had taken part in and, in effect, endorsed the fundamental goal of energy self-reliance.
- That outpouring of public interest in and support for the commission's work erased any doubt that energy "grown in Oregon" has a strong and reliable constituency.

With the task force reports in hand, and after formal public hearings on its own draft report, the commission in July and August wrote a final report which was submitted to me in September.

The report is an extraordinary document—far more detailed and comprehensive than might otherwise be produced in just eleven months.

As many of you know—because you have read it—the commission's final report is a meticulously detailed, comprehensive and provocative document.

- It tells us how much energy we can acquire from conservation and renewable resources.
- It tells us what we have to do—and how much it will cost—to get that energy.
- And, it tells us when it will be available.

The commission has recommended government actions which it believes will produce or conserve energy equal to more than 10 percent of Oregon's non-transportation demand growth for the rest of this century. How much more energy is produced beyond that 10 percent depends on actions by the private sector.

And, in describing costs, the commission pulled no punches. The report said, and I quote:

> "Developing these sustainable energy resources will cost as much as or more than conventional energy supplies."
>
> "However, many of the resources can be developed in the near-term—far sooner than some types of conventional resources."

Those points are important. The first says, in effect, that we've simply run out of cheap energy.

The second says that the relatively short lead-time required for conservation and renewables to make a difference means we can trim the power deficits expected in the mid 1980's.

It does not say we can erase those deficits ... or that we will not need new thermal generation to meet future demand growth.

It simply says that the eggs in this basket will hatch sooner than the eggs in that basket. And it also says something about not putting all your eggs in one basket ...

There were nearly 80 citizen volunteers on the commission's task forces who willingly contributed their time and talent and expertise to this all-important effort. I wish I could publicly acknowledge each and every one of them by name here today. Obviously, there is not time to do that.

But I am going to take the time now to offer my personal thanks again to Chairman John Gray and the other eight members of the Alternate Energy Development Commission.

I asked John Gray to head the commission because he is the busiest person I know. And, when there is a tough job to do and not a lot of time to do it, the wise manager picks the busiest person in the shop.

John's diligence and even-handed helmsmanship helped keep the ship on an even keel and a true course through a long and difficult passage.

His crew included Dr. Grace Phinney, of Corvallis, who represented the Alcohol Fuels Task Force ...

- Glen Andrews, of La Grande, the Wind Task Force ...
- Don Hodel, of Portland, the Hydro Task Force ...
- Paul Lienau, of Klamath Falls, the Geothermal Task Force ...
- John Reynolds, of Eugene, Solar/Conservation Task Force ...
- Pete Schnell, of Oregon City, the Biomass Task Force ...
- And, the commission's "members-at-large," Al Thompson, of Salem, and Burke Hayes, of Corvallis.

To the commission and the task forces ... To all of you and to each of you, I say: **"Well Done!"**

The ball is now in **my** court. And, over the past several weeks I have spent many, many hours pulling together the special energy program I will propose to the 1981 Legislature.

That package will give the Legislature an opportunity to **reaffirm** their overwhelming endorsement of the energy policies I pushed for and got in 1979 ... Policies which **consistently** have and will continue to help Oregonians achieve a higher level of energy self-reliance ... Policies which **consistently** have emphasized the need for a diverse array of energy resources and policies which **consistently** have refused to close the door on any options.

The design of my 1981 Legislative Energy Program involves unusually difficult decisions and choices.

I will make those decisions and choices. And, when I submit my energy program to the Legislature—and lay out the equally difficult decisions and choices **they** must make—my message will be urgent and direct:

"Let us reach as far as we can."

Oregon traditionally has upstaged the nation in adopting effective energy-saving strategies. We are second to none in conservation and that claim was **documented** earlier this year in a 50-state survey by Common Cause.

And, the programs we have in place for developing renewable energy resource are unmatched anywhere else ...

- Tax credits and low-interest loans for homeowners who install alternate energy systems. By the end of this year, the Oregon Department of Energy will have certified more than **2,600** residential systems for tax credits ...
- Tax credits for commercial and industrial firms which install waste heat recovery and renewable energy systems. Almost $6 million has been invested by the private sector under this program in 1980.
- A $300 million bonding program for long-term, low interest loans for local, small-scale renewable energy projects—a measure which won solid voter approval in May of this year.
- Important financial and technical assistance to promote cogeneration, geothermal heating districts and research on the energy economics of wood wastes.

All of these efforts are on-line now. Moreover, many of the Alternate Energy Development Commission's recommendations which require neither legislation nor additional funding are being implemented by the State Departments of Energy, Environmental Quality, Water Resources, Land Use and Development, and others right now.

We are moving ahead. We have achieved important milestones. And, we have even more exciting opportunities to lay the foundations for a stable energy future.

I am sure you have all heard the story about the fellow who was up to "here" in alligators. It was awfully hard for him to keep in mind that his original plan was to drain the swamp.

It is vitally important that we never lose sight of why we are pushing so hard for conservation and renewable energy resources ...

- Or, why we believe the Pacific Northwest Power Bill is an irreplaceable element of this region's future ...
- Or, why we as individuals and we as a nation must come to grips with things as they are and will be—not as things were or as we might wish them to be.

Vulnerability is the handmaiden of dependency. The fact that we rely so heavily on foreign oil imports that can be cut off at any moment by war, terrorism or revolution verges on suicidal.

Before this hour is up Americans will have spent another $10 million for imported oil ... $10 million an hour ... every hour ... adds up to a $90 billion pricetag in 1980 alone.

If you owned all the assets of General Motors, Ford and IBM—and cashed them in—you would not have enough money to pay America's bill for foreign oil this year.

As a nation, Americans comprise just 6 percent of the world's population. But, we account for 30 percent of the world's energy consumption and we import about 20 percent of the energy we use. Simple arithmetic shows that 94 percent of the world population shares the remaining two-thirds of available energy ... and simple logic raises the question of whether those relative shares can be maintained.

Let me bring the issue into a sharper, closer-to-home focus:

There are good reasons why we in Oregon and the Pacific Northwest must continue to challenge and change some of our own "old traditions."

To a great extent, we are what we are because of cheap and abundant federal hydro power. The hydropower cornucopia gave us industry, jobs, and a quality of life envied the world over. It also gave us a false sense of security. But, with the federal hydro system fully developed and the power allocated by law to preference customers, Oregon's investor-owned utilities turned to expensive new thermal generation to meet demand.

We were forced to acknowledge a new reality: there is a practical limit on our capacity to produce energy from even our most abundant renewable resource. And, energy to meet demand above and beyond that capacity simply cannot be produced as cheaply.

But, it costs less to save energy than it does to produce it.

Energy conservation is the least expensive, quickest and most benign way to improve our energy security, to save non-renewable resources, to strengthen our economy and to reduce our public, corporate and personal energy costs.

Portland General Electric Company and Pacific Power and Light can offer interest-free, deferred-payment weatherization loans to their space heating customers because it costs 12 to 18 mills to help customers save a kilowatt hour of electricity and 40 to 60 mills per kilowatt hour to build new thermal generation.

I would say that is a darned good "why" for energy conservation.

Here is another: America imports nearly half of its petroleum.

In Oregon, we import every drop that we use. But, do we really need as much as the "old tradition" seemed to indicate?

The fact is, we do not.

Beginning in May 1979, when the Iranian revolution cut off about 5 percent of U.S. oil imports—and reduced gasoline supplies by about the same amount—Oregonians voluntarily reduced consumption by more than 7 percent for the remainder of the year.

We met that shortage calmly and effectively. No one hit the panic button.

The shortage is long-since over. Now, we are almost literally awash in gasoline. Prices have been inching downward recently.

Nonetheless, the conservation trend established in 1979 and maintained throughout this year indicates that Oregonians will use about 11 percent less gasoline in 1980 than in the peak consumption year of 1978.

That is a lot of gasoline saved—almost 160 million gallons.

But the fact remains that prices are likely to never return to those of "the good old days" and a sizeable portion of our foreign supplies are in constant jeopardy.

That is looking at things as they are—and another good "why" for conservation.

There is a score of good reasons why the Pacific Northwest needs the Regional Power Bill and this audience is well aware of them.

From an Oregonian's stand-point—if I may be provincial for a moment—passage of the regional bill is the only guarantee we have that each of the member states will be credited—not penalized for energy conserved and energy produced from renewable resources.

In mid-November, Congress will begin a lame duck session. The Regional Power Bill is high on the House agenda and the Senate is ready to accept a House version that is not radically different from the bill approved by the Rules Committee.

But for the delaying tactics of a lone dissenter, the regional bill could have been approved ten weeks ago. And, each week that the bill has been delayed equals about $1 million that will not be delivered to Oregon ratepayers through rate reductions implemented through the bill.

Our increasing awareness of and concern for energy-related issues do not always reflect perfect consensus. To almost every consumer—and to low-income families and our elderly poor, in particular—the spiraling cost of energy is a gnawing, persistent worry.

To others, availability and reliability of supply is a matter of growing concern. Still others worry that important social, economic and environmental values will be compromised if we are ever tempted to rally 'round the banner of those who would pursue "energy at any cost."

And, finally, there are those who stubbornly cling to the misguided notion that we have all the energy we need. All we have to do to survive is turn back the clock 150 years.

My firm belief is this ... and I want to make my position very clear:

OREGON NEEDS ENERGY!

We can and we must put the brakes on demand growth by using energy wisely and efficiently. And we can and we must extract as much energy as is economically and environmentally acceptable from sources that can never be used up.

We must weigh and balance the need for long-range energy security against short-range discomforts. And, we must, above all, remember that the social and economic costs—particularly for the elderly and the poor—can and must be restrained.

If you perceive a sense of urgency in my words, you are absolutely right.

We face decisions of unprecedented magnitude. I believe we are in a far better position today to approach those critical decision points with confidence and determination than we have ever been.

We cannot afford to wait.

Thank you. ▮

Resource Assessment: A Report on the Oregon Alternate Energy Development Commission

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Linda Craig is a biomass specialist, manager of the Business Tax Credit Program with the Oregon Department of Energy, and the department's staff member to the citizen task force on energy from biomass. Ms. Craig previously worked as a research and planning consultant on biomass energy for the department, as coordinator of the Pacific Northwest Bioconversion Workshop, and as project monitor of the Pacific Northwest Regional Commission.

Before becoming an expert on biomass energy, Ms. Craig was an educator. She was a research associate for the American College Testing Program, an evaluation specialist for the Portland Public Schools, and program manager for the education staff at the Oregon Museum of Science and Industry.

Ms. Craig graduated from the University of Northern Iowa with a B.A. in Mathematics, and received an M.A. in Psychology and Testing from the University of Iowa.

The Governor has introduced you to the Alternate Energy Development Commission, the AEDC, and some of its findings. Any of you who have tried to do a similar kind of report know that it is close to impossible to estimate how renewable resources will be used fifteen or even five years from now. The Commission results represent hours of work by Oregon experts in the resources and a great deal of public review. We're certainly comfortable with the belief that these estimates are the best that are available.

I'm going to back into the subject of resource assessment by showing you the Commission's estimates of resource availability and costs, by talking about some of the constraints they identified for the resources, and then by examining how improved resource assessment would resolve those constraints. The AEDC has recommended that some resource assessment can best be done by government, but the utilities and the private sector need to continue the work when government is through.

Table I shows the Commission's theoretical development schedule for renewable resource electrical generation. The task forces faced different problems in preparing their estimates. For example, the Biomass Task Force only predicted to 1990 feeling that they didn't know how to estimate the competition for or supply of wood after 1990. The year 2000 estimates here shown for biomass assume no increase over the 1990 figures. The Wind Task Force, on the other hand, felt that a major constraint was the availability of machines, so their estimate is based on slow growth until 1985 and much more rapid growth after 1985.

By 1985, the Commission estimates 773 MW of generated or displaced electricity could be available. Hydroelectric accounts for 102 MW, 43 MW are wind or geothermal, 160 MW is cogeneration with biomass fuels and the bulk of the resource, 468 MW is conservation and solar applications.

By 1990, 1880 MW of electricity from renewable sources could be available. Conservation combined with solar and biomass are still the largest resources, but by 2000, wind and geothermal electric could play large roles in the electric supply picture. Table 1 shows no contribution from solar photovoltaics.

Table 2 shows task force estimates of resources to be used for thermal energy. These estimates will primarily displace oil or natural gas, except that geothermal direct uses do displace some electrical space heating. To put these figures into perspective, it's helpful to know that

Table 1: **Theoretical Development Schedule for Renewable Resource Electrical Generation**

	Average Megawatts (av MW)		
Electric Power	**1985**	**1990**	**2000**
Wind	5	110	423
Geothermal	38	225	600
Hydro	102	205	410
Biomass	160	405	405
Displaceable MW (Conservation/Solar)	468	935	1870
TOTAL	**773**	**1880**	**3708**

Oregon's 1980 energy requirements for all uses except transportation totalled about 350 trillion Btu.

Table 2: **Theoretical Development Schedule for Renewable Resource Thermal Energy**

	Trillion BTU per year		
Thermal Power	**1985**	**1990**	**2000**
Conservation/ Solar	20	40	80
Geothermal	6	33	46
Biomass	51	77	77
TOTAL	**77**	**149**	**203**

The next major question is, "Will these resources be cost competitive with coal?"

The task forces identified a likely **range** of costs for each of the resources, a low estimate and a high estimate. With the exception of some conservation options, most of the resources were not less expensive than a conventional coal plant, but most of them were not more expensive either.

The right side and bottom of Table 3 is resources more expensive than a 530 MW coal plant which would come on line today at 42.1 mills/kWh. Photovoltaics and large and small wind systems are in this category and are estimated to cost 57 mills per kWh or greater. The resources in the center may be more expensive or less expensive than the coal reference. The resources in the upper left are less expensive than coal. The Commission report goes into much more detail on the actual costs and assumptions they used to derive them. The result is that if the actual costs are at the high end of the range, the resources have the potential to cost-effectively provide 75% of projected energy demand between 1980 and 2000. If the low cost estimates are assumed, 100% of the demand can be met cost-effectively by renewables.

Now let's turn to questions of resource assessment. How is development of these resources constrained by lack of resource data?

Hydro sites have been extensively inventoried and work continues by the Army Corps and others to identify the best potential sites. Development constraints are not in identification of potential sites, so much as in planning projects which will have minimal environmental impa or where environmental impacts can be successfully mitigated.

The resources identified in the Solar/Conservation Task Force have also been identified by other reports. Deciding who benefits from conservation and how the beneficiaries can share the costs appears to be the major constraint.

That leaves three resources where resource data play a major role. Lack of sufficient information is seen as a particular constraint for wind, geothermal and biomass resources.

Studies done by Bonneville Power Administration, Oregon State University and Battelle PNW Labs have measured the wind resource at over 70 sites in Oregon. Several prime potential wind farm sites have been identified and measured. There are enough data at these several locations to assure a minimal financial risk for private developers to begin the long-term wind monitoring necessary to site a wind farm. However, the Wind Task Force and the Commission recommended that government should continue to assess wind resources. Although there may be enough data for private or utility developers at a few sites, many sites where wind potential may be great could be ignored unless more complete assessments are developed for them. The Commission has recommended that the State fund continues assessments of wind resources. They have also recommended a new State tax credit for wind measuring equipment. The credit would be available for residential or business investors. The data generated would be accumulated by the State for public use.

The Biomass Task Force did not recommend new State-sponsored resource assessment. Data on wood volumes exist through several sources in quite a great deal of detail. The Biomass Task Force report contains a new estimate of forest residues prepared by Oregon Department of Forestry. Also, the PNW Forest and Range Experiment Station is currently engaged in a major forest residue assessment in Washington, Oregon and Idaho. Private parties are doing feasibility studies including fuel supply assessments at many sites. The task force and the Commission recommended instead that

Table 3: **Costs for Conservation/Renewable Options**

9.8 mills/kWh — **37 mills/kWh**	**28 mills** — **Coal Reference** — **68 mills**	**57 mills/kWh**
Industrial Heat Recovery	▼ **42.1 mills**	Photovoltaics
Industrial Efficiency Improvements	Residential Efficiency Improvements	Wind Systems
Commercial Conservation	Geothermal Electric	
Residential Weatherization	Biomass Congeneration	
Existing hydro	Micro-hydro	

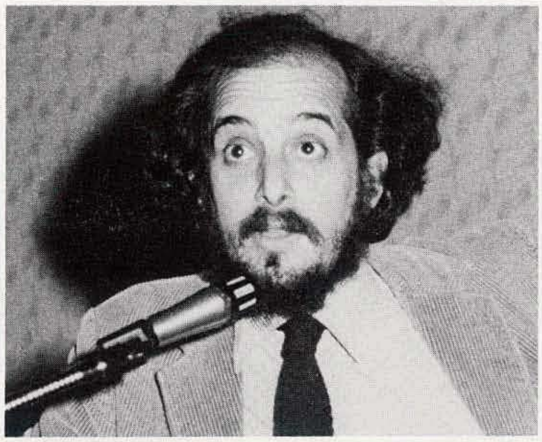
the State compile the result of private and publicly funded assessments and make the resource data available to the public.

There are uncertainties about the availability of biomass fuels, but those uncertainties are primarily the result of the fuel being tied to the forest products industry, which oscillates widely around the economy and housing starts. Several utilities are successfully negotiating for wood fuel-fired power plants but their ability to do so hasn't depended on government-supplied information.

Geothermal is our most uncertain resource. Estimates of its potential for electrical generation in Oregon vary from 0 to 750 MW by the year 2000, the latter is the recent theoretical estimate from BPA. Although no test well has yet confirmed geothermal temperatures high enough for electrical generation, some experts believe Oregon has good potential for high temperature resources. Resource assessment for geothermal is very costly because well drilling is expensive; and private developers are often reluctant to assume the financial risks inherent in resource exploration and drilling programs. The Geothermal Task Force and the Commission recommended that Oregon's Department of Geology and Mineral Industries (DOGAMI), be funded to drill test wells, which will confirm the resource in the most promising areas. Seven **private** companies are also prospecting for electric quality resources in the State.

To conclude, if Commission recommendations are funded by the Legislature, the State will be gathering new resource information on wind and geothermal to reduce the financial risk borne by private or utility developers of those resources. It will also be compiling data as it is available for biomass resources. However, there isn't any reason for you to wait. We believe that there are **already** sufficient data for the utilities to begin work on developing at least 730 MW of renewable resources and conservation which could be on line by 1985.

The Commission and Task Force reports are available from the Oregon Department of Energy.



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(The text of Mr. Luboff's speech was not available at the time the Proceedings were published. You may contact him directly for information regarding it.)

Montana's Renewable Energy Resources Assessment and Implementation Plan

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I. Introduction

Renewable energy development is being encouraged by the Energy Division of the Montana Department of Natural Resources and Conservation (DNRC). State laws have been passed to encourage energy conservation and renewable energy utilization. These include income tax credit for renewable energy systems, ten year renewable energy system property tax exemptions, tax deductions for extra thermal insulation expenses, authorization of solar easements, and reduced tax rates on gasohol fuels. These laws help implement a state policy of encouraging non-renewable energy conservation. Since government policy represents deviation from free market economics, there is always a danger of causing unforeseen damage to the economy. (This is not to say that free markets don't injure the economy from time to time). To minimize this danger while encouraging renewable energy use, DNRC has initiated a Renewable Energy Viability (REV) project.[1]

Objectives of the REV project include assembling technical information relevant to Montana; assessing opportunities in terms of economic, environmental, and social effects; and identifying the most appropriate state energy policy. Temporal focus will be from the present to the end of the century. The project is to consist of several elements including a resource assessment, technology analysis, impact analysis, and a supply/demand analysis. Federal and state grants are being sought to fund the project. The purpose of this paper is to report the proposed procedure for the resource assessment and to discuss its function in the REV project.

II. Resource Assessment

Energy resources like coal, oil and natural gas may not be strictly non-renewable; nature is probably producing them at its own pace. That pace is so slow, however, that we're using up those resources faster than they are being produced. A resource is considered "non-renewable" whenever it is used faster than nature makes it available. Solar energy is renewable, because it is replaced every day the sun shines. Wind energy is simply solar energy converted to a kinetic energy form. Hydropower resources are replaced on an annual basis if properly managed. Since a forest can be replaced in a few decades, wood can be managed as a renewable resource. Geothermal energy is not strictly renewable (it originates from radioactive decay), but we don't appear likely to come close to causing a global impact on this vast heat reservoir. Thus, geothermal energy is taken as renewable.

Non-renewable resources are being assessed by DNRC. Only renewable resources will be assessed in the REV project. In the following, the term "resource" will mean "renewable energy resource." Resources to be studied are classified as solar, wind, hydro, geothermal, and biomass. The objectives of the project are:

1) to gather pertinent existing information on resources in the state. This will include specification of key parameters necessary to characterize each resource and an estimation of the data accuracy;

2) to identify important gaps in the information, fill the gaps and recommend procedures for data improvement where necessary;

3) to put the information in a form suitable for defining spatial and temporal resource distribution; and

4) to distribute the information to DNRC, other interested government agencies, REV personnel and the general public.

III. Methodology

Much of the necessary data have been obtained by private, government and academic researchers. These data will be gathered and put in a form useful to the REV project. There are no plans for physical measurements in this project.

A. Solar Energy

Until recently, there have been only three reliable solar monitoring stations in Montana: Glasgow, Great Falls and Summit. Data from these stations are available through the National Oceanic and Atmospheric Administration. Monitoring programs have been initiated at two other sites. These are Butte (by the National Center for Appropriate Technology) and Bozeman (by the Montana State University Engineering Experiment Station). These five locations contribute sparse data for such a large state. Recently, estimates of solar radiation have been made using cloud cover data.[2] Cloud cover is an hourly estimate made by a trained observer. Cloud cover data are available from several airports. It is proposed that cloud cover data be used to estimate solar radiation. These estimates will be compared with actual radiation data to validate and/or help refine the estimation procedure. Then cloud cover data throughout the state will be translated to solar data.

B. Wind Energy

Western Montana is characterized by low wind speeds while eastern Montana is characterized by moderate speeds. In between, on the east slope of the Rocky Mountains, is a high speed zone. This zone will receive the most detailed attention starting from the work of Reed.[3] He lists monthly ranges (percent time wind speed is in each specified range) for fourteen locations in Montana. There are large variations in average wind power over short distances. For example, wind power at Great Falls International Airport exceeds wind power at Malmstrom Air Force Base (ten miles away) by 80 percent. Effects of geomorphic characteristics on local wind speed have been reported.[4] Methods reported by Marwitz and Marrs[5] will be used in the REV project to predict locations of intense and reliable wind power. Predictions for the Livingston, Montana area will be compared with Brelsford's[6] detailed wind power study of that area to validate and/or refine the prediction procedure.

C. Hydropower

Little needs to be done beyond collecting information from the U.S. Geological Survey, Corps of Engineers, Montana Power Company, and Montana DNRC. The emphasis of this study will be directed toward extant dams that could be retrofitted for electric power generation.

D. Geothermal

A project to explore the hot dry rock potential near Marysville involved a 7000 foot test hole. The project was abandoned when temperature at that depth turned out to be only about 100°C. To justify the expense of more test holes, an exceptional geothermal anomaly would be required. Such an anomaly does not appear to exist.[7] The REV task, therefore, will focus on wet stream and liquid sources. None of these appears to be suitable for electrical power generation, but many could be used for space or process heat. Geothermal energy data are available through the Montana Bureau of Mines, DNRC, and U.S. Geological Survey and there appears to be [illegible]000 acres of Federal land in the state that is geothermally valuable.[8] Future data could become available with a change in oil lease agreements. The change would require test holes to be logged for flow rates and temperatures.[7]

E. Biomass

Animal and human wastes can produce pipeline quality methane gas. Methane extraction might best be performed in large scale plants, so the geographical distribution of this resource is important. Large cattle and hog feedlots will be located and characterized. There are about 150 of these.[9] Those feedlots appear to represent a methane resource for 22,000 MCF per day.

Combustible trash is generated in Montana at a rate of nearly 400,000 tons per year.[10] This resource, at 4000 Btu per pound, is equivalent to 47 million barrels of oil. The geographical distribution of this resource should automatically match the geographical distribution of energy demand.

F. Wood

There are over 20 million acres of forest in Montana. Wood waste from logging, known as slash, is produced at a rate of 13 million tons per year.[11] The energy content of that combustible material is equivalent to over 30 million barrels of oil. The annual production of dead timber by nature will also be estimated from U.S. Forest Service data. Sawdust and wood chip production will also be estimated from mill industry data. The possibility of managing selected forest areas as wood fuel "farms" will be explored. The task of assessing environmental impacts from increased wood burning is not part of the resource assessment, but is part of the total REV project.

IV. Discussion of REV Project

Resource assessment, technology analysis, and supply/demand analysis will combine to form the technical core of the REV project. The objectives of the technology assessment task are to define non-renewable energy conservation technologies, characterize their unit energy savings, and estimate their initial and operating costs. This information, together with the resource assessment, will fuel a supply/demand analysis. The demand side of this analysis will focus on end uses. The supply/demand analysis will not be used just to attempt to predict the future. Rather, it will be used to compare the economic and social effects of various government energy policy scenarios. Scenarios to be compared include the following:

1. no government policy incentives for conservation or renewable energy use;
2. government energy policies to encourage only cost-effective conservation and renewable energy use strategies; and
3. government energy policies to maximize the fraction of energy use supplied by renewable resources.

Other tasks in the REV project include Public Input, Public Information Dissemination, Impact Analysis, and a Transition Analysis. These tasks are included to help avoid damage to the human environment that could result from policies based on the purely technical tasks discussed above. Part of the transition analysis includes a model energy communities program. This program will assist competitively selected communities in instituting local policy to conserve energy. The program has the added advantage of providing a real-life "laboratory" for all personnel in the REV project to discover the actual impact of the fruits of their labors. It is hoped that the REV project can be adequately funded and that those fruits will be largely nutritious. ▮

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Summary: Idaho's Activity in Renewables

Idaho's activity conforms closely with what one would expect, given the nature of the State and its people and the nature of the renewable resources themselves. Activity underway is very decentralized, often of a do-it-yourself character, and subject to alternating cycles of keen interest and boredom. Not surprisingly these cycles tend to coincide with the degree of uncertainty as to foreign fuel sources and the current visibility level of federal subsidies for renewables. Most activity now underway in Idaho has been taken without reference to these cycles by small operators who know a good thing when they see one and are willing to go out and make it work on their own, without waiting for subsidies and technical assistance.

Basic resource data and much specific resource assessment has been carried out for all forms of renewable energy. Predictions of actual resource potential are admittedly shaky but feel they do indicate an order of magnitude which offers really significant replacement of non-renewable energy. (See Figures 1 and 2 for an example)

The most significant questions for development of renewable energy sources in Idaho concern institutional matters like the stance of the federal government, the regulators, and the financial community. As it appears to me many of these renewables are economically viable now; the rest may soon be with current growth rates of

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conventional fuel costs. If the resources are there, and they are economically feasible now, why so little (compared to what could be) progress?

Many developers, especially the larger ones who often appear least in need of outside help, seem to be in a holding pattern, waiting for new funds from the fede money tree before committing resources to renewable

Figure 1: **Idaho Direct Use Potential**

Site	Geothermal Energy Usage (Btu's per year)			Source
	1980	1990	2000	
Weiser		2.1024x10″	8.4096x10″	IOE estimate 1979—284°F, 1000GPM
Grandview		.7x10″	2.1x10″	IOE estimate 1980—170°F, 500GPM
Magic		2.19x10″	4.38x10″	IOE estimate 1980—284°F, 500GPM
Hailey		3.57x10″	3.57x10″	IOE estimate 1979—176°F, 2200GPM
Stanley		.657x10″	.657x10″	IOE estimate 1979—167°F, 500GPM
Fairfield		1.25x10″	6.0x10″	IOE estimate 1979—212°F, 500GPM
Butte City		.42x10″	.84x10″	IOE estimate 1979—170°F, 300GPM
Rexburg		1.30x10″	2.60x10″	Rexburg PON estimate 1979
Idaho State Complex: Capitol Mall		.7848x10″	.7848x10″	IOE estimate based on actual fuel bills—1978
Ag-Health	.11x10″	.20x10″	.20x10″	Actual fuel bills—1979
Ind. Admin.		.1035x10″	.1035x10″	CH^{2}M Hill estimate—1979
Boise Geothermal		13.1x10″	17.5x10″	Boise Geothermal Energy Systems Plan estimate—1979
TOTALS	**.11x10″**	**26.377x10″**	**47.149x10″**	

energy projects. These developers could go ahead, but prefer to wait in hope that federal moneys may be used to reduce risk and make potential projects more profitable than they now are. Financial institutions especially in the current recession, are even more cautious than normal in lending money or credence to other than conventional projects. Workshops and other information dissemination aimed at the financial community seems to have had little impact so far.

At the state level the Idaho Office of Energy has done much to provide information of different levels of detail to different groups of decision makers who might consider use of renewables. But the most positive sign of commitment of renewables, couples with the power to back it up, comes from the Idaho Public Utilities Commission. PURPA hearings started in December of last year were designed to consider very broadly all renewables in an attempt to "do all in our power as a regulatory agency to remove institutional barriers and encourage development of cogeneration and alternative energy sources." Preliminary findings issued in April are "that these resources can make a significant contribution toward meeting the energy demands of Idaho."

Technically feasible and economically profitable projects based on renewable energy sources abound in Idaho, yet very few of them get carried through to completed facilities. I am impatient with the slow pace of

Figure 2: **Idaho Electricity Generation Potential**

Source: Geothermal Energy in Idaho Site Data Base & Development Status, O.I.T., Klamath Falls, July 1980

	Geothermal Energy On Line (MW)		
SITE	**1980**	**1990**	**2000**
Battle Creek			50
Big Creek			50
Blackfoot			50
Bonneville	—	—	—
Crane Creek		100	
Cove Creek		50	
Indian Creek			50
Magic			50
Raft River	5	55	100
Roystone			50
Vulcan		50	
White Licks			50
Weiser		50	
TOTALS	**5**	**305**	**450**

renewables. Market demonstration projects of intermediate size represent the only way to quicken the pace. ▮

Regional Overview—Resource Assessment

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In addition to the resource assessment efforts being conducted at the State level, regional resource assessments are important for regional power planning, supporting and complementing State efforts, and providing a common data base for comparatively analyzing resource alternatives, including their costs and their impacts. The focus of this talk is on the regional assessments for near-term alternatives that can make some contribution during the 1980s in meeting electrical energy needs through the production of electricity or displacement of electrical demands. Technologies discussed are solar, biomass, small hydro, geothermal, and wind. Examples of regional studies currently being performed include inventories of (1) potential hydro projects by the U.S. Army Corps of Engineers, Water Resources Research Institute, and the Water and Power Resources Service; (2) solar technologies by the Solar Energy Research Institute; (3) direct-use renewables, a joint effort by Pacific Northwest Utilities Conference Committee, Washington Water Power, and Bonneville; and (4) geothermal resources by the U.S. Geological Survey.

The goal of Bonneville's resource assessments is to compile results of assessment activities performed by others and to prepare estimates of energy costs and benefits, technical feasibility, operating characteristics, fuel availability, and environmental impacts for each near-term technology. The potentials are being expressed both in terms of maximum or theoretical potential by the year 2000 and as practical or achievable potential considering economic, environmental, and institutional factors. Bonneville activities this past year include continuation and expansion of efforts to measure wind and solar resources at several sites in the region; developing processes, models and data inputs for including renewables in system planning; assessing the capability of the existing power system to integrate and provide backup for renewable resources; and participation in pilot projects which demonstrate renewable resource technologies.

At Bonneville, resource assessment efforts are being carried out by two separate groups. One group is assessing the electric energy contribution from the larger-scale, utility-type projects such as cogeneration, wood-fired plants, small hydro, large wind turbines, and geothermal electric plants. Another group is analyzing the potential for reducing electric energy requirements through conservation measures and the direct use of renewable resources, including active and passive solar systems, small wind machines, and geothermal district heating.

Following is a brief progress report summarizing regional assessment activities. Much of what I will report to you is based on preliminary findings. A great deal of additional work is necessary to determine the contribution renewable resources might make in meeting the region's energy needs.

Solar Energy

Today in the Pacific Northwest, there are numerous examples of direct-use applications of solar energy, especially residential space and water heating projects. However, these operating systems are only making a minor contribution to reducing regional electric energy requirements. Bonneville is systematically appraising the potential for reduction of regional energy requirements which can be achieved through widespread application of direct-use solar technologies. The recently compiled end-use data base for the residential sector (that was reported on this morning) is being used for this ~urpose.

The biggest task in this effort is first to isolate the amount of potential contribution from solar technologies which are included in the forecast of electric demand. This is an important step to solve the double counting errors prevalent in many estimates of potential (particularly for weatherization). Next, an analysis is performed for each sector (residential, commercial, industrial, and agricultural) for each appropriate solar technology.

In the residential sector, residential water heating and residential space heating is expected to be the largest contributor. Solar industrial process heat technologies are not expected to reduce electric loads in the industrial sector.

If DOE's goals are realized in the photovoltaic program, solar irrigation is expected to be cost-effective by the mid-1980s. Photovoltaics may also have significant potential in the residential sector, particularly if the waste heat is used for space and water heating.

Biomass

Bonneville's efforts to assess biomass potential have focused on applications which will likely add to the electric generation supply. Potential fuel supplies include wood (forest and mill residues and energy farms), agricultural residues, and municipal solid waste. Based on a March 1980 report prepared by Bonneville, total theoretical potential for electrical generation from forest and mill residues is expected to be about 1,700 MW. However, by the year 2000 this report assumes that due to economics and other competing uses for wood fiber only 25 percent can be considered as being practicably harvested and used for electric generation. Energy farms, on which biomass would be grown specifically for energy production, are estimated to have a large theoretical potential. However, how much could practicably be developed is highly uncertain and needs further investigation. Municipal solid waste could potentially contribute additional generation in the region. Significant progress is being made in the Portland area on proposals for municipal waste facilities which include power production. However, development will be slow until landfill disposal costs are higher and the cost of energy increases. Also, the regulatory issues over land fills and the scarcity of sites are making alternatives such as waste burning more attractive. Agricultural residues are not considered to contribute much to electrical production in the region even if all are used for this purpose.

Biomass utilization in the residential sector has also been examined by Bonneville. This morning, Terry ~velt reported on the survey conducted by Bonneville and the Pacific Northwest Utilities Conference Committee to collect end-use data in the residential sector. Results revealed a sharp increase in the use of wood for home heating. It is expected that use of wood will increase, but not as dramatically as it has over the past few years.

Industrial Cogeneration

Biomass is also an important fuel for industrial cogeneration. Eighty percent of the potential for cogeneration is in the forest products industry. To the extent that cogeneration using wood fuel is developed, it will decrease the fuel available for the wood-fired power plants. Cogeneration applications are a more efficient use of the wood energy and generally more cost effective. Rocket Research Company survey, dated January 1979, identifies the region's potential for additional industrial cogeneration as over 1,200 MW capacity. If additional condensing cycle generation and other cogeneration cycles are considered, this technical potential might increase by 15 percent to about 1,400 MW capacity. There are many factors influencing the full development of cogeneration including economics, financing, fuel supply, regulations, and rates. Taking these factors into account, about half the technical potential could be achieved by the year 2000.

Small Hydro

The potential for small hydro development in the region is the focus of several investigations underway right now. The National Hydroelectric Study, done by the Corps of Engineers, provides a start at examining the potential at new and existing hydro sites. Since that study began, however, new information on sites has been acquired which has not yet been completely assimulated into their study results. Preliminary results published in July 1980, indicate that small hydro in the range of .05 to 25 MW could add 310 MW average energy to the region's resource base from 107 sites at existing dams, and 1,800 MW average energy from 195 undeveloped sites. This inventory represents the theoretical potential for development. Detailed investigations of these sites will be necessary to determine which are practicably developable especially with respect to economic and environmental feasibility.

The Water and Power Resources Service, in their July 1980 report titled "Small Hydroelectric Development at Existing Facilities," has identified 37 sites as economically feasible with no significant environmental and social impacts. Eleven of these sites are in Oregon, Washington, and Idaho with a projected total capacity of over 60 MW.

As a part of a 2-year regional project conducted by the State Water Resources Research Institutes, published in September 1979, 67 sites were identified on irrigation canals with varying flow durations. Examples are Summer Falls which has a theoretical capacity of 87 MW and Dry Fall Dam, 18 MW. Many irrigation districts are considering projects to generate power.

A good indication of the region's interest in hydro development is the status of projects undergoing FERC licensing. As of June 30, 1980, four licenses for small hydro projects were issued, totaling 45 MW. Another four applications totaling 33 MW are pending. The number of preliminary permits issued for investigations are also encouraging. Twelve have been issued representing 10 MW while another 10 permits are pending totaling 89 MW.

Another plus for encouraging development at existing dam sites are the loans for feasibility studies available through the Department of Energy. The capital cost risk of investigating a site is removed since the loan is forgiven for sites found not feasible.

Development of hydro resources will depend on State and local interest in projects, further investigations of feasibility, and the impacts of project on fish and wildlife.

Geothermal

Through a contract with the Geo-Heat Utilization Center at the Oregon Institute of Technology (OIT), Bonneville is examining geothermal energy potential for direct heat utilization and electric generation. Based on the information on OIT's draft report, it is estimated that the direct use of geothermal resources could displace approximately 530 MW of the electric load and that about 230 MW would likely be developed by the year 2000 based on population growth, local interest, legal, institutional, and environmental constraints, and retrofit and new development costs. The use of geothermal energy for residential space and water heating will be the most technically feasible use of the resource by the year 2000 and has the largest potential for development. In OIT's final report, several pilot projects will be recommended that would be appropriate to demonstrate end-use geothermal technology.

The potential for geothermal electric development has not been determined. Based on U.S. Geological Survey Circular 790, 3,232 MW of electrical capacity is technically possible. This projection may be low since recent exploration has identified additional reservoirs with temperatures about 150°C. On the other hand, this estimate may prove high if the Raft River demonstration project shows the binary system to be uneconomical at these temperatures. Bonneville has not estimated how much geothermal energy can practically be developed considering economic, environmental, and institutional factors.

Wind

Bonneville has completed its assessment of large-scale wind power potential. The assessment is based largely on wind data collected by Oregon State University (OSU) for Bonneville. Resource estimates will continue to be refined as more data from more sites are acquired. Bonneville has also issued a companion report on the first phase of a study to describe the effects of integrating large amounts of wind energy into the existing power system.

The maximum technical potential for the wind resource is not known due to a lack of basic wind data and to a fluctuating range of variables which define the potential. However, based on limited site data, OSU has postulated a wind network on the order of 3,000 MW capacity. Since this network would utilize only six of the prime potential sites in the Pacific Northwest, it can be assumed that the maximum technical potential of wind power is well above 3,000 MW. The practical potential of the resource depends on many factors and has not yet been estimated by Bonneville. Experience with the MOD-2 demonstration facilities and the continued wind monitoring programs will help refine these estimates. Also, preliminary investigations which place the burden of integration entirely on the Federal hydro system suggest that 25 percent of the gross energy produced by a windfarm network may not be available due to operating difficulties (particularly scheduling) encountered because of the intermittent nature of the wind resource.

Based on these studies, it is recommended that:

1. Wind data collection and monitoring programs be continued and expanded in order to assess candidate sites for large wind turbines. It takes 3-5 years of monitoring to prove these sites as having prime wind potential. As the wind machines become commercially available, it will be important to have a large inventory of promising sites to choose from, especially since some won't make the selection process because of environmental and land use considerations.
2. Additional work needs to be carried out to investigate problems with integrating wind energy and other renewable resources with the existing power system.
3. Siting procedures for renewable resources, similar to those for the State of Oregon for its wind resource, need to be developed in order to head off potential conflicts when projects are proposed for commercial development. Planning at all government levels must also be taken into account. Potential land use conflicts can preclude not only wind resources projects, but other renewable energy projects as well.

Small-scale wind systems are already commercially available today. Systems of 10 kW or less can be purchased and installed in two months. Although the potential has not yet been determined accurately, we estimate that the maximum regional potential is roughly 2 percent of the magnitude of the large-scale wind projections. Bonneville is installing 12 small wind machines at private residences and farms in Klickitat County, Washington, to test the feasibility and cost effectiveness of small wind generators. Experience gained in this project will provide data on the cost-effectiveness of wind-generated electricity. ▮

Overview for the Panel on Technology Profile

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The conference up to now has been devoted to the esoterica of end-use data bases, the analysis of that data, and resource assessment, all very necessary if we are to fully comprehend and understand the many ramifications of alternative and renewable energy resources. Lacking that full and complete understanding, our collective efforts to further the use of the many forms of alternative energy would be seriously impaired, if not completely defeated. For that reason I commend to you the ideas and information passed to you during the three preceeding panel discussions.

Before we look at a technology profile of where we are in the Northwest in some of the possible and existing alternative energy forms, I would like to discuss with you for a minute a question raised in another panel, quote, "Is there **really** an energy crisis in the United States today?" You heard that close analysis of our situation today would indicate that maybe few if any crisis situations really exist. You heard that any crisis situation probably is one only of better distribution of existing resources or simply putting to use any one of many other forms of energy rather than those which have become in short supply.

I wish to take issue with this thesis and point out to you four crises which have and still do exist in our achieving a more reliable, secure energy posture in the United States.

Crisis No. 1—**TIME:** The amount of time required to get new energy facilities on line has reached astronomical proportions; from 12 to 15 years for a new nuclear power plant; from 8 to 10 years for a new refinery; from 5 to 10 years to open a new coal mine; from 5 to 6 years simply to get a new pipeline approved for construction, let alone build it; from 10 to 20 years to develop the technology required to use solar capability to any meaningful extent; all these are examples of why time is so critical.

Crisis No. 2—**PRICE:** Increases in the cost of energy which now, in many sections of the country result in the cost of energy exceeding the cost of mortgage payments for homeowners; a 40 percent increase in the cost of natural gas in the Northwest; a quadrupling of the cost of diesel oil for ferry operations; increases in heating oil prices to the point where low income and elderly in many instances have to choose between heat and food; the ever-increasing costs of building new energy development activities, from nuclear power plants to thermal windows designed to save energy. All these and many more examples of the impact of increasing costs of energy are before us every day.

Crisis No. 3—**CAPITAL:** Since the Arab Embargo of 1973 and the quadrupling of crude oil prices following that action, following in 1979 by another doubling of prices, there has been the greatest movement of capital out of the industrialized nations of the world that the world has ever seen. This transfer of capital has created deficit or adverse balance of payment conditions which fuel the fires of inflation, created stagnation in the availability of capital for expansion of the industrial base, and sharply restricted the ability of countries still developing to improve their standard of living. Only a drastic reduction in the demand for foreign crude oil can assist in solving this problem.

Crisis No. 4—**SECURITY:** With nearly 50 percent of the crude oil required by the United States now being imported, we must look seriously to where those imports originate. Currently most of them come from the Persian

Gulf, an area of tremendous uncertainty and volatility. The current war there is an all too convincing indication of how insecure that source of supply can be. We are attempting to reduce that reliance on Persian Gulf crude but this is a slow and tedious process.

How does all of this affect our deliberations on the use of alternate energy forms? It simply re-emphasizes the urgency of the situation we find ourselves in and dictates that we do everything possible to speed the availability of alternate forms which will permit a further reduction in the demand for conventional energy sources such as oil and natural gas.

Here in the Northwest we have been making progress in adopting alternate energy forms and that is what we want to discuss with you now. We will present material on the state-of-the-art as we see it, where we are, and where we think we will be able to go. Our time is limited but we have five experts with us who will discuss in order Solid Fuel and Biomass, Cogeneration, Wind-Solar-Photovoltaics, Small-scale Hydro, and lastly, Geothermal. You must realize that these presentations are going to be pretty sketchy so we urge you to follow them up with reading from the mass of material now available on any of the subjects. Thank you. ▌

Active Biomass/Solid Fuel Projects

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For too long we have become too dependent upon oil and petroleum products. Oil flows, it can be turned off—or down—and easily controlled, stored and transported. In short, we have become enslaved by its convenience. Now we seek among all alternatives, of which Biomass is in a minor role considering the enormous demand of, particularly, portable liquid fuels.

Here in the Northwest we hear too often that Biomass—Renewable Resources—Forest Wastes—Agricultural Residues—is the obvious answer to our increasing energy requirements with the attendant decrease in oil and power supplies and increasing costs. The ease with which the statement is made and repeated makes the answer seem easy.

First let us look at our Biomass resources, Figure 1, and the current costs of these fuels as compared with other fuels, Figure 2. Oregon's 10 million tons of all residues represent—on paper—700,000,000 total gallons of oil. In fact, the figure is 350,000,000 gallons of recoverable residues or one-third of our State's yearly use of oil products.

Field or Agricultural Residues

We also can—at least figuratively—retrieve 500,000 tons of straw (field residues) from grass seed and small grain croplands of the Willamette Valley—which would theoretically convert to the energy equivalent of 50 million gallons of oil.

Sawmill Residues

A residue more easily retrieved and used is mill refuse. With forest trim and slash we have to go after it in the woods or at the landing, and pay the cost—somehow—of gathering, sorting, bundling, hauling—and dealing with the dirt and rocks that come with it. Some of this can be left to form the humus for the renewable forest tree seedbeds. What is brought to the landing—the loading area in or near the timber—may be more realistically brought out of the woods to an energy center at a reasonable cost. But mill refuse—both sawmill, plywood and pulp mill waste—is already at an energy center, and its cost has been paid by the logs, lumber, boards and chips from which this is the residual matter.

The waste is "hogged" by a hammermill or knife hog, producing a uniform mix of rot, bark and trims. Increasingly mills are using this hogged fuel to supply part of their own energy—dry kilns, steam and even power. There is no need to legislate when the material is at hand and the economics all point to this waste utilization within a mill or lumber factory. The cost of Hog Fuel (HF) in Eugene, for example, is presently $23/Unit—or the equivalent of $1.30/MM Btu. This is a recent rapid increase due to its current utilization value from $7.00/Unit of 40^c/MM Btu two years ago.

Alcohol from Crops

Oregon uses 2 billion gallons of petroleum of which 1.2 billion is gasoline. If we extend this by 10%, it would take all the crop, grain and straw from **1/3 of the arable lands in the State** to make the needed 120 million gallons of alcohol—or 14,000 gal/hr for every hour in the year. That is, presuming we had invested in the large scale alcohol production process to satisfy that requirement.

Animal Residues

Biogas is the biological conversion, by microbes, of animal manures. Biogas is 60% methane and 40% carbondioxide, and contains 600 Btu/ft.^{3}—as compared with methane at 1,000 Btu/ft.^{3} It is a process that has not yet found a home in Oregon and is impractical except with confined herds of 200 cows or more. It also requires nearby needs for gaseous fuels. Monroe, Washington has to date one of the very few operating methane systems, funded amply by the Federal Government as a Demonstration. We were engaged to investigate the potential for another large dairy, chicken and egg farm—but the capital required in the present state of development is too great for an individual farm, and their real need is for portable liquid fuels.

To produce the Biogas energy equivalent of **1 gallon of gasoline per day** it requires:

7 dairy cows
or 50 pigs
or 500 chickens—in your backyard.

We recently completed a series of combustion test firings of dried cow manure, concluding that fluidized bed combustion or pelletizing and then gasifying are the only two ways to burn this material.

Multifuel Combinations

One of the most promising energy sources and at a reasonable cost, is to concentrate on stationary—not transportable—fuels such as steam heat, hot water, and warm air. Mills use their wood waste in this manner. Other industries with combustible wastes are taking similar steps. Rather than one single fuel providing all the energy there are circumstances where one fuel can be used to extend another, often with beneficial gains in reduced emissions, increased capacity and stabilizing combustion.

Quinault-Pacific Corporation in Shelton, Washington happens to have an excess supply of fuel wood—not good for chips, but easily hogged for fuel. Shelton Correction Center is only 5 miles away, has 3 boilers making steam and hot water for its "residents" or inmates. The institution normally operates its boilers on Washington coal, bought on State contract, but was willing to experiment. The Department of Energy, Region X, was enthusiastic about helping to finance a demonstration. We provided the know-how. Wood and coal burn well together—that is, one above the other. The supply of coal is not only extended but the actual combustion is improved, capacity is increased and cleaner emissions result from the combination of the fuels. No drying or densification is necessary, helping to reduce processing and thus costs. This idea is not new—the techniques had to be retrieved from the days of less convenience than we presently know. The economics are there if you have all the right circumstances. One of the factors contributing to the economy of direct fuel use is that you avoid densification of wood, which requires grinding and drying prior to

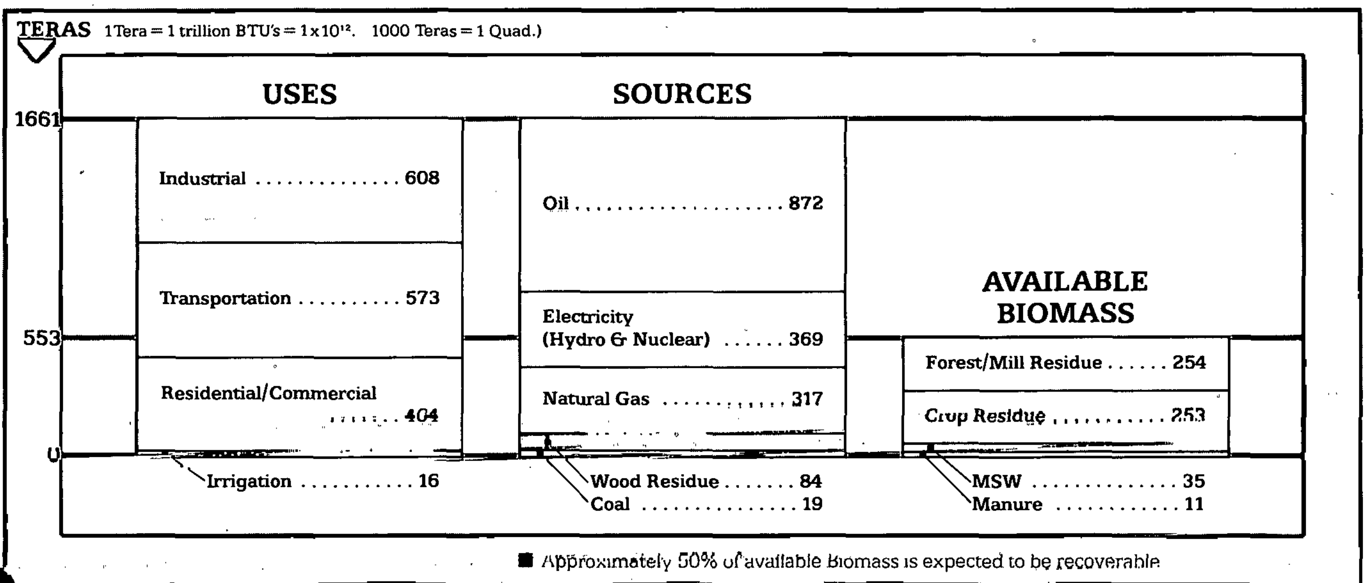

Figure 1: **Northwest Energy: Uses and Sources (Oregon/Washington/Idaho)**

Figure 2: **COMPARATIVE FUEL AND ENERGY VALUES WITH COSTS**

	% Moisture Wet Basis	Nominal Heat Value	AS DELIVERED Cost	AS DELIVERED MM Btu/Ton	AS DELIVERED $/MM Btu	Conversion Efficiency	Cost per 1000 Lb. Steam (1 MM Btu)
		Btu/Lb.	$/Ton				
SOLID FUELS							
Sawmill Residue*	50%	4,500	$10.00/Grn Ton or $20.00/Unit	9.0	$ 1.11	65%	$ 1.70
Logging Residues*	50%	4,500	$30.00/Grn Ton	9.0	3.32	65%	5.10
RDF (Refuse Derived Fuel from MSW)	30%	5,500	7.50/Ton	11.0	.68	65%	1.04
Coal	10%	11,000	50.00/Ton	22.0	2.27	80%	2.83
Pelleted Wood	15%	8,500	42.00/Ton	17.0	2.47	78%	3.17
Straw	15%	7,500	45.00/Ton	15.0	3.00	75%	4.00
Cord Wood at 1 Ton	20%	6,700	100.00/Ton	13.4	7.46	70%	10.60
"Firelog" (w/wax)	10%	15,000	$430.00/Ton	30.0	$14.30	80%	$17.85
NATURAL GAS		1,000 Btu/CF or 100,000 Btu/Th	$/Therm				
Industrial			$ .42	—	$ 4.20	83%	$ 5.06
Residential			.52	—	5.20	83%	6.26
"PORTABLE" FUELS		Btu/Gal.	$/Gal.				
OIL Industrial Bunker C		150,000	$ .60	35.0	$ 4.00	80%	$ 5.00
PS-300		145,000	$ .80	35.0	5.51	80%	6.88
Residential Heating		140,000	1.00	—	7.14	80%	8.90
Diesel Transportation		140,000	1.00	—	7.14	80%	8.90
Propane		91,500	.90	43.0	9.83	83%	11.84
Gasoline		120,000	1.30	43.0	10.82	—	—
Gashohol (15% Ethanol)		113,000	1.40	40.5	12.38	—	—
Methanol		57,100	.80	17.0	14.04	—	—
Ethanol		77,000	1.75	23.0	22.72	—	—
ELECTRIC ENERGY (PNW Area)		Btu/kWh	$/kWh				
Electricity-Industrial +		3,400	$ .03		$ 8.82		
Residential		3,400	.05		14.70		
Flashlight Battery**			$100.00		$30,000.00		

* 1 Unit of Green Wood Residue = approx. 4,000 Lb., or approx. 2,000 Lb. B.D. (Bone Dry)
\+ 10 Lb. Steam (10,000 Btu) produces 1 kW
** Courtesy Battelle PNW LABORATORIES.

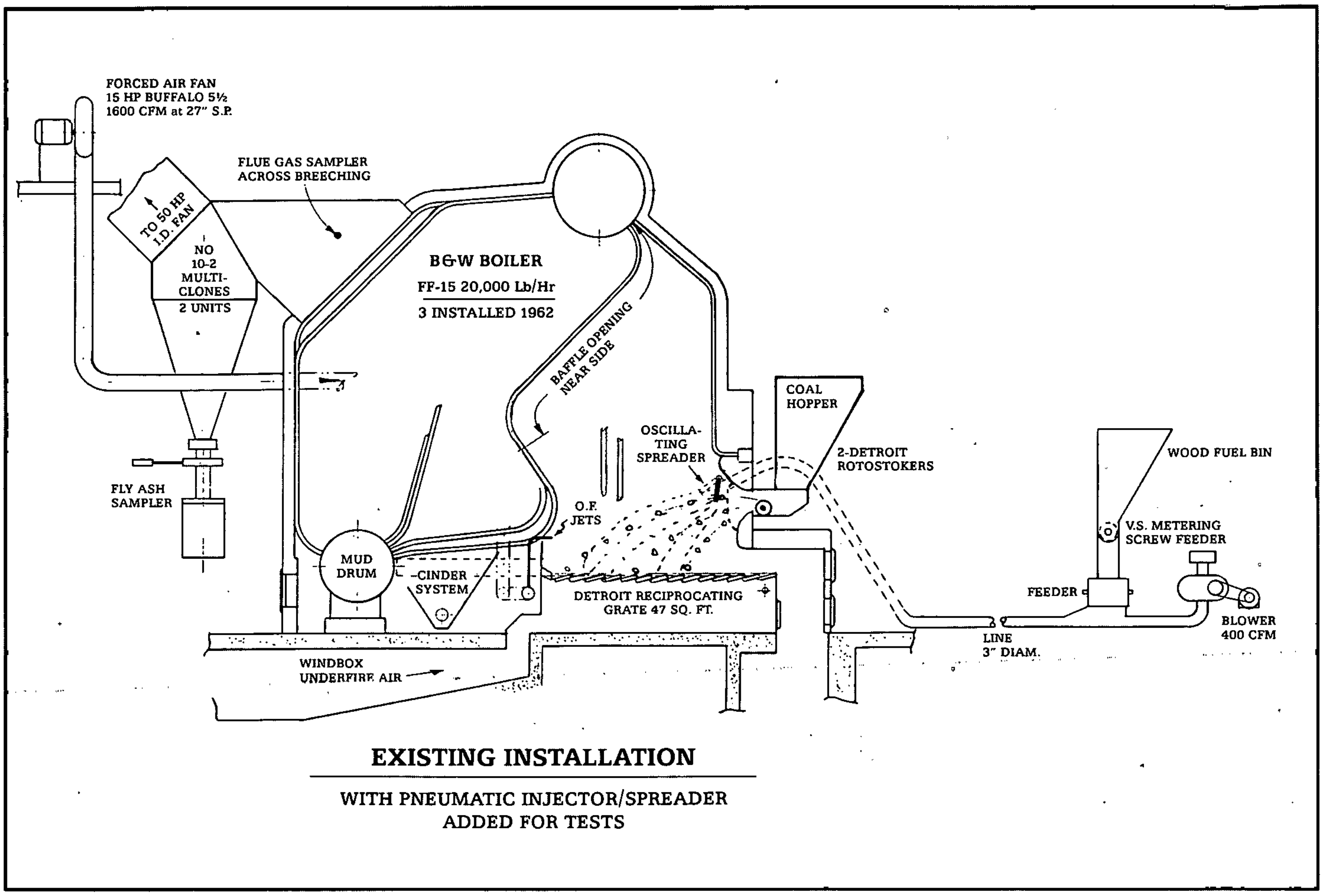

Figure 3: **Schematic of Boiler Installation, Shelton Correction Facility, Shelton Washington (5-1-80)**
Thomas R. Miles, Consulting Design Engineers, Portland, Oregon

pelletizing.

Figure 3 illustrates the existing boiler installation with the simple addition of pneumatically fired wood fuels, providing individually variable firing rates.

Whenever you look at a residue—the minute you have to do something to it to use it—it costs money, increases its own value, and thus of course it ceases to be a residue. The key is to derive the highest energy or heat (Btu) value at the least cost or, in other words, with the least amount of processing. By simply hogging and separately introducing the hogged wood into the combustion area above the burning coal bed, the high volatile wood burns and reignites the coal gases that are rising. So, you get more complete combustion, greater capacity and lower emissions. Another advantage of burning a wood/coal combination is the non-clinkering, friable ash resulting.

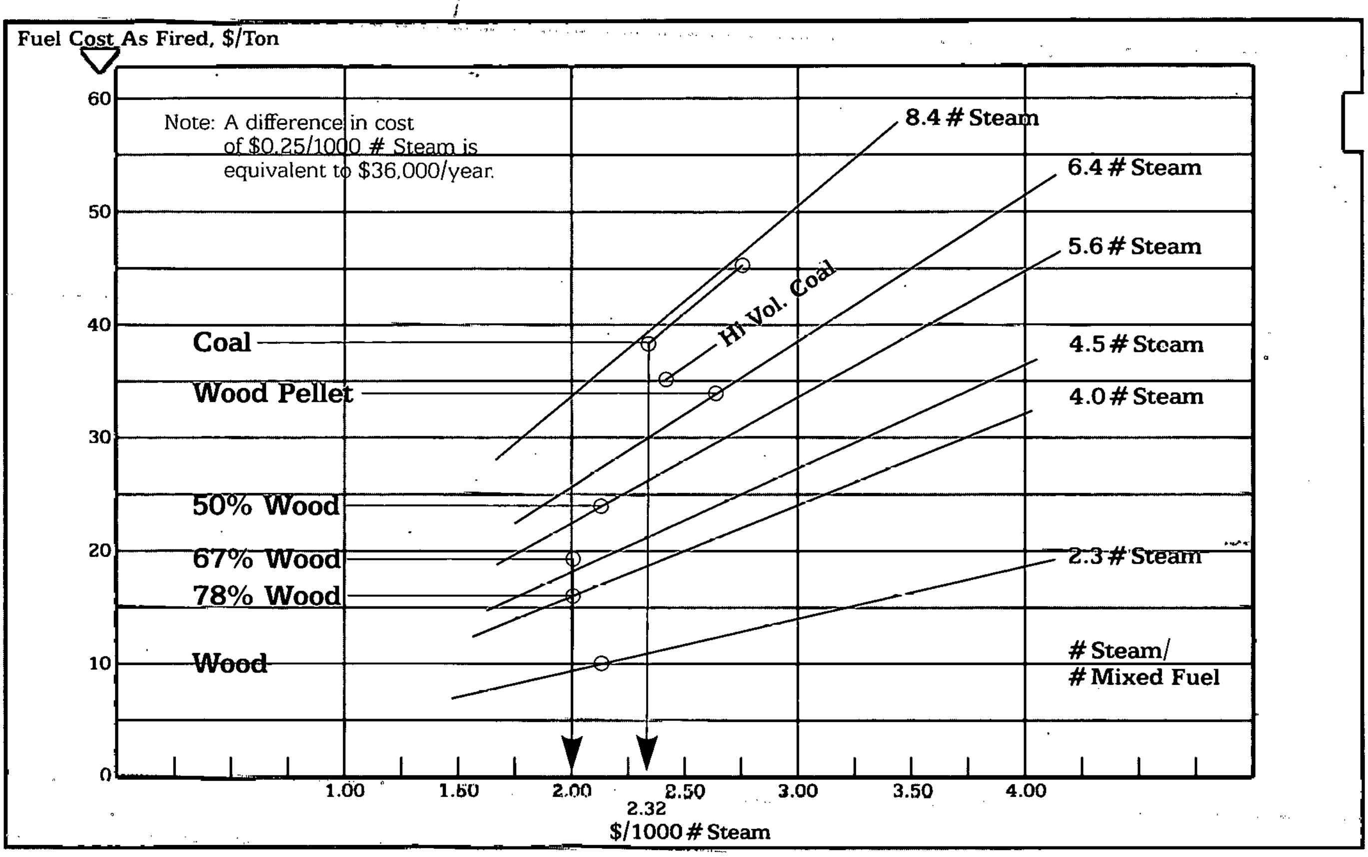

Figure 4: **Fuel Alternatives and Costs at Shelton**

Figure 4 tabulates our calculations of burning coal and wood mixtures and the pounds of steam produced from the mixed fuels. Test data substantiated these figures. Note the increased cost of pelletized wood.

People or Urban Residues

You cannot always arrange such optimum circumstances as the wood/coal combination firing. However, in general, where you need stationary heat you also have people, and people make waste—at the rate of 5 to 7 pounds per person per day. Presorted, picked and processed, the combustible fraction is known as Refuse Derived Fuel (RDF). At the University of Oregon hog fuel has produced steam and electricity for 30 years. Eugene's sawmills are now reducing production as well as using their own mill wastes as heat sources. The University generates waste term papers, and Lane County has a workable—if not presently working—recovery plant. We are making plans in the very near future for RDF combustion at the U of O Boiler Plant.

By improving the Resource Recovery Plant to produce a low-ash RDF which we then cube to facilitate handling and prevent carry-over, the recovered RDF will be fired approximately 50-50 with hog fuel—again COMBINATIONS OF FUELS.

Residues in Our Future

In a quick scan of current and coming uses we now have a good working agricultural residue furnace that can provide heat from grain, hops and other agricultural drying using as fuel the agricultural dry wastes such as straws, stems, prunings and vines.

The Concentric Vortex Furnace concept was first introduced in 1974 as an experimental field burning machine, and we have developed it further, since 1976, in stationary combustion trials. We designed one furnace for Iowa State University to burn corn-stover to dry corn, subsequently improved on that design and furnished them our revisions, which they have built and operated in the Agricultural Engineering Department. ISU has passed the designs along to a local agricultural manufacturing company, which is marketing it there locally.

Here in Oregon, meanwhile, we have continued developing the furnace for agricultural processing, and in our prototype we have successfully burned various materials in addition to straw bales and cornstalks, such as hop vines, with minimum emissions and no odor. We have tried barnyard manure that is dirt laden and recommend against its use in this furnace. We also ha burned cotton gin waste, with the same negative recommendation.

There are many opportunities for the small 5 million Btu/Hr concentric vortex unit in agricultural processes :ch as crop drying, alcohol plants, and in small lustries. We are about to fit it to a boiler for steam production.

We have been retained to retrofit a cement plant in Fiji with wood fuel locally available to replace up to 50% of imported coal now being used, and which has become very expensive. This is another COMBINATION FIRING application. We are also looking at locally identifiable residues for many other small industry installations. Not the least of these is the ultimate goal to make the farm energy self-sufficient with various combinations of fuels.

Conversion by Gasification

Gasification of biomass shows promise in directly converting biomass into a useful gaseous fuel for internal combustion engines to drive pumps and electric generators. We have designed three operating feeders for introducing biomass into gasifiers under pressure, and are currently designing two more—one to operate at 300 psi!

Precautions

There are certain fundamental concerns with most biomass fuels that must be fully recognized in both the design, fuel handling procedures and use:

1) Minimal turn-down in combustion rates.
2) Often seasonally produced, and usually requiring storage as well as different handling systems. Wood and RDF are at least year-round supplies as opposed to seasonally occurring agricultural residues.
3) All biomass by its biological nature is subject to biological destruction and must be protected from weather.
4) Cost is higher than you might think—each handling, each processing increases the cost while it enhances the value or conversion from a waste to a usable material.
5) Most biomass residues must bear their own collection costs, etc. They are not "FREE."
6) All biomass fuels are dreadfully "inconvenient" to use as compared with gas and oil.

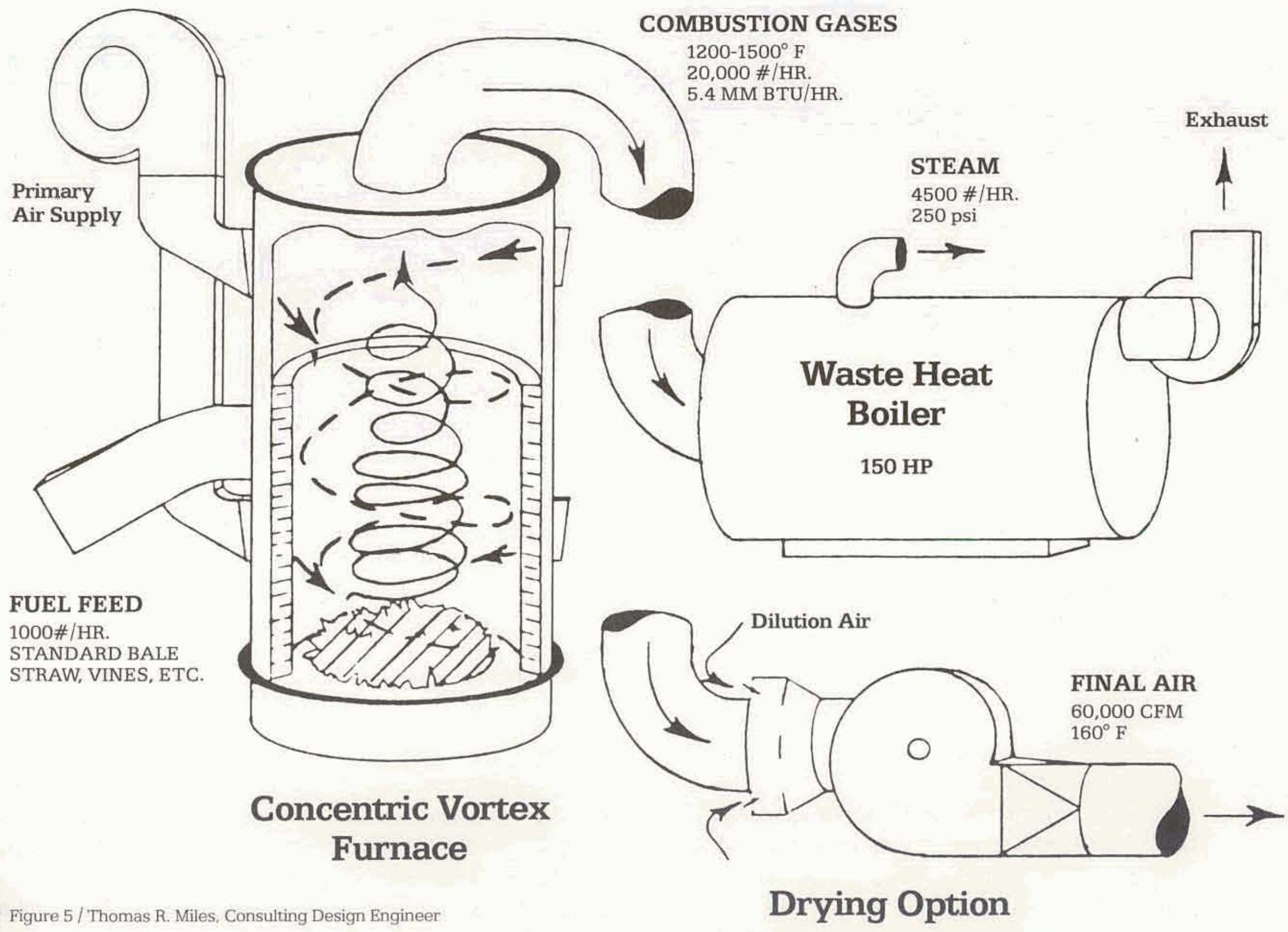

Figure 5 / Thomas R. Miles, Consulting Design Engineer

Conclusions

Convenience of oil is a major difficulty to be overcome, not only in respect to comparisons of cost and availability, but also in terms of turn-down, flow, safety and ease of use.

Suitability of the biomass fuel is important. For example, biomass is best used as a stationary fuel to produce heat, dry air and steam. It applies to farm processes or to institutions better than to factories and to homes. Suitability can be improved if a specific end use justifies further processing, such as wood pellets for domestic heating or for gasification. It is possible that pellets may be useful to a small integrated community, rather than for industries where other fibrous wastes may be more appropriately directly fired.

It is important to do as little as possible to a residue material in order to make it a fuel.

Combinations of fuels are often ignored, and probably offer the best opportunities to extend the use of coal, oil or wood.

Safety is a major factor in dealing with any fuel. Kerosene heaters are, for example, sold in Oregon but their installation and use are violations of the building code if they are unvented. Straws present a storage hazard, both in fire safety and, if large stacks are stored, they may tip and fall. Straw bales certainly provide safe harbor for nesting rodents. Owls and hawks as well as cats and skunks are, in this case, the farmer's friends.

The cost of development of really good conversion systems is sufficiently expensive, except in the case of the small farm-use furnace system already developed that biomass utilization will proceed most rapidly in the hands of mature corporations already conversant with fuel needs, handling and marketing. The return on investment is too long-term, and/or cost is too high, either for small entrepreneurs or for government to support.

And of course we are still too willing to pay increasing gas and oil costs to really seriously get at the development of biomass systems.

Biomass must be developed slowly, with a lot of inconvenience, a lot of dollars, a great deal of attention to availability and suitability. It is not readily transported any distance, and generally it does not make a transport energy fuel. It is available in very small proportion to the total energy resource need, but it can be used as one small increment in the complex of all energy resources.

And finally, we will restate a favorite phrase: "Never have so many had it so good, and for so long—and at so little cost."

Cogeneration

Cogeneration has been around for a long time in the forest products industry. It was common practice years ago for many lumber and paper mills to burn wood waste products to produce steam and electricity for themselves. But the advent of cheap petroleum-based fuel and hydroelectric power made cogeneration less attractive.

For cogeneration to be a profitable venture over time, several special conditions must be met. There must be:

- A steady and continuous long-term need for steam and electricity
- A favorable heat balance (economic use for exhaust steam)
- A steady supply of low cost fuel
- Physical space for equipment and safe fuel storage
- Reasonable environmental requirements/regulations
  - •• Effluent
  - •• Emissions/Dust
  - •• Noise
  - •• Vibration

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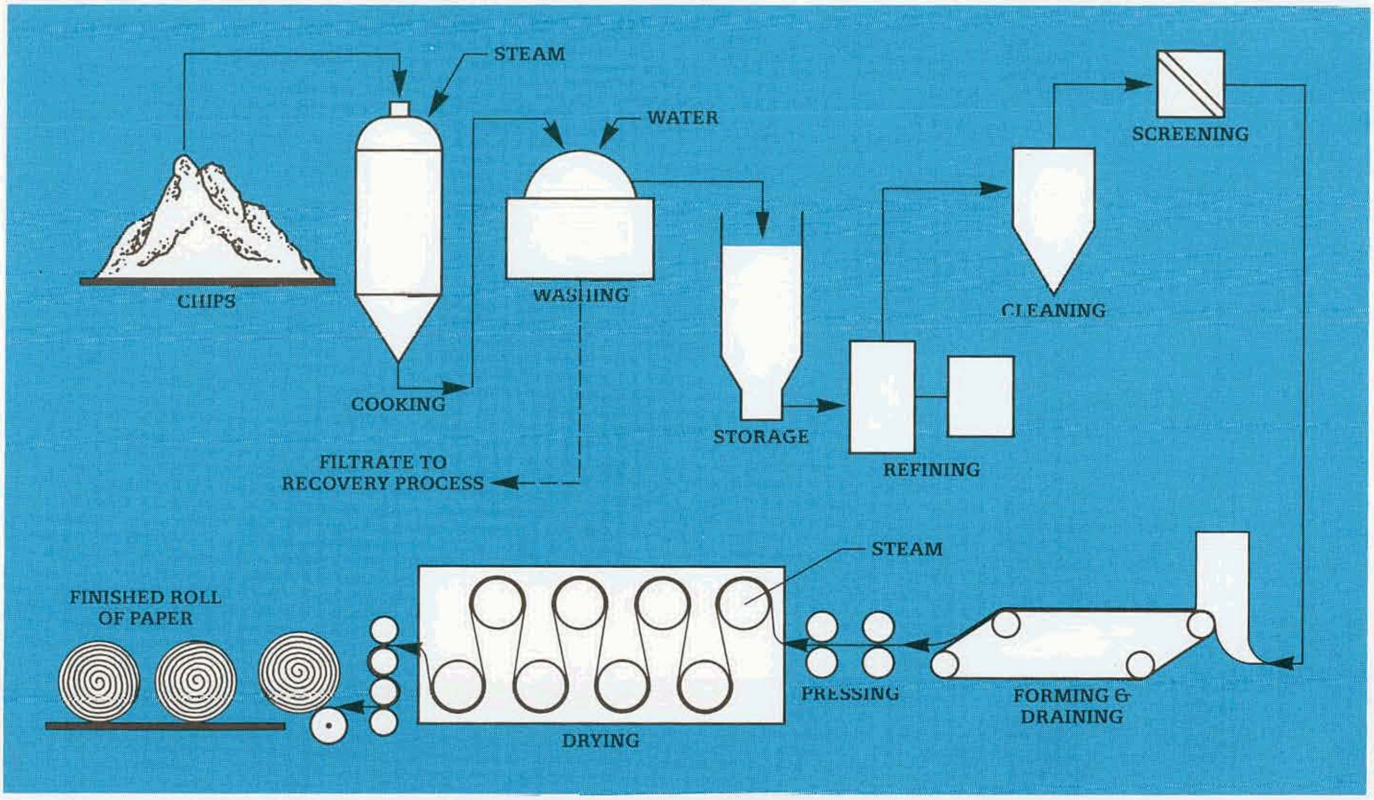


Figure 1: **Pulp and Paper-Making Process, "Unbleached Paper"**

- Acceptable logistics (such as movement of vehicles through community and on-site)
- Good contracts between parties involved (trust, respect and commitment)

To understand how some of these conditions affect our industry, the flow chart, Figure 1, shows how a typical linerboard facility where wood chips are turned into rolls of paper for making corrugated boxes and containers.

But as you can see from the flow chart, there are many interactions in the process that must be taken into account if any one element is to be changed.

It is interesting to note that we make more steam from liquor burning than from hog fuel. One half the weight of wood chip goes into pulp and the other half goes into liquor burning. Our steam production is:

Liquor	39%
Hog Fuel	27%
Fossil Fuel	34%
	100%

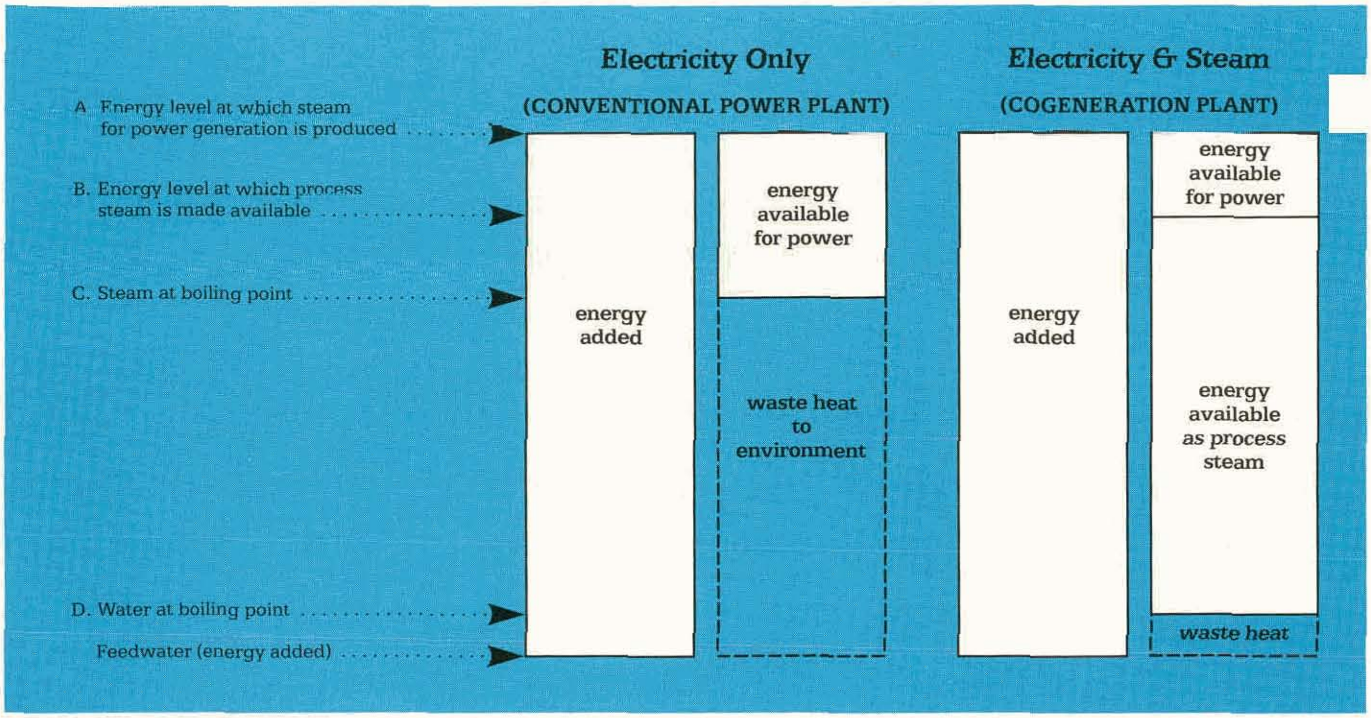


Figure 2: **Comparison of Energy Utilization in a Conventional Electric Power Plant and a Cogeneration Plant**
*From National Science Foundation, **Energy Industrial Center Study**, prepared by Dow Chemical et al, June 1975, Figure 34, p.103

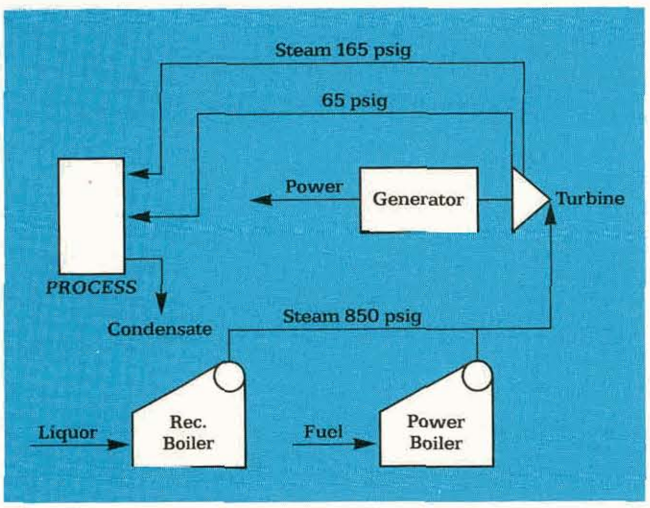


Figure 3: **COGENERATION SYSTEM: Typical Pulp and Paper Mill System**

Figure 2 shows the comparison of energy utilization in a conventional electric power plant and a cogeneration plant. Most utilities recover about 30% of the energy content in their fuel for end-use compared to about 80% recovery by an industrial cogeneration facility using back pressure generation. The electrical energy can be produced for about 45 Btu/kW for the cogeneration plant whereas it takes about 10,000 Btu/kW in a conventional power plant.

Figure 3 shows how the heat energy is charged to the process whereas Figure 4 shows how the waste heat from a utility system goes to the atmosphere.

In our industry, cogeneration is an integral part of the planning activity in any new facility or major modification process. Planning means analyzing energy supply and demand, and its impact on the profitability of the process over time. For example, in Figure 5 cogeneration is a viable unit operation in the existing facility. However, with the trend toward energy conservation, the future configuration could reduce the total energy requirement 25-30%; and if the major reduction comes from conservation of steam usage, then cogeneration may no longer be viable.

One specific cogeneration operation worth menti ing is that at Weyerhaeuser's Springfield, Oregon lin board plant. The large steam requirements of this plant

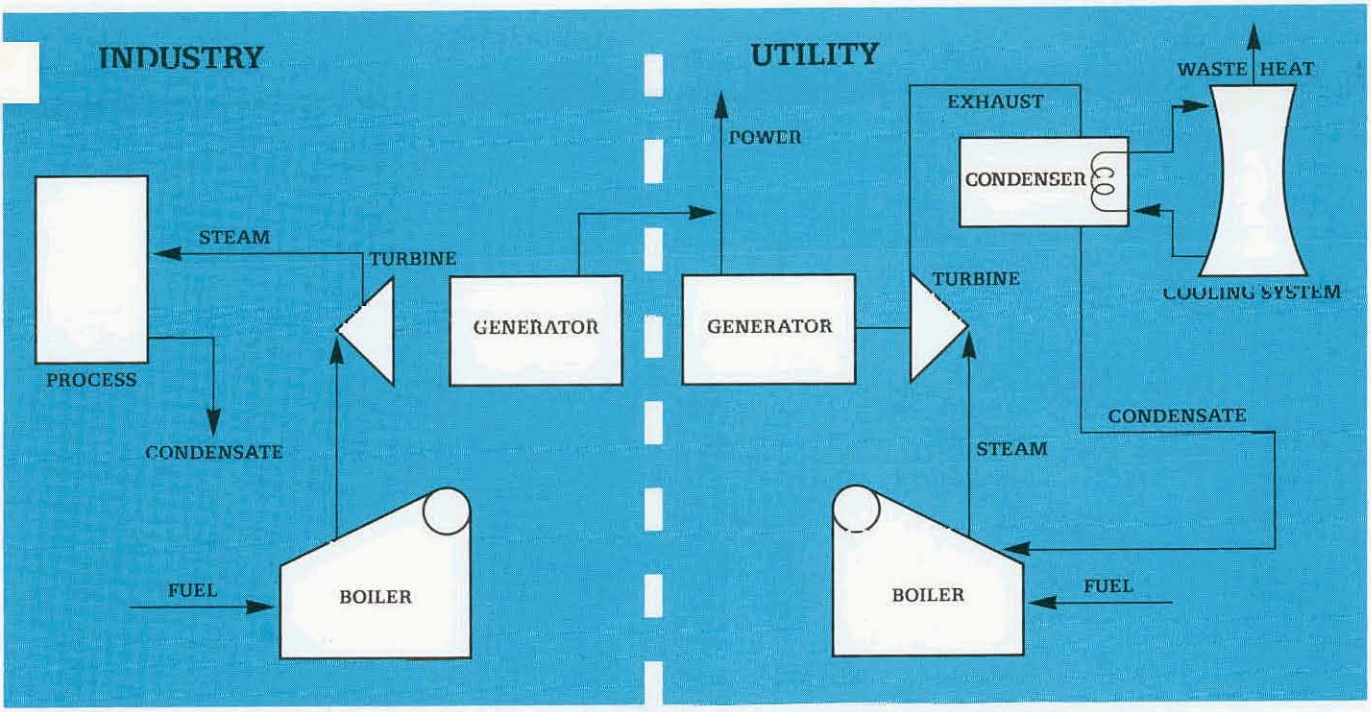


Figure 4: **Cogeneration System—Industrial Back-Pressure Utility Condensing System**

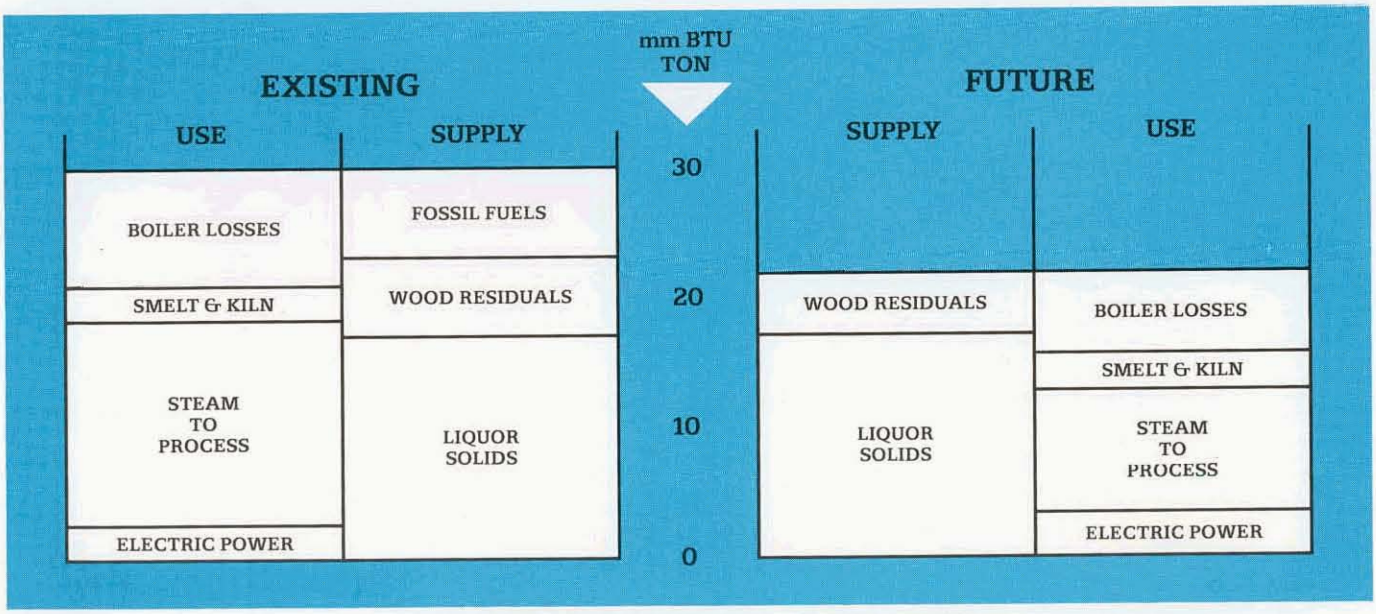


Figure 5: **Energy Supply & Demand—Linerboard Mill**

made it a good candidate for cogeneration. A unique plan was developed for the Weyerhaeuser plant to combine efforts with the local public utility to capture energy in high-pressure steam from boilers that would otherwise be operated at lower pressure. The captured steam flows through a turbine generator (owned by the public utility) to produce electric energy. Then the steam returns at lower pressure for process use by the plant.

The property is leased by EWEB. Weyerhaeuser owns the boilers and accessories and EWEB owns the turbine generator and associated equipment. Figures 6 and 7, show the steam generation before and after the joint cogeneration effort with EWEB. A power sales agreement was signed by EWEB and three cities in California: Burbank, Glendale and Pasadena.

The contract negotiations for the project took seven months, until both parties were comfortable in the knowledge that there was sufficient present and long-term benefit and cash flow (based on their different corporate styles and standards) to justify the venture. The negotiations began late in 1974 and the plant started up in the Fall of 1976.

One interesting aspect of the negotiations involved contacting 17 private and public agencies and obtaining various contracts and documents from 13 different parties. The single most difficult hurdle was receiving approval from the EPA. Although we had State and County approval, the EPA delayed our project by 4

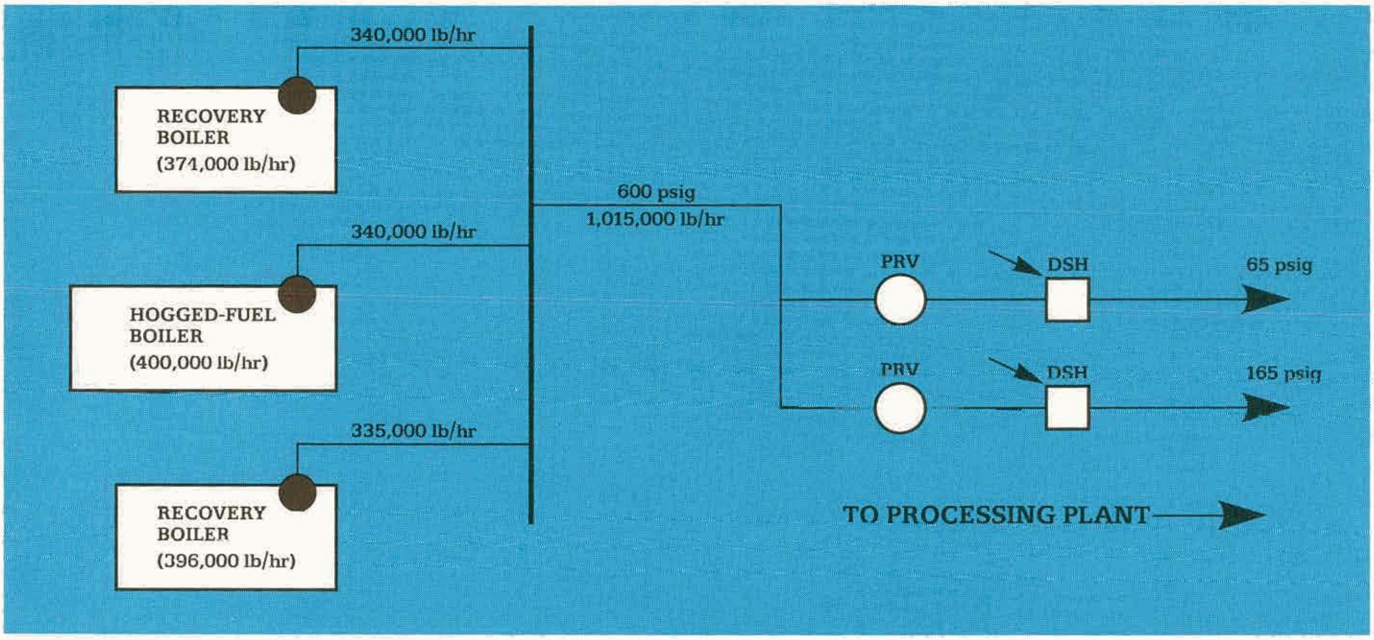


Figure 6: **BEFORE: Steam Generation Only**

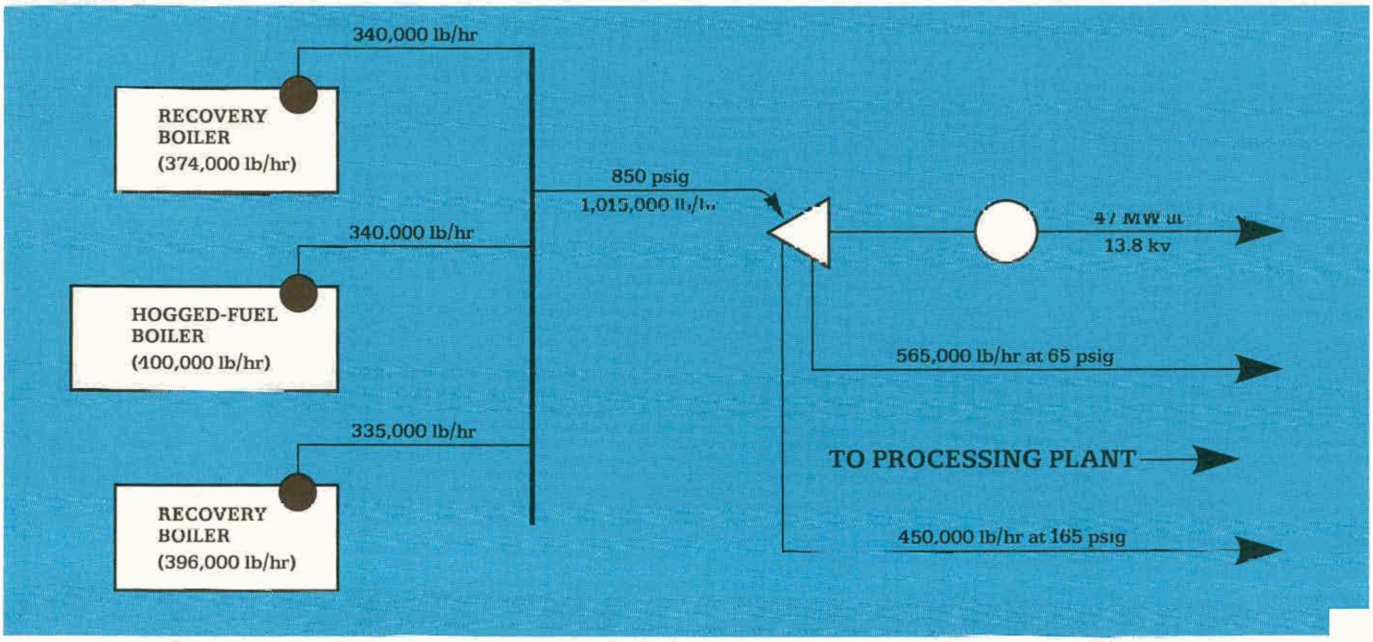


Figure 7: **AFTER: Cogeneration with EWEB**

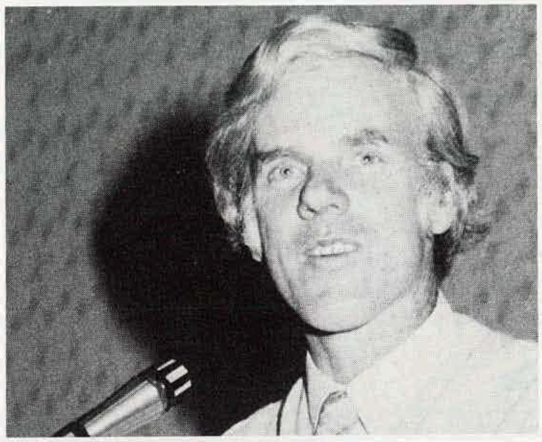
months. Our boiler was purchased for 400,000 lbs/hr at 875 psig, 825°F. The EPA insisted in deaerating the boiler to 396,000 lbs/hr even though our stack was in compliance.

An operations committee has been established, composed of two persons from each partner. It is responsible for monitoring the project and making recommendations on procedures, operations and maintenance. The commitment to make it work on each side was strong and was a vital component in the eventual success of the project. The project received **Power** magazine's energy conservation award in 1978.

There is much to be said for the present enthusiasm over cogeneration, and especially for the creative approaches and mutual cooperation between energy users and producers that we are currently witnessing. But enthusiasm can be costly if misdirected or hastily applied.

Only when the total system is examined can it provide true benefits in cost and energy savings over time. In those cases, both industry and society will reap the rewards of sound, long-range planning.

Views on the Commercial Readiness of Some Solar Technologies



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Dr. Donald W. Aitken is the Executive Director of Western SUN, the Deparment of Energy's Western Regional Solar Energy Center, headquartered in Portland, Oregon. Dr. Aitken has held this position for 1½ years, during which he created the agency and the Portland and thirteen field offices, hired and directed a staff which now totals about 85, and developed the first multi-state programs. Dr. Aitken also designed the solar-assisted, energy-efficient conversion of the Portland Western SUN offices, continuing his interest in solar building design which dates back to the early 1970's. Dr. Aitken spent the 1960's as a Research Physicist at Stanford University in California, moving to San Jose University in 1970, to found and direct the Environmental Studies degree programs and the Center for Solar Energy Applications. Dr. Aitken, recently elected as the national Vice Chairman of the American Section of the International Solar Energy Society, has over $58 million in solar building and system designs to his credit.

I was asked to present my views on the commercial readiness of some solar technologies, but in the interest of meeting a very tight speaker time schedule, it was suggested that I present a few illustrative examples, rather than try to rush a comprehensive overview. It is in this same spirit that I offer these views, rather than an overview, in the following.

Wind-Electric

Another paper in this same conference (Robert Neil) suggests that wind as an electric energy production resource may be more competitive than radiant solar energy beyond the year 2,000 for both public and private utilities in the Northwest. It is indeed a **major** Northwest resource! (It is helpful to note that a 25 mph wind carries about the same energy density per square meter of intercepted surface as the bright noonday sun).

Utility economics, in turn, would seem to favor the purchase and construction of very large wind-electric generators, to realize an economy of scale. This has been the federal assumption, in placing its major emphasis on demonstrating turbines that now range up to the 2.5 MW rating of each of the three going up in the Columbia River Gorge. But work in the private sector is leading to a new appraisal of the relative merits of "wind farms," constructed of many smaller generators placed in favorable wind regimes. The U.S. Windpower Company, for example, is standardizing on about 50 kW rated machines, that can be built from readily available machinery parts and easily and inexpensively erected and maintained without major total energy output dislocations during individual machine downtime. An attractive proposal for a pilot application of one of their farms on the Oregon coast is being pursued by this company.

This would seem to suggest that the smaller wind machines may indeed play a major role in the U.S. electric energy production future, and hence should not be overlooked in our early government-assisted efforts.

*A joint program of the U.S. Dept. of Energy and the Western States to further the public awareness and commercialization of solar energy in Alaska, Arizona, California, Colorado, Hawaii, Idaho, Montana, Nevada, New Mexico, Oregon, Utah, Washington and Wyoming.

In addition, the small wind turbines (in the 25-200 kW sizes), used individually, may provide only a small return as measured by the displacement of nonrenewable electric energy resources, but they may play a significant role in the support of isolated communities, remote communication and scientific sites, and self-sufficient farming. The impact of these applications transcends measurement in quads or dollars, and should also not be underrated.

These few comments illustrate the thesis that we must keep an open mind and balanced effort in our research and pilot applications of wind turbines. I see the current Federal preoccupation with the large machines as probably unrealistic.

The promotion of windpower commercialization need not suggest primarily the promotion of the sale of wind turbines. It can just as well suggest promoting the sale of power from wind turbines. Long term leases by private companies with utilities or municipalities for a guaranteed average annual kWh delivery can be more economically attractive for both the purchaser of the power and the venture capital financing the construction of hardware under a long-term guaranteed payment period. It can be a remarkably safe and very lucrative investment.

I believe that less effort should be expended in getting utilities to buy wind machines than simply in facilitating their ability to buy the power under reasonable multi-year guarantees, in order to attract more private venture capital into the field. The recently enacted Northwest Power Bill should be very helpful in this regard.

Solar Thermal and Daylight

The key to achieving energy end-use efficiency is to match the energy resource quality to the end-use need, and to use all available useful characteristics of that resource. This is particularly true when providing for home and building thermal comfort. But how can this be relevant to a conference focusing on electric energy?

It is important to note that about 35% of the nation's consumption of energy in 1980 went to buildings, with 80% of that (or 28% of the nation's total) to the combined uses of heating, cooling and lighting (50% for heating, and 15% each for cooling and lighting). Lighting and cooling are provided by electric energy resources, and heating is increasingly being transferred to electricity. In commercial buildings, about half of the total building energy use is for electric lighting.

But solar energy as a thermal resource is almost precisely matched to the temperature regimes that are needed to promote building thermal comfort and to yield hot water at the desired end-use temperature. And solar energy arrives in the form of light, converting to heat upon absorption. As such, available solar energy may be used directly to heat and light spaces: it may even be used to promote cooling air circulation; and it certainly ought to be used as the standard approach to heating water for domestic use. Whenever such use of solar displaces electricity, it is fully equivalent, as far as the rest of the electric grid is concerned, to the production of new electricity. The major commercial challenge in this area, then, lies in demonstrating the architectural and mechanical ease with which these objectives may often be met.

It is still the impression of most that to utilize solar energy implies the use of "active" systems, in which a fluid or air is pumped through externally-mounted solar "collectors," with the heat then stored and extracted for building thermal comfort. This is indeed a powerful method, with many specifically suitable applications, offering a considerable flexibility in the collection and use of solar energy for building climate control. And as a form of heating water for domestic use, this is an "off-the-shelf" technology.

And yet this is not always a trouble-free approach. Considerable work remains to be done in agreeing upon suitable and helpful codes, standards, and consumer assurance guarantees, and in promoting responsible and experienced business and financial support. There is also room for additional improvement in collector materials and design, but no longer in terms of offering substantial performance gains, and in developing low-cost mass production approaches, but also no longer with substantial installed system price reduction expectations.

In view of this, the Federal government has partly pulled the rug out from under the active solar business areas, in part by the early funding of some extremely unfortunate "demonstrations," and then by allowing the government funding support for active systems to peak in 1977 and decline after that, just as the need for government assistance was clarified by experience and a growing market interest.

More commercially accessible have been the "passive" approaches, where solar energy is utilized directly upon receipt for home and building thermal comfort. With new structures this hardly amounts to more than sensible, properly-oriented architecture, judicious choice of building materials, and the reapplication of techniques that were widely used in this country as "indigenous" design approaches for climate-responsive structures, long before energy became so cheap and abundant that wasteful mechanical systems were substituted for sensible architecture. And a surprisingly large fraction (I estimate 50% or better) of all existing homes and buildings in this country are potentially suitable for some passive "retrofit" (conversion) applications, thus reducing their demand on regional energy resources.

The location of the main Western SUN offices in Portland, Oregon, offered an opportunity to demonstrate the value of some of these concepts in a commercial retrofit circumstance. If Western SUN had its central

Table 1: **Measured Energy Use and Savings—Both Western SUN Floors (1980)**

Month	Average Energy Use of Office Floors 6, 9 and 10 (kWh)	Energy Used by Western SUN (kWh)		Energy Saved by Western SUN (kWh)		Totaled Savings @3¢/kWh
		Floor 7	Floor 8	Floor 7	Floor 8	
September	9,951	5,228	3,319	4,723 (=47%)	6,632 (=67%)	**$341**
October	9,375	3,423	2,762	5,943 (=63%)	6,613 (=70.5%)	**$377**

offices in Arizona, or New Mexico, no one would have been surprised to see a solar-energy conversion of two floors of a ten-story downtown office building to solar-assisted heating, cooling and lighting. But to accomplish a practical design goal of 70% annual energy savings compared to the other floors of the same building by these simple techniques, in rainy Portland, and only utilizing the solar energy that was already impinging on the building's windows and building-standard venetian blinds, is a worthy demonstration.

This has been described in some detail in an article in the January 1981 issue of SOLAR AGE Magazine (the journal of the American Section of the International Solar Energy Society). Reprints of that article may be obtained by writing Western SUN in Portland (715 SW Morrison, Suite 800, Portland, Oregon 97205: attention, Public Response Specialist). Additional articles will appear in various professional trade journals in 1981. I reproduce in the following the table from the Solar Age manuscript, showing the results for the first two months actually measured. (Only floor #8 was operated according to the full design criteria during that period). All building energy systems are electric powered, so the shown energy savings are measured directly in kWh thus made available for better uses in Portland.

Solar-Electric (Photovoltaics)

As recently as 1978 I was still predicting that photovoltaics would not make a meaningful market penetration, nor a significant energy contribution, much before the year 2000. I couldn't have been more short-sighted! The technical advances have been remarkable, and private sector financial interest in furthering this technology has been equally outstanding. In this area, the support by the Department of Energy has been exemplary, but not backed-up by a long-awaited Federal commitment to a major photovoltaic acquisition program to stimulate assembly-line price reductions.

There are really no significant technical barriers left, although important technical advances will continue to be made in improving efficiencies, reliability and lifetime and in reducing costs with thin films, amorphous crystals, and compound cells made from less exotic materials. Technically this will be a straightforward progression, spurred by real market activity, similar to the development of the transistor and integrated circuit technology. In the risk of again being short-sighted, I would predict greater market success for thin film single and amorphous crystals, with the residential sector leading the way in commercial applications, rather than with concentrating systems and compound crystals.

In the laboratory, thin film efficiencies have now passed 10%, and in the field the conventional single-crystal cut-wafer systems are achieving 13% to 16% efficiencies. Compound cells have been manufactured in the laboratory with greater than 36% measured efficiencies, and the theoretical target of better than 40% probably will have been achieved (at Stanford University) by the time this conference **Proceedings** is published.

The following two tables present the "Commercial

Figure 2: DOE PHOTOVOLTAICS PROGRAM **Commercial Readiness Price Goals (1980$)**

Application and Year		Collector Price (FOB) ($/$W_p$)	System Prices* ($/$W_p$)	Production Scale (MW_p/Year)	User Energy Price** (¢/kWh)
REMOTE STAND-ALONE	1982	≤2.80	6-13		
RESIDENTIAL	1986	≤0.70	1.60-2.20	100-1000	5.0-9.0
INTERMEDIATE LOAD CENTER	1986	≤0.70	1.60-2.60	100-1000	6.0-9.0
CENTRAL STATION	1990	0.15-0.40	1.10-1.80	500-2500	4.0-8.0

*System price correlates with production scale.
**User energy price range reflects variations in locale (insolation), system price and utility sellback arrangement.

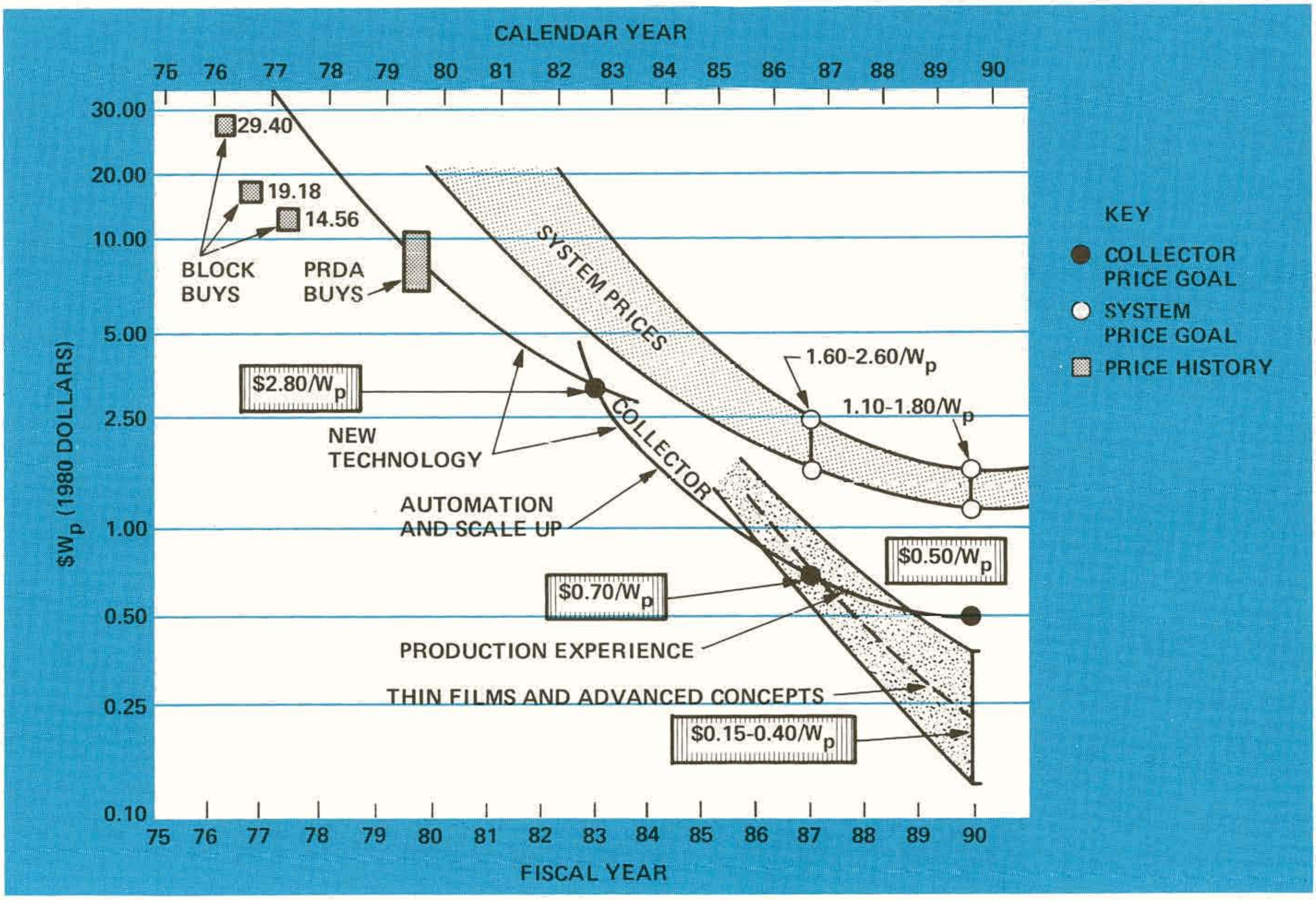

Figure 3: **Collector/System Price Goals (1980$)**
Source: DOE Photovoltaics Program

Readiness Price Goals" and the "Collector/System Price Goals" as currently accepted by the U.S. Department of Energy. An important distinction between the projected cost of the crystal arrays ("collectors") and the installed system cost (up to turn-key operation condition) needs to be noted: manufacturers are striving to lower the former, while the user relates to the latter.

The charts demonstrate a fairly aggressive set of price goals, but the private sector continues to exceed these goals. For example, the 1982 collector price goal of $2.80 per peak watt ($/Wp) has been met in late 1980 by at least one major manufacturer.

The 1986 goal of about $2.00 per peak watt installed system cost will begin to make both central station and intermediate load systems economically attractive by normal market dynamics. For example, that cost will come in lower than the marginal cost of 12 cents kWh for coal-fired plants as experienced today by the Sacramento Municipal Utility District. They (SMUD) are therefore looking seriously toward 1986 grid-connected photovoltaic array applications.

Even at $6.00 per peak watt installed system cost, the California residential tax credits, taken with the "PURPA" legislation (Public Utility Regulatory Policy Act of 1980), should begin to make grid-connected photovoltaic arrays on California residences economically "viable" by possibly as early as 1984. "Viability" as used here is Paul Maycock's definition in which one's total monthly bill for the array loan and maintenance will be equaled or exceeded by the dollar return to the array owner from the utility under the power-purchase requirements of the PURPA legislation. This capitalizes the entire array at no homeowner cost! "Lifetime costing" as normally applied (misused, actually) for solar systems will have no meaning whatsoever when the home energy system begins to earn monthly checks from the local utility company.

Architecturally the grid-connected photovoltaic systems will be sized to make maximum use of available roof space, rather than sized according to normal residence-load criteria, as with solar thermal systems. Fortunately, the rather "soft" annual output curves for photovoltaic arrays as a function of slope angle easily adapt to conventional architecture, with the common 4:12 pitched roof almost the theoretical ideal for all U.S. latitudes and most climate zones.

The private sector has responded to this rapidly growing area by investing typically $2 for each $1 by the Department of Energy in basic research. In actual market development, about $200 million in venture capital went into new photovoltaic manufacturing activities in the 18 months from about mid-1979 to late 1980. And a six-year old photovoltaic cell manufacturing company recently sold for $200 million!

In short, photovoltaic technology, Federal enabling legislation, and Federal and State financial incentive legislation will combine to trigger an impressive natural momentum in the use of solar-derived electricity by probably as early as 1985. It will impact utilities, homeowners, and communities, and start a reshaping of America's electric energy grids, where users and producers become one and the same. The load-leveling and utility and homeowner economic benefits of this change will start to be realized long before the actual solar-produced electricity will be measurable in quads.

Finally, "hybrid" photovoltaic arrays, with the cells serving as the surfaces for active solar thermal collectors (which, in turn, help keep the arrays cool and hence operating at higher efficiencies), may become the architectural norm. This will cause us all to be sorry that we sold active solar thermal systems short in the enthusiasm for passive systems, for we'll have some catch-up work to do. But then again thin photocell films sandwiched in window glass (e.g., like auto safety glass sandwiches) may allow us to collect a few hundred watts off of each of our south-facing windows, with only a nominal (perhaps 15%) reduction in light transmission through the window, suggesting that passive solar electric systems may not be left behind. Indeed, the ultimate hybrid may combine passive and active solar thermal, both supporting solar-electric generation, and daylighting. The debate about which radiant solar technology we should pursue will be long behind us. ▮

Small-Scale Hydro: A Profile of the Technology

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John Cassidy is director of the Washington Water Research Center and professor of civil engineering at Washington State University. He was chief hydrologist for Bechtel, Inc., professor of hydraulic engineering at the University of Missouri—Columbia, and a design engineer for the Montana State Water Conservation Board before coming to WSU. Professor Cassidy has conducted numerous research projects and published many articles on hydrology. He received his B.S. and M.S. in civil engineering from Montana State University, and his Ph.D. in hydraulics from the University of Iowa.

Historically, water power was one of the first energy sources to be exploited by mankind. Water wheels and crude, wooden vertical-axis Norse or bucket turbines have been in use in many parts of Europe and Asia since long before the Industrial Revolution. By the time the Industrial Revolution arrived, water wheel technology had been developed to a fine art and efficiencies approaching 70% were being achieved from the best machines.

Improved metallurgy, the need for higher-speed devices to generate electricity, and a better understanding of fluid flow led to the development of turbines during the 19th century. Up until the 1930's, small water turbines were used extensively in both the developed and developing world to provide electrical power particularly where no electrical grid existed.

Development of extensive grids, and low cost of electricity pushed hydroelectric technology development toward large multi-megawatt systems. Most manufacturers of small turbines, faced with a contracting market, either closed operations or turned to other products such as pumps.

The People's Republic of China is probably the most impressive example of small-hydro development. Although large grid-feeding hydro developments have been implemented, the number of small hydro plants grew from 50 (average power = 100kW) in 1949 to 60,000 plants (average power = 36kW) in 1973. Twenty thousand plants were constructed in the Yangze River basin alone.

Rapidly increasing fossil fuel costs, within the last six years, have created a new interest in small hydro equipment use and development. As a result, several manufacturers have revived their lines of small hydro equipment. Only a few of the large established manufacturing companies produce turbines with capacities smaller than 40kW. As a result, many new, very small manufacturers have emerged who manufacture or assemble turbines or turbine-generator combinations with capacities up to 25kW. Since fossil-fuel costs continue to increase, one must assume that further development in small hydro equipment will continue.

Small-scale, as used in describing a hydro installation, implies a limitation in size or power. For the purposes of this paper, 200kW will be adopted as an upper limit of size.

Available Hydraulic Turbines

Turbine designs generally fall into categories of head high, medium, and low. Figure 1 shows the ranges of head and output over which the various forms of turbines have been historically been used. Each range will be considered separately.

(High-Head Turbines 100>feet)

Impulse (Pelton) and Francis turbines have been in a high state of development for at least the past three decades. The development of multi-jet impulse turbines has increased their speed and extended their range of use down to as low as 20 feet for very small units (see Figure 2). An impulse unit installation has the advantage of the lowest cost in Civil construction. With high-speed operation (±1800rpm) the new multi-jet small impulse units can be directly connected to generators saving the cost of gearing for speed increasers commonly found on old units. These small, high-speed units take advantage of progress in metallurgy for impeller, shaft, and bearings. Whereas, old slow-turning impulse wheels commonly operated for decades with only minor maintenance, the new small higher-speed units have not be around long enough to prove their long-term reliabil -
Francis units in sizes smaller than 100kW are available

as a non-embedded design (See Figure 3). These units can be an economical choice in certain ranges and they ave proven reliability.

(Medium Head 100-50 feet, and Low Head, <50 feet)

Propeller, Kaplan, Bulb, Tube, Francis, and Banki turbines can all be used in medium head installations (See Figures 1 and 2). The choice is largely a matter of unit availability or the least cost of the Civil works required. Figure 4 shows a typical Propeller or Kaplan installation. These units have the advantage of proven reliability over many years. However, the complexity of concrete forming, and the depth of excavation, sometimes makes a bulb or tube unit a more economical choice. A tube unit (see Figure 5) provides a particularly adaptable configuration for economy in concrete forming. Tube units are available with both fixed and adjustable runner blades making them adaptable to both fixed and variable head installations.

Bulb turbines (Figure 6) have the particular advantage that, for small units, complete assembly can be done in the factory. Leroy-Somer, a firm in France, markets a small bulb-type unit called Hydrolec. Because the unit is self contained in sizes up to 60kW, it can be installed in a variety of ways making it very versatile for small-scale developments particularly where an old dam is being retrofitted for power production (See Figure 7).

Hydroelectric Systems

Many small hydroelectric systems have been developed by small manufacturers. In general, the systems are one of the following four types.

(Induction Generators)

Where a generator is connected directly to a grid, an induction generator can be used without governing. As long as the electrical inertia of the grid is large compared to that of the generator-turbine, the speed of the generator will be controlled by the grid. The frequency of electricity generated will lag that of the grid by a negligible angle. For cogeneration this is the most economical scheme. However, if a large number of such generators were hooked to the grid, a detectable effect on the frequency could occur.

(D.C. Generators)

For an isolated system, a D.C. generator can be used

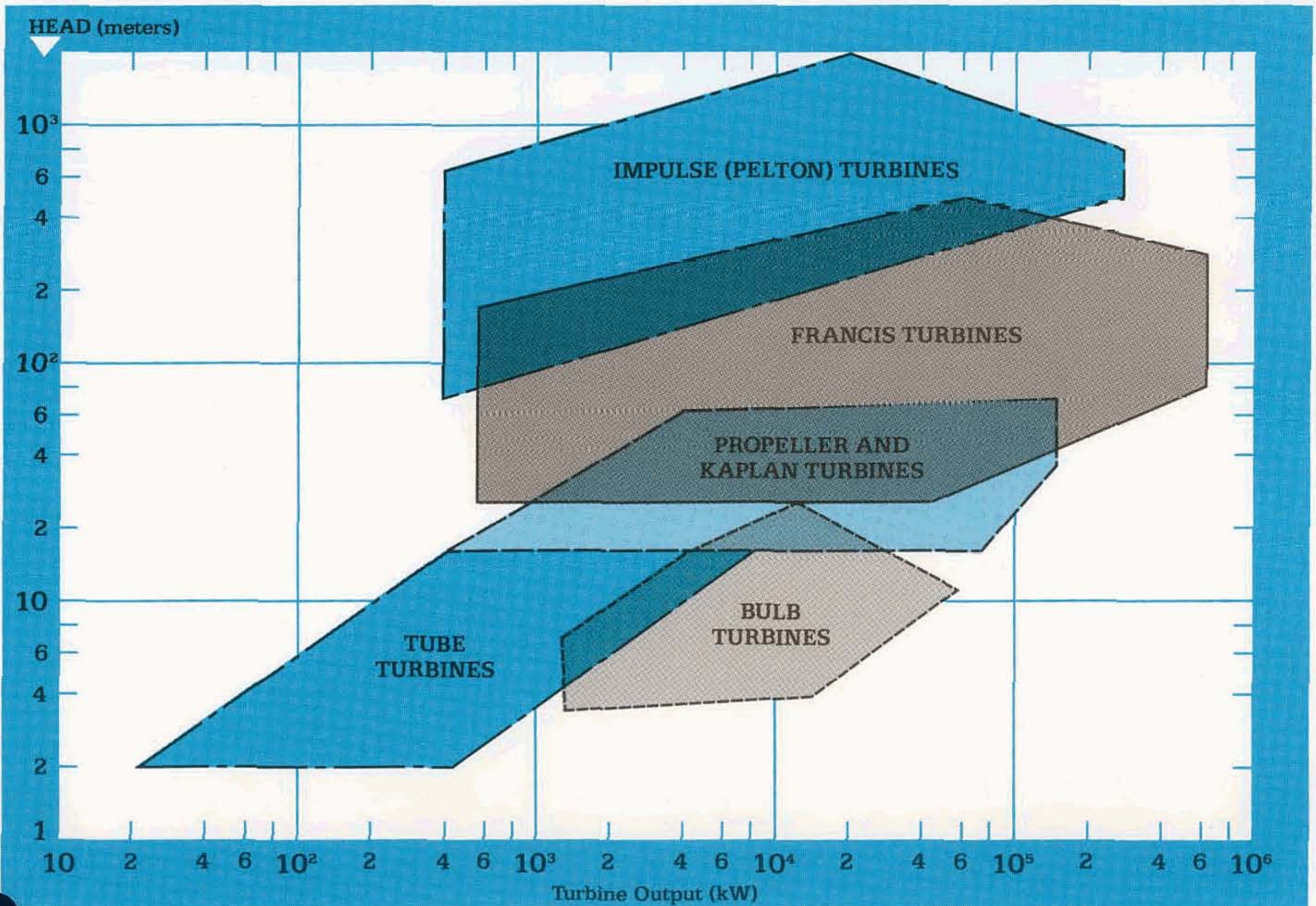

Figure 1: **Ranges of head and power where various standard types of hydraulic turbines have typically been used.**

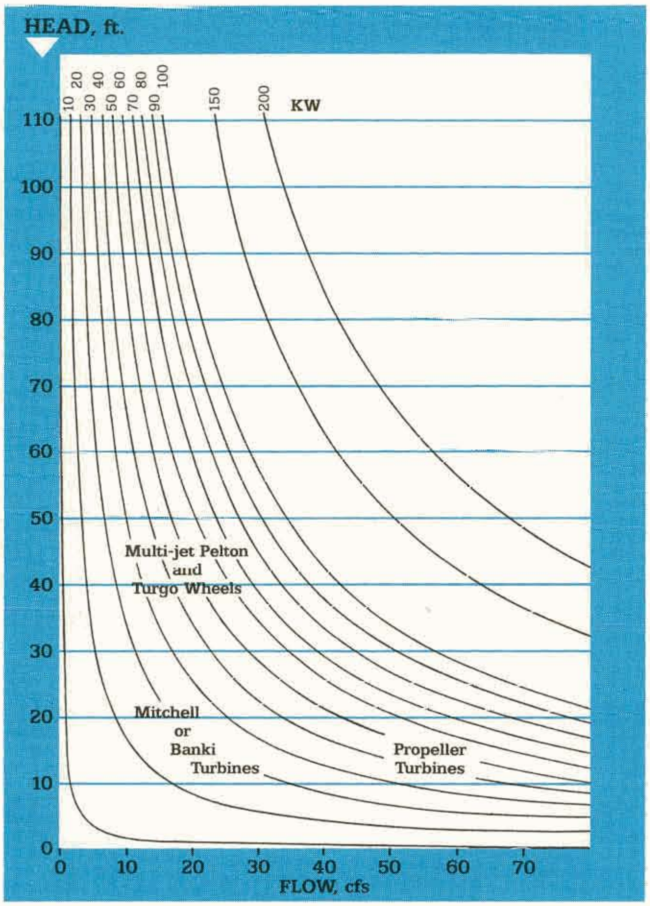

Figure 2: **Ranges of head, discharge and power where modern, small, high-speed hydraulic turbines have been used.**

without being concerned about speed control. The generator is connected to a battery bank (usually 32 volt) for storage of electricity. An invertor is then used to convert D.C. from the generator and/or the battery bank into 60 Hertz, 115/230 volt A.C. This system, available in sizes up to approximately 8kW, can provide peak outputs up to 12kW.

(Electronic Load Diverters)

Systems using electronic load diverters, utilize an A.C. generator and a resistance bank. The system generates a constant 60 Hertz, 115/230 volt A.C. voltage. The electronic diverter "senses" the load requirement and diverts more or less of the generated electricity to the resistance bank which is usually located in the penstock or draft tube. Systems of this type are readily available in sizes up to 50kW.

(Frequency Governed)

Systems which must provide 60 Hertz A.C. electricity for instruments or appliances (such as television sets) must have precise frequency-governing. In these systems, brushless alternators, can be used along with an electronic speed control to maintain constant turbine

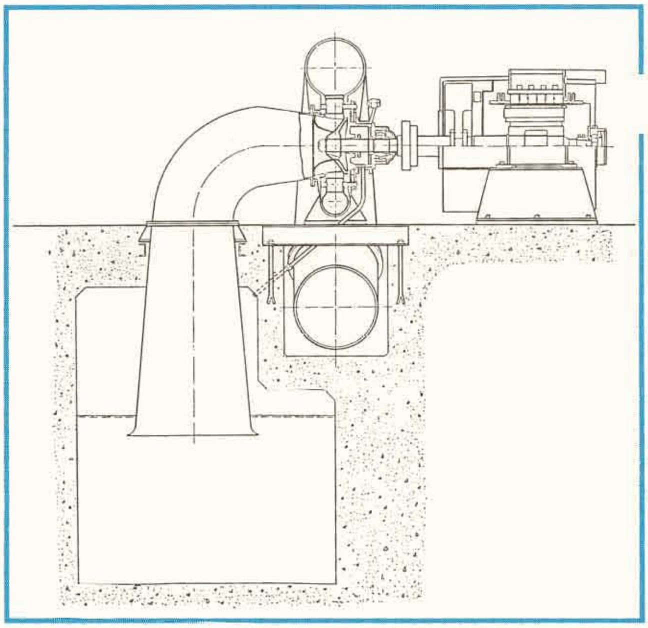

Figure 3: **Schematic illustration of a small Francis-type turbine and generator.**

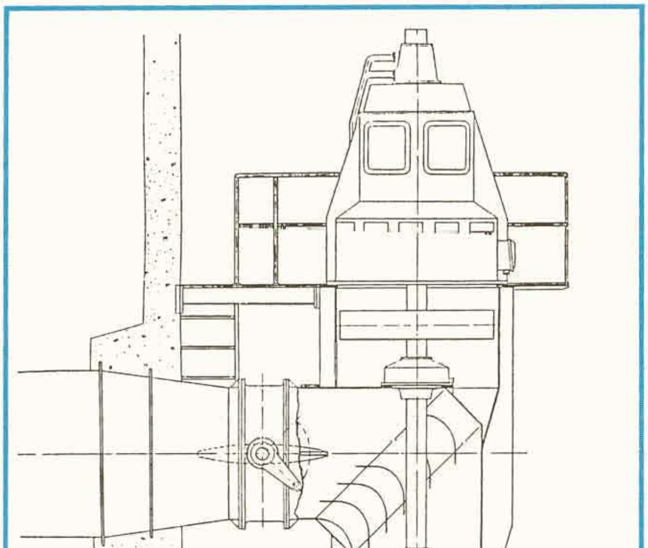

Figure 4: **Schematic illustration for a typical small propeller or Kaplan-type turbine and generator.**

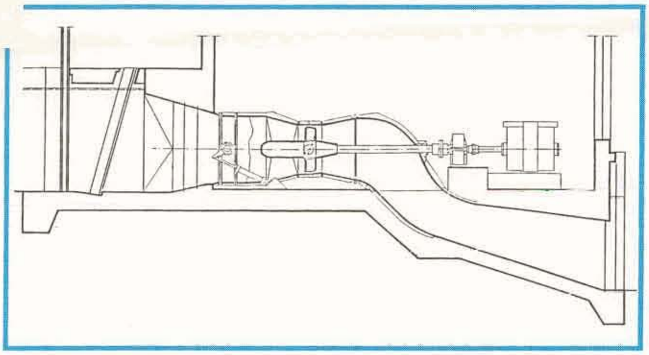

Figure 5: **Schematic illustration for a small horizontal-axis tube turbine and generator.**

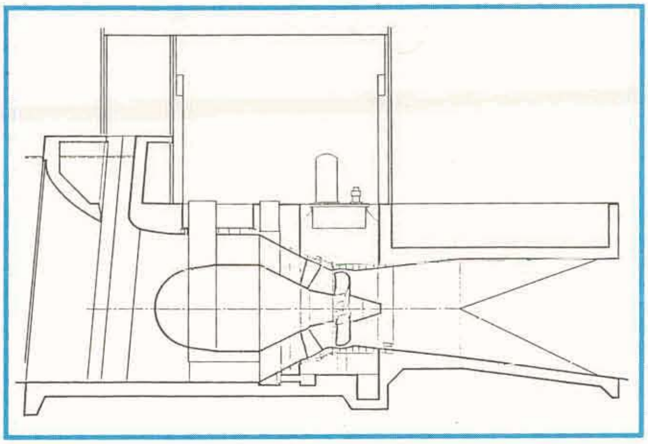

Figure 6: **Schematic illustration for bulb turbine-generator installation.**

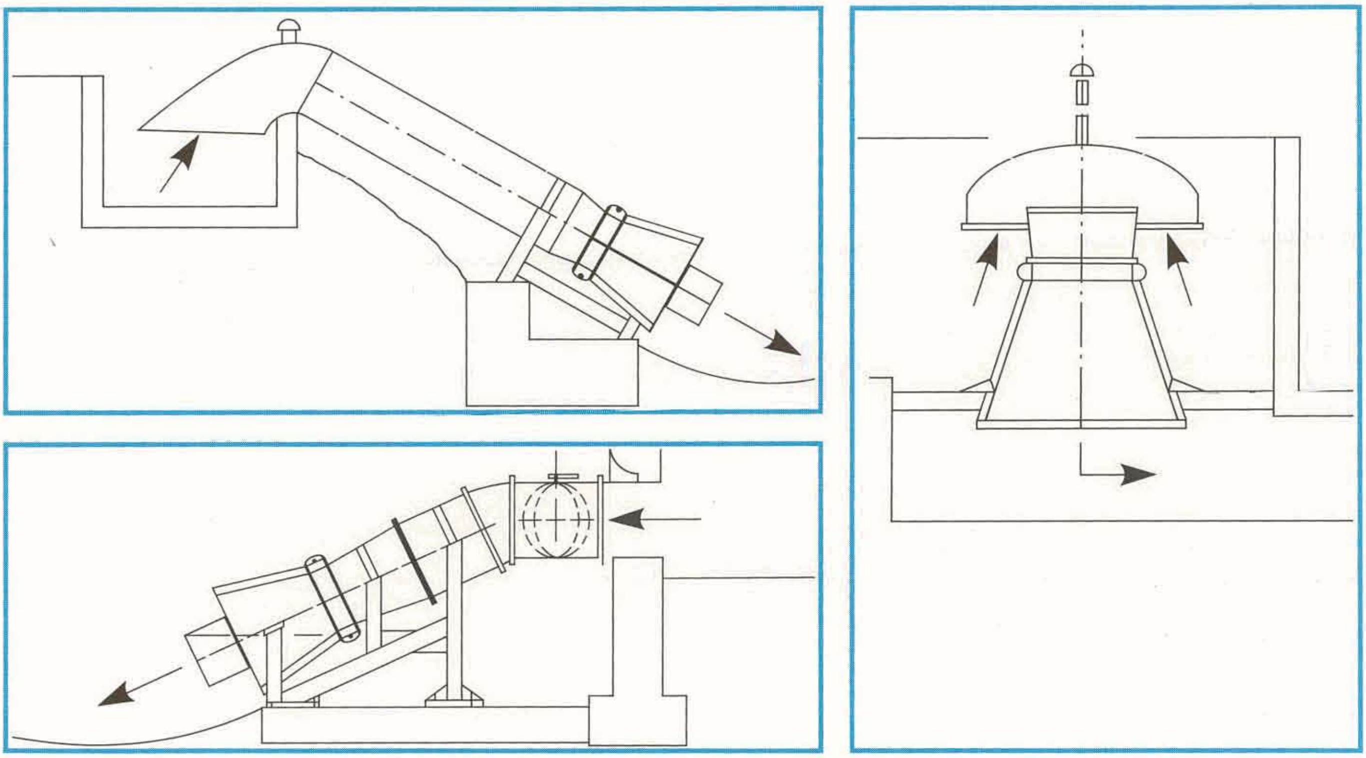

Figure 7: **Schematic arrangements for a "Hydrolec" turbine-generator system.**

speed. These controllers usually sense changes in frequency of generated electricity and respond by reducing or increasing the rate of flow to the turbine. Sizes up to 25kW are readily available.

Sources of Hydraulic Turbines and Hydroelectric Systems

Following is a list of manufacturers and/or marketers of modern small-scale hydroelectric equipment. The author hopes that the list includes all firms, particularly those in the Pacific Northwest. However, inclusion of a name on the list is intended for information purposes only and in no way constitutes an endorsement by the author, the Washington Water Research Center or the conference. The list considers only units smaller than 200kW. ▮

Sources of Hydraulic Turbines and Hydroelectric Systems

1. **Allis Chalmers** **Hydro-Turbine Division** **Box 712** **York, PA 17405**	(Tube Turbines, Hydroelectric systems, 30kW-100kW).
2. **James Leffel & Co.** **Springfield, OH 45501**	(Propeller and Francis turbines, 0.5kW-200kW).
3. **Karlstads Mekanista Werkstad** **Fack. S-861 01** **Kristinehamn, Sweden**	(Horizontal and Vertical shaft propeller turbines, 50kW-1800kW).
4. **Ossberger-Turbinenfabrik** **D-8832 Weissenberg** **Posttach 425** **Bayern, West Germany**	(Mitchell—Banke cross flow turbines, 1kW-1000kW).
5. **Sorumsand Verksted A/S** **N-1920** **Sorumsand, Norway**	(Francis and Tube Turbines, 100kW-10,000kW)
6. **AB Bofors-Nohab** **S-4601 Trollhattan** **Sweden**	(Horizontal and Vertical propeller turbine generator systems, 100kW-2000kW)
7. **Gilbert Gilkes and Gordon, Ltd.** **Kenda, Cumbria LA97B2** **United Kingdom**	(Impulse and Francis turbines, 10kW-50kW).
8. **Drees and Com, Gmbh.** **4760 Werl/Westf.** **Postfach 43** **West Germany**	(Kaplan, Francis and Pelton turbine generator systems, 10kW-5000kW).
9. **Maschinefabrik Kossler Gmbh.** **A-3151 St. Polten** **St. Georgen, Austria**	(Francis turbine generators, 12kW-1250kW).
10. **Briau S.A.** **B.P.43** **37009 Tours** **Cedex, France**	(Francis and Propeller turbine generators, 4kW-50kW).
11. **Independent Power Developers** **Box 1467** **Noxon, Montana 59853**	(Pelton and Propeller turbines/turbine generator 0.1kW-800kW).
12. **Small Hydroelectric Systems** **P.O. Box 124** **Custer, WA 98240**	(Pelton turbine generators, 5kW-25kW).
13. **Northern Waterpower, Inc.** **P.O. Box 49** **Harrisville, NH 03430**	(Horizontal propeller turbine generators, 20kW-300kW).
14. **Canyon Industries** **5346 Mosquito Lake Road** **Deming, WA 98244**	(Miniature, low-head turbine generators, .05kW-0.75kW).
15. **Small Hydroelectric Systems and Equipment** **15220 S.R. 530** **Arlington, WA 98223**	(Pelton turbine generators, up to 25kW)
16. **Short Stoppers Electric** **Route 4, Box 471B** **Coos Bay, OR 97420**	(Pelton and Banki turbine generators, up to 50kW)
17. **Little Spokane Hydro** **Chattaroy, WA 99003**	(Pelton, Propeller, and Kaplan turbines/turbine generators, up to 50kW)
18. **GSA International Corp.** **223 Katonah Avenue** **Courtyard Building** **Katonah, NY 10536**	(Pelton, and modified Francis turbine/turbine generators, up to 25kW)

(The text of Mr. Petterson's speech was not available at the time the Proceedings were published. You may contact him directly for information regarding it.)

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Financial Environment for Entrepreneurial Development of Small Hydroelectric and Cogeneration Projects

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R. Scott Clements recently established a financial consulting service to advise public and private agencies on financial management generally as well as on financing for alternative energy, pollution control, and economic development projects. Mr. Clements has seventeen years experience in commercial banking, with particular expertise in investment, hybrid financing, public finance, and funds management. His last position was that of senior vice-president and manager of the Bond Investment Department of the First National Bank of Oregon. His previous positions were with the Atlantic National Bank of Jacksonville and Hartford National Bank and Trust Company. Mr. Clements received his B.A. in economics from Dickinson College and his M.A. from Trinity College. He also graduated from the Stonier Graduate School of Banking at Rutgers University.

Summary of Presentation

The entrepreneur and the utility approach potential electric generation projects with very different orientations. The entrepreneur, whether a public or private entity, values a potential project in "marginal value" terms. The utility approaches the same transaction from an "average cost" perspective. Resolution, of these divergent starting points, is the first challenge to be met in bringing an entrepreneurially sponsored project to fruition.

Despite differences in orientation, identities of interest far outnumber the areas of difference between the entrepreneur and the utility.

Both the entrepreneur and the utility bring value to the bargaining table. The utility brings its vast experience of the project development process, its ability as an operator, the potential to limit the risk of the entrepreneur and the resources to support a project through its "seasoning stage". The entrepreneur, in turn, can contribute additional resources in time and talent to development of new projects, capital resources often outside those available to a utility and the potential for "off balance sheet financing". Recent PURPA regulations have, in the case of investor owned utilities, removed many of the historical differences relative to pricing philosophy.

Differences have and will continue to exist. Generally speaking, these differences focus around the specific terms of the power sales contract and in most instances they represent differences over degree rather than direction. One additional complicating factor, in the Pacific Northwest, is the distinction in power costs between investor owner and publicly owned utilities. The entrepreneur faces a very different set of needs depending on which type of utility he is negotiating with.

Mutual understanding of each party's orientation and needs, permit the development of accommodations which, in short, allow the process to progress. The non-utility entrepreneur is a fact of life in electric production. The utility is the primary vehicle for marketing available production. Acceptance of these realities and mutual determination to develop productive capacity are necessary ingredients in development of alternative energy resources in the Pacific Northwest. ▮

(The text of Mr. Durham's speech was not available at the time the Proceedings were published. You may contact him directly for information regarding it.)

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James Durham is a senior vice-president, general counsel, and secretary of Portland General Electric Company. He was previously the senior chief counsel and deputy attorney general of the state of Oregon. Mr. Durham serves on the Administrative Law and Corporate Counsel Committees of the Oregon State Bar Association. He received his B.S. in business administration from Pennsylvania State University, his M.B.A. from the University of Portland, and a law degree from Dickinson School of Law.

(The text of Mr. Johnson's speech was not available at the time the Proceedings were published. You may contact him directly for information regarding it.)

Lee Johnson
External Affairs Director
DOE Region 10

Laura Pilz

Assistant Vice President,
Utilities/Telecommunications Systems,
Bank of America

(The text of Ms. Pilz' speech was not available at the time the Proceedings were published. You may contact her directly for information regarding it.)

Joanne E. Devlin

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Joanne E. Devlin is senior vice-president of the Public Finance Department of Donaldson, Lufkin and Jenrette. Her principal responsibility is energy project financing. She has worked on public power issues for American Municipal Power-Ohio, Platte River Power Authority, National Rural Utilities Cooperative Finance Corporation, Piedmont Municipal Power Agency, and the Piqua, Ohio District Heating Project. Miss Devlin is a co-author of the article, "Geometric Debt Service." She received her B.A. in medieval history from Swarthmore and her M.B.A. from Columbia University.

Project Financing for Alternate Energy Resources

Scarcity of oil has prompted a national effort to develop alternative energy resources. Such resources are attractive because they are environmentally benign but they present challenging financing problems.

The federal government is certain to continue its role of encouraging alternative energy technologies but even the government's resources, though large, cannot provide all necessary capital to support a national alternative energy program. Ultimately, energy alternatives which demonstrate economic feasibility must and should be developed privately.

Hard-headed investors will not invest in alternative energy technology, regardless how socially desirable, unless prospective investment returns are commensurate with risk undertaken. Since many such technologies are in the experimental or developmental stage, without any operating track record, corporations and municipalities will be reluctant to expose their financial credit to such projects. Creative financing structures will be necessary in many cases to make even the most promising alternative energy technologies financeable.

Typically, project financings run the gamut from leveraged leases involving strong industrial credits and resulting in financing costs significantly lower than the cost of high quality debt, to oil and gas drilling programs in which the risk of a dry hole is substantial and investors must be highly compensated.

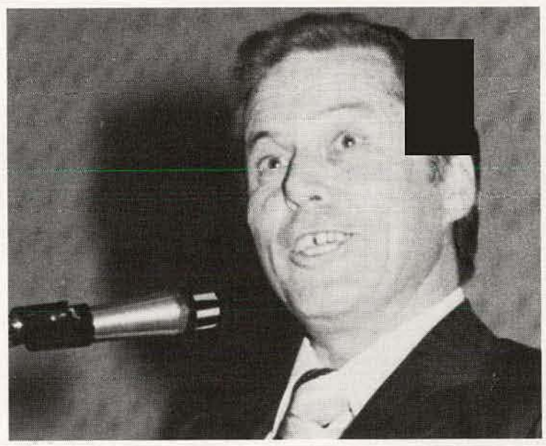
The sponsors of any alternative energy project will experience the same stages of development as a company moving from the initial venture capital stage to substantial credit-worthiness. In the initial stage of a project, the sponsor will discover that an investor will expect, as compensation for the risk of not being repaid, to be given the lion's share of income if a project is successful. As the feasibility of a technology becomes more readily demonstrable, the willingness of the investor to share the revenues with the sponsor will increase. Once a technology reaches the stage of established performance, the sponsor of a proprietary technology may expect to become a full financial partner with the capital investors.

In determining the parameters of a financial package for a speculative alternative energy project, oil and gas drilling programs are instructive. Typical arrangements include the provision of all necessary funds by investors who receive 85 percent of revenues and all tax benefits, the remaining 15 percent of revenues being paid to the project sponsor, who also supervises the program. An alternative arrangement would be to pay all revenues to capital investors until payout and then pay 25 percent to 30 percent of revenues to the sponsor.

A more fully developed alternative energy technology further along in the development stage with proven revenue developing capability may be able to be financed by the issuance of debt at reasonable rates, as long as sufficient equity exists in the project to cushion the risk that revenues will not cover debt service. A technology reaching this stage of development has, for all practical purposes, proven itself in the marketplace and is at or near the point where competition will occ for the right to exploit it.

Even though financings can be arranged along a spectrum as indicated above, this does not mean that a financing package is available for every alternative energy technology. Before any financing can be arranged, it will be necessary to have feasibility studies prepared by the most qualified available professional firms projecting possible economic results from exploiting that technology. Such studies will often demonstrate that the technology offers no reasonable likelihood of economic success on any basis. Many technologies, such as large-scale solar, wind, wave, and ocean thermal energy conversion, would not currently provide energy output at an economic value remotely justifying necessary capital expenditure. It is in these areas that government subsidy is indispensible if the technology is to be pursued to the point where costs can be reduced and investment return brought into the area of feasibility. ▮

The Role of the Small City in Alternate and Renewable Energy Sources



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As the City Administrator of Bandon, Oregon, I am here to inject government into this conference. I am also a representative of those people whose responsibility it will be to implement all of the measures we've been hearing about in the last two days. The field of Alternate and Renewable Energy is no different from many other areas of scientific endeavor. The theory is sound, however a large gap remains between that sound theory and practical and realistic implementation.

A small city can be a composite of the successes and problems that any size community will face as it looks for practical and realistic ways to implement energy conservation. Bandon does represent this but in two very important areas Bandon is not a typical small city. We are our own electric utility company and we are blessed with one of the best wind areas in Oregon. These are important factors to keep in mind as we examine the city's energy efforts. The City of Bandon has approached energy concerns in several areas including Planning, Policing, Public Education and Research.

The City is looking at the entire range of planning regulations. We are trying to encourage subdivisior housing orientation so as to maximize the passive solar possibilities. We are looking at the necessary regulations to implement solar easements to ensure solar access. We also have looked for necessary State laws which would allow us to implement wind easements. Unfortunately like many other things associated with wind, there are none. Government lags behind technology.

When talking about conservation and alternate energy we inevitably get around to the power to implement. A municipal corporation has the police power that is necessary to implement these measures. These powers include planning, zoning requirements, building and utility regulations. In these areas a city has substantially more power than a utility. In Bandon we are requiring strict enforcement of the building regulations to ensure maximum conservation potential for all new and rehabilitated dwellings. We are looking at ways we could supplement the building codes to increase the energy efficiency of homes. We are beginning to look at rate structures which would provide rate disincentives for people with inadequate insulation and incentives for people who voluntarily reduce their peak demand.

The ability of the City to tie utility rates to conservation goals by using police powers provides substantial benefits. The problem of getting these types of regulations accepted by the City Council and Planning Commission is easier in Bandon since energy is a City function. On the other hand the time necessary to validate the effectiveness of these regulations is scarce and public acceptance of this type of regulation is slow. The type of disincentive BPA is providing is assisting to make conservation more palatable. It will not accomplish the job but can provide the impetus for regulations that could not be implemented just a couple of years ago. We still run into public reaction when we restrict ones use of land. This can only be overcome by public education.

The importance of government involvement in public education of energy conservation should be emphasized. The City of Bandon is accumulating all available data on all forms of solar energy conversion. We are using our public library as a depository for this information, thus providing a local source of information for people interested in installing alternate energy devices. We disseminate information with our monthly utility bills and through the local newspaper. We keep our utility staff, charged with doing energy audits, aware of the technology so they can assist customers.

Finally, the City of Bandon has entered the area of energy research in a limited but important way. With Coastal Energy Impact Program funding we have been measuring wind speed since March 1980. Our wind resource looks very promising. From March 19 through September 30, 1980 our average wind speed has been 13.9 miles per hour with winds over 13 mph occurring 47.3 percent of the time. The winds over 13 mph had an average speed of 22.6 mph. Our winds also have a distance diurmal pattern. From noon until about 6 p.m. was 21.1 mph while from 11 p.m. to 7 a.m. it was 8.5 mph. Thus, due to our diurnal pattern our winds may be better than indicated by the arithmatic average.

We have four basic problems in implementing a WECS: Available technology, Financing, Legal and Environmental, and Flim-Flam operations. It continually amazes me that the use of WECS is so old and yet from a technological standpoint research and development of WECS is virtually nonexistant. There are a plethora of small WECS on the market and most of them claim to be cost effective and a panacea for our energy woes. Most of them are expensive, untried and sold to anybody that has the money.

The testing on small WECS looks like an encyclopedia compared to large utility size machines. This lack of hard data is one problem when looking at the capital investment needed for utility size WECS. When you combine the current high cost due to lack of production run machines with the gamble involved from lack of test information on reliability and maintenance data, it becomes problematical to consider this type of investment.

Financing and the accompanying tax incentives also become a major factor in considering any WECS. For a small WECS owner the state and federal tax incentives can make the difference between economic viability and financial folly.

Financing for large WECS or wind farms is even more dependent on tax incentives unless it is a public relations gimmick. There are many facits to tax incentives ranging from investment tax credits and depreciation to advantages in the utility regulation process. Unfortunately, for a municipal utility which pays no taxes the current tax incentives are of no advantage. One could say that since municipals pay no taxes and have access to cheaper money via municipal bonds that this is ample support. However, you are asking for municipals to gamble. This is a very difficult position to put locally elected officials in. You are basically saying that a municipal, in order to enter the alternate energy field, would have to abandon their historic pattern and gamble while private industry, with the various incentives, can recover the cost even if it proved uneconomical.

From a legal and environmental standpoint there are questions but virtually no answers. Wind rights legally don't exist. How one protects himself is something that needs to be legislated. This is not as big a problem when considering utility size machines as small WECS because utilities can protect themselves by purchasing land. Individuals particularly in urban situations, may be gambling on what will occur on surrounding lands so that a WECS does not become useless, is a necessary step if small WECS are going to be used to any extent. The second major problem is aesthetics. Small WECS in urban environments again pose the greatest problem. This problem is acute in a vista oriented area like Bandon. The changing of zoning codes can be done, but to what extent you allow view blocking, even as minute as it may be, is a problem that must be addressed.

Perhaps the most damaging thing to the future of wind energy are the hucksters and flim-flam artists that seem to be prevelant. This problem exists because of the lack of research and development, hard data on wind resource and the recent awareness generated by the campaign for alternate energy use. The hucksters take different approaches but basically prey on peoples genuine concern and use this concern to sell equipment. In large WECS operations the hucksters are mostly involved in purchasing wind rights for supposed windfarms. Whether they are trying to tie up the resource for future sales or as a gimmick to sell their own wind machines, they represent quick money, fast schemes with no real care for, or anticipation of, economic generation of electricity. Consumer protection in the area of energy conservation is one which government may yet have to speak to.

Small cities will continue to play an important role in the field of alternate and renewable energy. As a microcosm of communities throughout this nation the small city represents both hope and challenge for the future. ▮

Making the Transition to Alternative Energy Systems: Cooperation in a Metropolitan Area

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Mr. Enbom is president of Air Control, Inc., an air conditioning firm he founded in 1962.

The title of this panel, "Making the **Transition** to Alternative Energy Systems," really is intriguing. I believe the word transition is especially appropriate for what is happening in energy today. We are moving from an energy management system that has been successful for almost half a century, into a new way of managing energy; a way which relies upon new technologies, new public interest groups, new financing methods, and new members in the energy community to meet new challenges. We who are new team members are eager to work alongside those who for decades have provided us with one of the best and most reliable electrical energy systems in the world. I appreciate very much this opportunity to discuss with you renewable energy resources, the role of local governments in developing them, and the new definition of "business as usual" in the development of energy in the Pacific Northwest and throughout the nation.

As a businessman and president of my own corporation, I like many others have been overwhelmed with the new demands for marketing products including the demands of state and federal regulations. Purchasers now believe that my product must not only suit their needs for the intended use, but also be developed and supplied in a manner acceptable to their environmental, social and economic beliefs and philosophies. At the root of this, I think, is a very powerful special interest group. This interest group has emerged upon the scene within the last ten years. This group I call TAPP; T, A, P, P. TAPP stands for technology, accidents, passion and politics. And while this pressure group is not organized or chartered, it has achieved a far reaching consensus across our region, and in fact the nation. Most of our citizenry believes, reacts to, or supports one or more of TAPP's components—technology, accidents, passion or politics.

The technological advances in the last decade have been enormous, especially in the field of energy. Briefings by top level personnel in the U.S. Department of Energy Solar and Conservation branch have disclosed that within the last six months major breakthroughs in solar photovoltaics have occurred. These breakthroughs are expected to allow incredible new electrical generation devices—everything from cost effective hot water heaters to electrical generation on people's roofs. These devices are not only capable of supplying energy for household but actually producing sufficient amount: energy so that it may be cost effective to integrate it into regional grids: a concept called solar shingles.

It is just overwhelming to me that six months ago the U.S.D.O.E. was saying photovoltaics are five to ten years away and now they're saying "They're here." The only thing we are waiting for is the tooling and dying necessary to manufacture and process these devices on a full production scale. The advances in computer sciences have also been tremendous. Con-Edison and the Bonneville Power Administration currently use computer applications to maximize energy savings in the development and transmission of electrical energy. This technology may also allow conservation through peak rate pricing and will also allow effective monitoring of contingency plans for electrical energy and other energy forms.

These technological advances perhaps more than anything are changing the way we do business today.

The second component of this new pressure group is accidents. Referring back to my previous example on solar technologies, where one day we're looking at ten years, the next day we're looking at a year or two, tells me that the only way this discovery was made was through an accident. The nuclear industry and the results of the famous Three Mile Island accident we're all aware of and I won't belabor any longer. Accidents do not have to be large in magnitude or be the results of things uncontrollable by man. For example, a dinner party at the White House for some congressmen, scheduled at the last minute, resulted in one man being able to stop passage of the Pacific Northwest Power Bill before adjournment for elections. Examples are numerous, I could go on at length. Accidents do affect the ways we do business.

The next component—passion—the way people feel and believe about things. This is the driving force in most of us that causes us to replace economic reasoning with something else—comfort, beauty, or even fantasy. It is the reason soft drinks are marketed as "life," barraging the American public with commercials with rural and pristine environmental scenes, all in order to sell more soda pop. Well, the American public may be having a difficult time accepting major electrical generation resources. However, I'm told by our friends in the soft drink business that the American public has accepted Coke as "life." It is this component of passion that causes us to react to accidents, technologies and commercials and thereby change the way decisions are made and the ways goods are marketed. But I wish to repeat again that passion affects the ways decisions are made.

The way decisions are made brings me to the last element in what I perceive to be the new and most powerful pressure group. This element is politics. Passions, technologies and accidents all affect the way people vote, and the way people vote affects the way decisions are made. This country still is a nation of laws passed by representatives of the people, and what people believe (fantasy or not) is what our laws represent. Our laws are the rules and guidelines we're all expected to manage our businesses within. Gone are the days when I could run my business solely based on the most cost effective approach. I must now take into account the way people think, including the way they think as manifested in laws and governing ordinances, a result of political decisions.

What has happened to all of us who are in one way or another involved with energy? It has meant that we need to be sensitive to, and aware of, the components of TAPP and continue to manage by exercising sound economic and technical judgment in light of these new awarenesses. And, all in all I think we're doing a pretty good job. I say this because rather than reacting emotionally in a disorganized fashion to these new issues and pressures, the energy community decided to start where it should, at the policy level, in fact in the Congress of the United States of America. For four years we've been drafting what is called a Pacific Northwest Power Bill. It has received input from almost all segments of our society, and from the perspective of local governments in the Puget Sound region, it has resulted in a compromise that doesn't excite anybody too much but at the same time doesn't appear to be unlivable either. I think this is an indication of what all good bills in Congress are—a political consensus where everyone can operate and do what they need to do without hurting anyone, and with the end result ensuring the supply of important goods and services to those who need them.

Some very important findings of the bill include that all energy resources are important and should be developed as necessary, and that conservation and renewable resources are the number one priority.

The Puget Sound Council of Governments, its local government members and local governments throughout the nation are very eager to help in the ways that we can to establish renewable resources as a supply of electrical energy. Cities have wastes that can be burned; many have small scale hydroelectric potential in their water systems; some can help in some of the more exotic renewables such as geothermal and solar. In this regard we hope to be a significant contributor to our utilities in developing renewable resources and in meeting the challenges of the new way of doing business.

Even in this ever changing world, some things remain the same. One thing that has stayed the same, for which we can all be grateful, is the teamwork and cooperative participation that local governments and utilities have enjoyed since the inception of electrical utilities.

At a recent conference I had the opportunity to hear from a university professor, a scholar in the history of electrical utilities, some remarks that helped me greatly to appreciate the importance of a local government/utility team. He said that when Thomas Edison was establishing the first electric utility, a private utility, his first customers were municipal governments. Shortly after the turn of the century 95 percent of all the motorized transportation vehicles in this nation were electrically powered, most of these being trollies in cities and towns.

To be reassured of the viability of a working local government/utility team, we have only to look into our own history of electrical power in Washington State. Through the cooperation and support of general purpose local governments in Washington State, special purpose local governments, that is Public Utility Districts (PUD's), now distribute, in cooperation with municipal utilities, most of the electrical energy within Washington State. The county in Washington State in which the City of Mountlake Terrace is located is Snohomish County. I can personally say that the cooperation between the Snohomish County Public Utility District and the local governments which it serves has been excellent. Now with the new challenges that are ahead, we are working together even more earnestly.

The specific ways in which local governments can help utilities implement renewable resources are, in my opinion:

1. local governments can complete inventories of the potential renewable resources they own or have available to their municipal operations;

2. they can help to spearhead public information campaigns, helping the general public to know and appreciate renewable energy resources and informing them what local governments and utilities are doing to bring them about;

3. they can streamline ordinances and other regulatory mechanisms at the local level to aid in the development of renewable resources;

4. they can form coalitions to help pass state and federal legislation to provide financial incentives for developing renewable resources; and

5. local governments can improve their operations by sharing with utilities the economic benefits of renewable resources.

In the sharing of benefits we know our good friends in the utilities to be excellent accountants and dollar watchers. We appreciate the fact that when they enter into contracts with local governments, it is a business proposition. In this same way, we also appreciate the respect of local utilities when we enter into renewable resource agreements, demanding, in a businesslike manner, that we share the benefits.

Another reassuring thing about the local government/utility team is that we need not be the only members on the team. If the Pacific Northwest Power Bill passes, BPA will become an important member. The Puget Sound Council of Governments labored long and hard to write amendments to the bill that require BPA to provide technical and financial assistance to local governments to plan for and participate in the areas of energy where we can help. The Bill also allows BPA to provide for the planning, design and evaluation of potential local government energy resources such as solid waste and small scale hydro; and allows local governments to share in the benefits of conservation and renewable resources with the utilities through the direct credit mechanism. Also importantly, the Bill allows BPA to serve as a potential market for conservation and small scale resources where it is to the local governments' and utilities' benefit to meld the production costs of these resources into the regional rate base.

I know at least 56 local governments in Washington representing over half that state's population, our PSCOG members, who will be aggressively pursuing this technical and financial assistance for their communities and will be striving to implement energy programs as soon as possible after the bill is in effect.

Conservation and renewable resources are like any other resource development project; they will require money for their planning, design and implementation. The planning and design cost for renewable projects will likely be proportionate to construction costs in the same way they are for major resource projects. The check and balance, of course, is that only cost effective projects can be implemented, and we in local government think that is good.

We do promise to help in the ways we can, to take advantage of the provisions in the bill and to implement cost effective resources wherever and whenever they occur within our operations or sphere of influence. We look forward to continuing the cooperative teamwork with utilities in striving to implement these resources. I personally believe the new challenges to the energy community can be met and that we may even find it to be a rewarding experience.

Thank you for your kind attention and this opportunity to share the optimism of local government for renewable energy resources. ▮

Remarks

I would like to approach, from a totally different angle, where we are on the alternative resource development program. For six years now, our utility has been actively engaged in attempting to bring on line numerous alternative energy resources. All the things I've heard today, what I've read—and I've attended so many meetings in this area—are merely repeats of almost the first meeting. What we need to address now are the solutions to the problems that have been so eloquently addressed.

I have some little catch words, too, that I use. It's RRB/P—regulations, red tape, bureaucrats and politicians, not necessarily in that order, because a lot of politicians that I've known for the 33 years I've been in basic government and the utilities, in fact almost all of them, I can honestly say, have done what they felt was right and what the people wanted. But, one of the problems that elected officials have is translating what the people want into laws that can then be translated into action. That's why they hire people like me, why they have staffs, why they have regulations—to make these things come true. In the beginning, this worked because it was relatively simple. We only had a few elements that we were concerned with. However, in the past ten years, many things have changed. From what John Enbom has said, he was not even interested in energy ten years ago. He is now, thank God. I hope everybody begins to be interested in energy. This has been a long, hard road. But, would you believe, the people in this room are a very small minority of the people that actually understand our problem. Why is that true? Because we've always solved our problems, and besides, the politicians tell us each time that these things are going to be corrected.

Let me give you some examples real quickly. Six years ago, we made application for three dams that were already built, just to put some generators in there. I'd like to announce that we finally got the preliminary permit to begin the study and a lengthy regulatory process that you can't believe.

In 1976, we put on line a cogeneration plant. Everybody in the whole country said, "Oh, man, you've really got something new." There's nothing new about that. That's what we started 50 or 60 years ago.

Our problem is that people have this thing all out of balance. We need to look at it from the perspective that in the next ten years in this region, we've only got two things to keep us from going in the dark—conservation and small energy projects, which means that everybody's got to put something in the pot. I mean everybody. "Big Daddy" can no longer take care of these needs. We've got to do something to get the message across that we can no longer afford laws that go into thousands of pages of regulations that cost hundreds of thousands and millions to try to interpret—for what? We could have done a lot with the $1½ million our utility is going to spend to implement PURPA and NECPA.

Okay, I can't give you jokes because I'm serious. It's time we refocus and recognize that something can and must be done about these problems. The economics are catching up very fast. We have to make some choices and some trade-offs. Anything man does is going to spoil the environment in some way. We're going to have to decide what those levels are, but we've got to make these decisions now. The amount of work that we're going to have to put into getting a 24 megawatt project completed is almost as big as if it were 240 megawatts.

I just want to leave you with one thought. I hope the next conference deals with what has been done to solve the problems facing us now and what we can do to actually solve any problems in the future rather than outlining them over and over. Thank you.

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The Role of the State in Promoting and Coordinating the Near Term Development of Alternative and Renewable Energy Resources.

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Ted J. Doney was appointed director of the Montana Department of Natural Resources and Conservation in March 1978, after serving as deputy director and chief legal counsel for the department. He also served as staff attorney for the Executive Reorganization Office and as staff attorney for the governor. Mr. Doney received his B.S. in mathematics and economics from Montana State University and his law degree from the University of Montana Law School. He is currently working on his M.P.A.

Traditionally, the role of state government in energy has been limited to the leasing of land for exploration and extraction of fossil fuel resources and to utility regulation. During the last several years, state government's involvement in energy matters has grown primarily in response to the disruptions in the energy supply and distribution system. This expanded role has resulted in a number of government functions and programs including energy conservation programs, energy forecasting, facility siting and energy policy analysis.

State energy agencies received mandates for these new functions and programs from diverse sources ranging from the state legislature, Department of Energy, and the Congress. In specific instances, certain energy functions and programs have been generated within the agency, because state energy officials have perceived their need independently of an external mandate. In Montana, the mandates for the principal energy programs and functions have been received from the federal government and the legislature. Montana's conservation program is totally funded by the U.S. Department of Energy and its facility siting functions are established by statute and maintained by state appropriation. Energy emergency planning is generally required by both the state and federal government. However, policy analysis, energy data collection and analysis and the energy planning function in general have evolved under the direction of the Executive.

The growth of Montana's Energy Division in the Department of Natural Resources and Conservation has been to provide the state with the capability to respond to energy developments affecting activity within the state. The response is generally reactive in nature. State initiative in the area of energy planning has been limited; however, the very events that require state response also emphasize the need to strengthen state initiative in energy planning.

In contrast to the relative lack of initiative of state government in energy planning, the federal government has a history of energy initiatives dating from the founding of the Tennessee Valley Authority, the Bonneville Power Administration, the Rural Electrification Administration, and the Federal Power Commission. These agencies served to implement a national policy of electrification. Similarly, the federal government initiated various policies and programs to promote the production and utilization of petroleum. The economic activity of the post war era promoted an expanded role for the national government in technology research and development. The creation of the Atomic Energy Commission, the Energy Research and Development Administration and, finally, the Department of Energy (including the national laboratories and the Solar Energy Research Institute) represents the federal government's interest in energy technology research, development and demonstration.

The initiatives that the federal government has taken in energy matters have been beyond the scope and resources of state government. State governments simply lack access to funds and expertise required to implement major energy initiatives especially in the realm of energy conversion technology. Perhaps the crucial factor which has promoted federal rather than state initiative is the centralized and fairly homogeneous structure of power supply systems across the United States. Government participation in the development of such an infrastructure requires massive investment of public funds, a highly trained bureaucracy and a close relationship with national energy firms. State governments simply have not been appropriate institutions for the development of this infrastructure.

Moreover, the federal government has had no overriding reason to involve state governments in its energy initiatives on a partnership basis.

The mandate received by the states from the federal government during the last several years expanding the role of state government in energy issues has not been intended to involve state government in the federal government's conventional energy supply programs. For example, the federal government generally does not request state government participation in nuclear supply technology development or in synthetic fuel technology development. In fact, Montana's experience has been that the DOE has kept state government at arms length in the recent deliberations to choose among the various synthetic fuel proposals.

On the other hand, the federal government has been more than willing to have the states take responsibility for the impacts of energy supply projects promoted by the federal government and to shoulder responsibility for disruptions in the energy supply and delivery system. The federal conservation programs, and the energy emergency programs testify to this federal attitude toward the states. Federally initiated renewable energy programs such as Western SUN which depend upon state involvement are not really departures from this attitude. Federal renewable energy R & D supply programs generally do not require state participation. Commercialization programs such as Western SUN are principally efforts to supplement the current energy supply system to insure a greater degree of reliability.

Essentially, the impetus for state involvement in energy affairs has been as a response to the disruptions in the operation of existing energy supply and distribution system. In short, although the infrastructure of that system is highly centralized, the impacts are decentralized, requiring state and local government involvement.

Now that state governments have become increasingly involved in energy matters, there is a growing concern among state energy officials that the nation has made a series of mistakes by managing such programs as energy conservation through the federal bureaucracy. Concurrently, these state officials are becoming convinced that state and especially local governments will need to take a greater initiative in planning their energy futures and that current energy problems can ultimately be solved only by a shift to a sustainable energy future. Sustainable energy refers to energy conservation and the utilization of renewable energy resources. A sustainable energy infrastructure would probably depend upon the dispersed application of site specific renewable energy technology. However, substantial capital investment in renewable energy systems will probably occur once conservation opportunities have been pursued. The pursuit of a sustainable energy future can begin in earnest with the establishment of community energy management programs.

Recently, many of Montana's communities have recognized the need for such programs. In Montana, as elsewhere, the inflationary rise in energy prices has placed an increased burden on government budgets. According to the Energy Report for 1979-80 released by the City of Helena, the cost of energy to the city increased $31,703 from FY 77 to FY 79 (or 13 percent) and the cost of energy is projected to increase $182,509 from FY 80 to FY 81 (or 40 percent). The tax base for the same time period is expected to increase less than 5 percent each year. At a minimum, local governments require a management program to trim their own energy costs. A community energy management program, however, would address community-wide energy consumption.

Local governments make decisions that significantly influence energy consumption in the communities. They control land-use planning, which in turn affects energy consumption. They undertake transportation planning—decisions about mass transit systems, parking facilities, traffic flow patterns, and bikeways affect energy consumption. Local governments also enforce building codes which directly affect energy consumption. Nonetheless, except for a few instances, Montana's local governments have lacked the information and resources to incorporate energy considerations into the execution of their traditional responsibilities.

The goal of Montana's Energy Extension Service program is to develop energy planning capabilities of local governments. During its first year the program will award four $20,000 community energy planning grants to four of Montana's ten largest cities on a competitive basis. In addition to these grants, the state EES program will provide technical assistance to all communities interested in energy planning through libraries and the cooperative extension service. EES will train local librarians to be knowledgeable about sustainable energy publications so that local libraries can become technical reference centers for energy. EES will also use the local cooperative extension service to train volunteers as "Master Conservers." Master Conservers will answer questions about renewable energy use and energy conservation phoned in by local residents. EES will also cooperate with banks and contracting firms to increase the energy efficiency of both new and old buildings.

If community energy planning is to become a reality throughout Montana's 126 incorporated towns and cities and 56 counties, sound information is required about the feasibility of sustainable energy options in Montana in the near term. Sound methodologies for examining current energy use and for determining appropriate sustainable energy options within a particular community must be made available. In the near future the Energy Division will begin the Montana Renewable Energy Viability (REV) Project to meet these needs. The design report for the REV Project has already been prepared and released.

The REV Project is designed to facilitate the implementation of existing state energy policies. It is designed to both draw upon and contribute to state energy programs in the areas of energy conservation, renewable energy sources and general energy plannings. The project will develop information regarding a possible energy future which is more reliant on energy conservation and renewable energy sources. Using a range of techniques, the REV Project will examine conditions at the state, local, and private levels. The project does not presuppose that some level of Montana's energy needs should come from sustainable sources. Its task is to develop information which will permit conventional and sustainable alternatives to be compared, using the same criteria. The project will focus on the intermediate future, from the present to five to twenty years ahead.

The REV Project will investigate various aspects of the transition to greater reliance on conservation and renewable energy. The most innovative aspect will be four case studies of "model energy communities," communities competitively selected from the cities, towns, counties, and Indian reservations of Montana. These studies will examine the human response to the transition, a factor just as important as the economic and technological viability of conservation and renewable energy. The REV Project also will assess patterns of energy end-use projected over the next five to twenty years. It will develop working estimates for the amount of each major renewable energy resources in Montana, survey the technologies to use those resources, and then will evaluate the possible economic, environmental, and social impacts of deploying those technologies on a state-wide basis.

The REV Project makes provision for public input and participation throughout the study. Members of the public were involved in developing the design report, and the public will assist in choosing the direction of various components of the project itself. In the community case studies, the public will be invited to actually participate in the study.

The REV Project will complement on-going state energy activities. The governor and the legislature currently depend on DNRC to prepare environmental impact statements on major energy facilities, to administer demonstration grants for renewable energy, and to run Montana's conservation program. The REV Project will make possible greater coordination among these activities. The study will improve the basis on which state officials formulate policies to guarantee Montanans adequate supplies of energy and continued economic development. The REV project is designed to be of use to local officials, private individuals, and businesses as well.

The REV Project will give Montana a more accurate assessment of sustainable energy futures. If Montana pursues a path toward greater reliance on renewable energy sources such as wind, water, and geothermal resources, their site specific nature, as well as the technology required to harness them, tends toward th development of dispersed small scale energy systems. Planning and implementation of these energy systems can certainly be accomplished at the local level if the local governments are prepared for such an undertaking. The State of Montana can offer the financial resources and technical expertise that local governments require to establish a comprehensive community energy plan. Local governments possess decision making powers that greatly influence community energy use. A coordinated state and local approach to community energy planning promises to be more effective than either the state or local government acting separately. One of the responsibilities of local government is to recognize the need for comprehensive community energy planning. Conversely, one of the responsibilities of Montana state government is to provide the assistance necessary to make local governments full partners in planning for Montana's energy future. ▮

Implications of Regional Energy Legislation for Renewable Resource Development in the Pacific Northwest

Earl E. Gjelde
Bonneville Power Administration
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Mr. Gjelde is the Assistant Administrator for Power Management, Bonneville Power Administration. He represents BPA with electric utility leaders in the Pacific Northwest and the Pacific Southwest, and with State and Federal Government organizations involved in energy planning and operations. He is involved with the entire spectrum of Federal electric power management: planning, acquisition, and coordination of new electric resources; marketing of Federal power, including wholesale power and transmission rates; and the operation of the Federal Columbia River Power System in coordination with non-Federal projects in the Pacific Northwest and Canadian projects under the United States-Canadian Treaty.

Our region faces many challenges. One of the most important we face is the one Mr. Munro left us with yesterday, and that is to lead the nation in the application of conservation and the development of renewable resources.

Not simply as an exercise to show it can be done; or as some kind of convenient national experiment—but because we **know** its the best way to go. Here in the Pacific Northwest, we know what it's like to live and grow with renewable-based energy—our tremendous hydro system—and we have been learning the lessons of shifting reliance onto fossil-fueled resources under changing economic and political conditions. It's not going to be less expensive, at least not in the short-run, but as our experience with our hydro has taught us it will be less expensive, and perhaps more acceptable, in the long run.

We have the experience, we have the lesson, we have the potential. The net result is that all of us have a special obligation to undertake all the renewable resource development possible, in a manner which is consistent with the lowest, long-run cost, consistent with preservation of environmental values, and consistent with using electricity as efficiently as possible in order to get the most out of our renewables.

I can assure you that we at Bonneville have lived the experience, we are living the lesson, and we understand the purpose.

In order to meet the purpose, it is up to all of us to redouble our efforts to assess resource potentials, and plan and develop projects which merit public support and which can help stave off our current deficiencies and build a solid future.

It is appropriate that we address the implications of the proposed Pacific Northwest Power Planning and Conservation Act during this conference because, passage or not, it represents a significant statement of broad Congressional interest. Also, it may very well pass this year, and it has major implications for the development of renewable resources.

Before I discuss some of the principal features of the Pacific Northwest Power Planning and Conservation Act which do bear directly on renewable and alternative resources, I think it might help to put matters in perspective by describing Bonneville's present authorities and, although limited, what we currently can do to encourage the development and integration of renewable resources into the regional power system.

Present Situation

Our participation and co-sponsorship in this conference is a sample of one of those ways—providing information, encouragement, and technical assistance.

Identifying or assessing what's possible, what's really achievable, is the core of that assistance.

But there are others, and in some ways more tangible ways, that we can facilitate the development of renewable resources under existing authorities. Bonneville can use the "storage battery" capability of the Federal Columbia River Power System to ensure that renewable resource projects, typically with periodic or intermittent output, can be usefully integrated into the regional power system. The extensive regional Federal transmission system provides the vehicle for integration. The services which we can provide to renewable resource sponsors are, although subject to certain planning and operational constraints, fundamentally these:

1. **Shaping**— what we call load factoring services to "shape" the output of a generating resource to enable its delivery at times and in amounts that conform to a

utility's total resource requirements to meet load.

2. **Reserves**—making the resource reliable for service to loads by Bonneville's providing certain amounts of power from the Federal system during times when the resource is unavailable due to a forced outage.

3. **Transmission**—Bonneville provides transmission of non-Federal power and system integration.

4. **Trust agent**—Bonneville may, under certain circumstances, act as a utility's agent in acquiring or disposing of power to ease the administrative overheads and burdens.

In some very limited circumstances, we can even buy the resources for a short period. Our present authorities to acquire power, however, are limited to short-term agreements to meet contractual commitments already in place. We have signed such agreements for up to 5 years. This can sometimes help assure the marketability of more risky or high-cost renewable resource and thereby increase the economic justification and feasibility of proposed projects. But a short-term commitment to acquire project output is usually not sufficient basis to attract the financing necessary to develop projects.

Besides these key services, we can assist in research and development, a further example of which you'll see this afternoon at Goodnoe Hills.

Under Section 210 of the Public Utility Regulatory Policies Act of 1978, or PURPA, the Federal Energy Regulatory Commission requires that electric utilities purchase electric energy and capacity made available by qualifying cogenerators and small power producers, which are typically renewables.

To comply with the requirements of Section 210 of PURPA and the implementing FERC regulations governing development of the system cost data from which "avoidable cost" can be calculated, Bonneville has applied a long-run incremental cost analysis to the power system. The results are representative of costs associated with new energy and capacity development in this decade. But regardless of our efforts and intent, Bonneville has such limited authority to purchase power that compliance becomes almost a moot point in terms of actual effect.

These limited services and assistance are unquestionably important and, in some cases, even necessary to the development and integration of renewables. But I'm sure many, probably most of you, have encountered the many frustrating things that seem to get in the way of achieving the broad-based, regionwide, extensive development of renewables we really need and want.

There are a lot of variables to cope with. Uncertainty with regard to the availability and cost of financing, the degree of load growth or need, construction schedules for already committed new thermal resources, prohibitions against the "lending of credit," perceptions of risk which encourage utilities to focus on other choices, Bonneville's principal services limited to only half the region, the preference customers, and recent court decisions affecting fisheries have all introduced additional complexities in making the policy decisions necessary to get the renewables moving as they should.

Coupled with these uncertainties are the standard myriad of laws, regulations, and procedures which must be followed when planning, constructing, and operating any single resource or group of resources.

Perhaps the greatest problem and certainly the most subtle one we face is a problem not even tied to renewable resources; it is an impediment to any conservation and resource development—that is, the uncertainty caused by our own allocation and the controversy sure to surround it. Effective and certainly cooperative planning is stymied in an atmosphere of competition and controversy. In spite of this we remain today, sure of the need, excited about the potential, encouraged by what we have seen and shared, yet, at the same time, frustrated too, because we have not yet settled the uncertainties and found the remaining tools we need to make it the success, I believe, the people in this region want and so desperately need.

Future Under Legislation

After 4 years of effort by many individuals and organizations, numerous hearings inside and outside the region by congressional committees, Senate passage of a bill in 1979, and House action by two major committees, and finally a joint House Committee proposal, the Pacific Northwest Power Planning and Conservation Act is now scheduled to be an early item on the agenda when Congress reconvenes November 12.

The proposed legislation goes a long way in providing this region, all of us, the tools we need to get moving, and get moving now.

—It settles the questions and uncertainties of allocation.

—It allows and encourages us to work together with common responsibilities and common purposes; not just through Bonneville or only one way, but through acting in concert—Bonneville, utilities, State and local governments, and all of us individually.

—It provides the mechanisms and the mandates to use our energy efficiently.

—It places the needed regional support behind the development of renewable resources. All renewable resources—large or small, those that generate or displace electricity, central station or dispersed, and those developed by a utility, a State or local government, or by just folks—simply any and all renewable-based resources.

—It makes renewable resources the first choice, right after conservation, and provides the mandates and tools to make it work.

—It makes the capital intensive (vs. high operating cost) renewable resources more competitive and mo[illegible] viable.

—It makes the risks currently associated with renewables more acceptable.

—It supports and thereby lowers the costs of ˜nancing.

—It provides the marginal price signals to utilities—freeing up local choices from any adverse impacts.

—It also provides the necessary safeguards: regional guidance and accountability through the Council and free utility choices, lowest rates through the cost-effective tests, protection of the environment, and full public involvement.

—It attempts to blend control and decisionmaking with the advantages of one-system support.

Well, enough of all those generalities about what I believe and hope the legislation does. Let's get down to specifics. It's a piece of legislation that is now 103 pages long with literally volumes of legislative report language to support it. I can't possibly relate it all to you in any detail, even on renewables, because aside from settling the allocation issue, conservation and renewable resource development is fundamentally what it's all about. What I will try to do, however, is provide you a "road map" on where to find the key features that relate to renewables.

Section 2 of the legislation establishes six purposes which must be consistent with other applicable laws. The first purpose is of major importance to us here today.

> It seeks to encourage, through the unique opportunity provided by the Federal Columbia River Power System, conservation and efficiency in the use of electric power, and **renewable resource development** in the Pacific Northwest.

Section 3 is the definition section. Although many are important, the definition of "renewable resource" and "cost-effective" are key.

"Renewable resource" is defined because of resource priorities established in Section 4(e)(1) of the Bill. Such resources use only regenerative or essentially inexhaustible energy sources for electric power generation or reduction of a customer's electric power requirements, including direct applications by consumers. Solar, wind, hydro, geothermal, biomass, or similar energy sources are identified as renewable.

A resource or conservation measure is "cost-effective" when it is forecast to be reliable and available within the time it is needed and it would meet or reduce the electrical power demand, as determined by the Council or Administrator, of the consumers of the customers at an estimated incremental system cost no greater than that of the least cost similarly reliable and available resource or measure. To determine "system cost," all direct costs over the effective life of a resource or measure are to be estimated. If applicable, direct costs include distribution and transmission costs to consumers, and, among other factors, waste disposal costs, end-of-cycle costs, fuel costs (including projected fuel cost escalation), and such quantifiable environmental costs and benefits as the Administrator determines are directly attributable to the resource or measure.

Projected realization and plant factors as well as appropriate historical experience with similar measures or resources will also be considered in estimating the amount of power to be saved or generated. Conservation will be considered cost-effective if its costs do not exceed 110 percent of the costs of nonconservation alternatives. However, Section 4(k)(2) provides a mechanism whereby Section 3(4)(D) may be held by the Administrator to be inapplicable under certain specified conditions following receipt of a Council analysis based on 5-year's experience with implementation of conservation and resource measures under the Bill.

Section 4 contains the regional planning and public participation provisions. There Congress gives its consent for the formation of a regional agency to be called the Pacific Northwest Electric Power and Conservation Council. The Council, with two voting members from each State, is responsible for preparing and adopting, within 2 years of its establishment, and thereafter periodically amending and participating in the implementation of a regional electric power and conservation plan. Broad public participation is provided for in the development of regional power policies.

The plan must set forth a general scheme for implementing conservation measures and developing resources consistent with the priorities of putting renewables right after conservation and ahead of all else. It will include an energy conservation program containing model conservation standards, recommendations for research and development, a methodology for determining quantifiable environmental costs and benefits, a regional demand forecast of at least 20 years, an analysis of reserve and reliability requirements and cost-effective methods, a fish and wildlife program, and a method for calculating conservation surcharges.

Section 5 of the Act mandates that the Administrator offer to sell each requesting utility the firm or reliable power each needs beyond its own firm power resources. All power sales under this Act are subject at all times to the preference provisions of the Bonneville Project Act.

Bonneville, if requested, must undertake the responsibility for meeting new and existing firm power requirements including first the preference agencies and also those of the investor-owned utilities, Federal agencies, and direct-service industries, and that in order to do so, we will need additional resources. The point is that these sales and obligations are what ultimately binds all the regions utilities together and embrace the Bill's resource priorities and decisionmaking.

Section 6 contains provisions most interesting to this audience—the conservation and resource acquisition provisions. It authorizes and directs the Administrator to acquire resources to meet contract obligations according to resource priorities, cost-effectiveness, and other criteria established in the legislation.

In order to ensure that the Administrator will pursue cost-effective conservation and renewable resources before investing in conventional resources, the Act specifies priorities for resource development and acquisition: first, conservation; second, renewable resources; third, resources using waste heat or having high fuel conversion efficiency, and only thereafter fourth, other resources. In each case, priority is given to resources which are cost-effective.

Under provisions of the legislation, Bonneville may provide financial support to sponsors of a resource which may be eligible for acquisition. Subject to a number of conditions, BPA may fund or reimburse certain investigations and preconstruction expenses which the sponsor incurs in the development of resources having regional benefit. Funding for investigations is contingent on BPA gaining a first right-of-refusal option on the project's capability.

This authority offers an opportunity for utilities—particularly public bodies—to investigate renewable resources where previously they have encountered difficulties due to the risks involved and State constitutional limits on "lending of credit."

These investigations of proposed projects would provide for environmental, economic, and technical engineering analyses necessary to determine the project's cost-effectiveness, reliability, compatibility with the existing system, and fish and wildlife and environmental impacts.

Other authorities in Section 6 provide additional support of conservation and renewable resources.

1. BPA may acquire small resources of an experimental, developmental, demonstration, or pilot project nature which possess potential for providing cost-effective service—again a direct benefit to proving renewables viable;

2. BPA is authorized to investigate opportunities for adding to the region's resources or reducing the region's power costs through accelerated or cooperative development of renewable resources outside the region;

3. BPA is authorized to acquire and integrate new and replacement resources. Acquisition is to be accomplished by contract to pay for the capability or a specific amount of power from a utility system or power associated with a generating resource, conservation resource, or group of resources.

4. BPA is authorized to grant billing credits and provide services for BPA customers who undertake independent conservation activities before or after the date of enactment, or develop their resources independently after the date of enactment. This provision is included because these customer actions would reduce BPA's obligations to acquire resources and a meaningful cost comparison or incentive was necessary to individu-ˡ development of conservation and renewable resource

5. The legislation provides that environmental impact statements for resource acquisition may be prepared jointly by States and the Federal government.

6. And finally, Section 6 establishes procedures applicable to proposed major resource acquisitions, payments or reimbursements for investigations and preconstruction expenses, and/or billing credits or services for a major resource. For each proposal, public notice and hearings are required; an administrative record must be prepared; a written decision, including a consistency determination, must be communicated to the Council and the public; and, if the acquisition is deemed inconsistent, the Administrator may not proceed until 90 days after the funding for the proposal has been specifically authorized by Congress. Other applicable law, such as NEPA, continues to apply as well.

The legislation improves the prospect for financing resources by providing grants, loans, loan guarantees, bond assurances, and additional borrowings. Most significantly, since the legislation authorizes Bonneville to use various financing mechanisms to assist in planning and acquiring renewable resource capability, and pledges Federal Columbia River Power System revenues as backing, bond buyers should be less reluctant to invest in and risk money on resources which they believe rely on "unproven technologies" or which may be subject to periodic fuel supply constraints (such as in the wood processing industry). The holder of a revenue bond wants assurance that revenues will be forthcoming. By integrating a resource into the regional system and pledging the revenues from all the region's ratepayers, bond holders are provided the assurances they demand.

The legislation also authorizes the expenditure of funds borrowed under Bonneville's existing $1.25 billion borrowing limit for the acquisition, development, or investigation of renewable resources under 50 average MW. It also grants BPA and additional $1.25 billion borrowing authority for making loans and grants directly for conservation and small renewable resources.

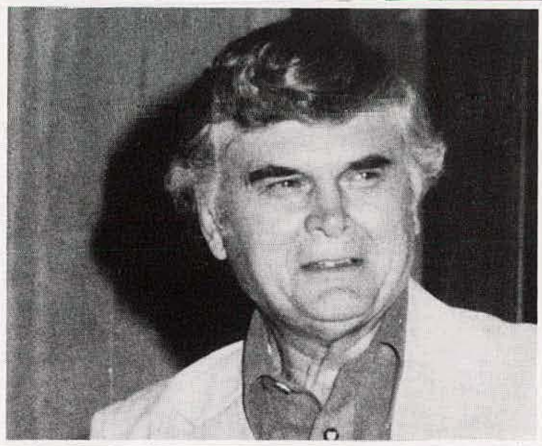
Where do we go from here?

We have the positive experience of living and growing with renewable base energy; we are living the lesson of further reliance on fossil-fuel resources; we understand the priority, the direction, and the purpose. With enactment, the necessary financing and planning mechanisms will be in place, much of the uncertainty currently impeding development will be eliminated, and many, many more tools available to achieve our joint purpose. Things would, I believe, be easier and accomplished more quickly.

But even with enactment, the public's preference ... renewables has nonetheless been successfully expressed—through the political process evidenced by all the congressional activity; the endorsement by the States and major cities or our region; the utilities, industries, and others—and through the very participation and encouragement of all of you—and through the commitments in the form of actual development by the many people in our region. You are the renewables' "natural constituency." Let's see what we can do, together and individually, to get renewables moving "in the pipeline,"—big ones, small ones, generating, and nongenerating.

With all of us working together, we can meet the challenge to lead the nation in the development of conservation and renewable resources.

Thank you. ∎



Al Ullman
Former U.S. Congressman
for Oregon

Al Ullman served as the U.S. representative from Oregon's second district from 1957 to 1980. He was a member of the House Committee on Interior and Insular Affairs from 1957 to 1961 and a member of the Committee on Ways and Means from 1961 until 1980. In 1973 and 1974, he served as acting chairman of the committee, and was elected its chairman in 1975.

Congressman Ullman authored much legislation to improve Federal natural resource management and to encourage rural development. As chairman of the Committee on Ways and Means, he was a leading proponent of a national energy policy, introducing the first comprehensive energy policy legislation in 1975 and playing a major role in the enactment of the National Energy Act of 1978. He also made a significant contribution to tax reform legislation.

Mr. Ullman received his B.A. in political science from Whitman College and his M.A. in public law from Columbia University.

Remarks

I'm extremely pleased to have this opportunity to address the Second Annual Pacific Northwest Alternative and Renewable Energy Resources Conference, and I want to thank Jack Hornor, the conference chairman, and Don Davey, the conference coordinator, as well as BPA Administrator Munro for inviting me here this evening.

I'm particularly glad to be able to speak on the topic of renewable resources here in my home state of Oregon, which has taken a position of national leadership in the drive to reduce our reliance on conventional energy sources.

In 1979, Governor Atiyeh set out an ambitious agenda whose goal was to maximize the use of conservation and renewables, declaring it state policy to develop our state's solar, wind, geothermal, biomass, hydroelectric and energy-conserving potential to the fullest extent.

And, just two months ago, The Oregon Alternate Energy Development Commission found this potential to be great indeed, and laid out a set of sound recommendations on how best to develop it in the coming years.

This focus on conservation and renewables is thoroughly in step with the energy preferences of Oregonians. A poll conducted earlier this year by Pacific Power and Light revealed that they strongly preferred the use of renewable resources over conventional generation, for which they displayed a marked lack of enthusiasm.

Indeed, given a hypothetical choice, more than half of those surveyed would not accept the siting of a coal-fired plant in their county; this percentage increased to nearly two-thirds in the case of a nuclear facility. In contrast, solar, hydro, wind and geothermal received high marks in terms of preference as well as of perceived practicality.

And, last May, Oregon voters by a wide margin approved a multi-million dollar loan fund to finance small-scale renewable resource projects, clearly demonstrating their support for alternative technologies and for individual and local initiative in reaching energy independence.

This strong preference for conservation and renewables and for broad-based public participation in energy affairs is one I share.

In my view, it is indisputable that conservation and renewable resources are the direction that our energy planning must take, on the national as well as on the state and local levels.

It is widely recognized that our current patterns of energy use are quite flexible. Reputable estimates hold that the United States could use thirty to forty percent less energy than it now does without a decrease in our living standard, given an aggressive national conservation effort. And, of course, it is now a truism to note that energy conservation is the cheapest, quickest, and environmentally safest source of energy there is to be developed.

As for renewable resources such as solar energy, a domestic policy review of this option ordered by the President found a significant potential for expanding solar and other renewables with existing technology, and concluded that the goal of deriving twenty percent of our energy from solar by the year 2000—a goal I endorse—is well within the realm of achievability.

Further, a recent study by the Harvard Business School echoes many of the current misgivings about the ability of conventional resources, such as coal and nuclear, to add reliably to our energy mix. This study states that "only a modest contribution in increased energy can be counted on with reasonable certainty from these sources," and cites air pollution and the dangers of nuclear waste as posing unique obstacles in this respect.

Accordingly, the Harvard study places its greatest emphasis and hope on the development of solar and related renewables as well as on conservation, which it terms "an immediate priority" resource.

Aside from arguments based on objective merits, however, I am attracted to conservation and renewables on account of less tangible, yet equally important advantages they possess.

A constant complaint I hear in Congress and among government officials concerns the supposed apathy of the average citizen about our energy problems. The person on the street, so the story goes, isn't willing to help reduce energy use or to undertake needed efforts, and is simply waiting for the government to step in with a magic solution.

This is nonsense. And Oregonians are proving it to be nonsense every day.

To me, one of the prime virtues of conservation and renewables is that they offer an alternative to those who have the initiative and the ability to help solve our energy problems. Since these are technologies that can be employed by the average homeowner, businessman or local public utility, we have here a means of tapping one of our greatest resources—the energy and enterprising spirit of our people.

As a member of Congress, I receive hundreds of inquiries from seniors who ask for advice and assistance in weatherizing their homes; from farmers who are looking into setting up alcohol fuels stills to help run their operations; and just from ordinary citizens who want to heat their homes with solar equipment or generate electricity from windmills. And the public utility districts and rural electric cooperatives of central and eastern Oregon are hard at work developing their own energy from biomass, cogeneration and small-scale hydro.

Especially at a time when our energy security is severely threatened by events halfway around the world, I find it fitting that we are returning to the traditional American values of individual and local initiative, and using our natural resources, to find lasting solutions for our energy future.

The area of conservation and renewables, then, seems to me to be where our future efforts will reap the biggest rewards—in terms of the amount of energy produced the quickness with which we can put these resources line, and the ability to draw upon the initiative and resourcefulness of all Americans.

Much of my work in Washington has involved me closely in this area for many years.

—In 1978, I pushed for enactment of the first federal tax credits for solar, wind, geothermal and conservation, the excise tax exemption for gasohol, and for depreciation incentives for industrial conservation.

—And, as part of the windfall profit tax legislation signed into law earlier this year, I worked to expand these provisions, to add more items to the list of equipment eligible for the conservation credit, and to create incentives for newer areas such as cogeneration and ocean thermal conversion.

During this period, Congress also approved a wide range of incentives for conservation and renewables, including the establishment of a conservation and solar bank, increased funding for alcohol fuels production, and programs to stimulate geothermal resource exploration.

The progress we have made so far is good. But we must do more.

—All too often, in the pressures of the Congressional appropriations process, funding for needed conservation programs is the first to go when reductions are made, and without a careful review of the beneficial impacts these programs have on employment and in reducing the need to import oil. We must work to sustain or increase our appropriations levels in this area.

—Additionally, I support higher funding of innovative activities, such as the Appropriate Technology Small Grants Program, which are the most accessible to the general public for developing renewable energy applications at the grass-roots level.

And, in my capacity as chairman of the Committee on Ways and Means, I am working on several fronts.

—In September, my committee held hearings on a passive solar tax credit that would grant homebuilders up to two thousand dollars for incorporating key passive components in their construction. I believe quick action in this area is necessary, and I am hopeful that this credit can be passed in the post election session of this Congress.

—I have been involved in discussions with the White House and the Treasury Department to urge prompt action on the discretionary credit for wood-burning stoves, and am pleased that the Administration has now given its consideration top priority.

—Further, I am co-sponsoring legislation which would reauthorize the energy conservation program for schools and hospitals and would extend full funding to the conservation program for units of local governm and public care. Along with Energy and Power Subc mittee chairman John Dingell, I am working to add provisions to this legislation which would insure that funds are utilized to the fullest possible extent and would go to those areas which have the greatest need.

—And, as a result of my talks with people here in Hood River County and around the state, I have become intrigued by the potential that remains in the field of small-scale hydroelectricity. Many Oregonians have already developed local sites for residential and farm use, and I am convinced that with additional incentives this resource can make a significant contribution to our energy supplies.

I am therefore directing my Ways and Means staff to study the possibility of a federal tax credit applicable to small-scale hydro for residential purposes, in the expectation of holding committee hearings on this subject as soon as possible next year.

To sum up, I feel that we are now beginning to turn the corner in our appreciation of the problem that faces us, and of the role that conservation and renewable energy must play in solving it.

First, we must recognize that developing these resources must be our absolute top priority, our main line of attack in the fight to attain energy independence.

Second, at all levels of government, from the national to the local, we must redouble our efforts to support and encourage these energy options through significant and workable incentives.

Finally, in so doing we must call upon, and be responsive to, the resourcefulness and grass-roots initiative of all Americans as a key factor in our energy thinking.

Given this kind of commitment, I can envision an America reliant not on sources of energy whose supply is limited or whose ability to contribute in the future is suspect, but instead an America reliant upon renewable sources of energy that will provide us with a safer and more secure energy future.

To some, this notion will sound hopelessly idealistic. Others will see it as accepting lowered expectations or a limited world outlook. But I submit to them that the virtues of self-sufficiency, use of our own domestic resources, and broad-based popular participation are the most genuine and most American virtues of all.

This is a view of the future that I share with my fellow Oregonians, and one toward which I will work with all of my efforts.

Thank you very much. ▌

Nick Cimino is a solar research analyst for the Idaho Office of Energy and Western SUN. He has been at the Idaho Office of Energy since 1979, and specializes in solar heating and cooling technology, with emphasis on the legal and institutional issues. He was formerly employed by the environmental consulting firm of Jones, Stokes, Associates.

Panel 5 moderator Nick Cimino

Richard L. Durham is biomass specialist and special assistant to the director of the Oregon Department of Energy, on loan from the U.S. Department of Energy, for which he was special projects officer, Office of the Assistant Manager for Regional Activities, Hanford Site, Richland Operations Office. He was previously special assistant to the assistant manager for administration at the Hanford Site, intelligence advisor to the director of the Arms Control and Disarmament Agency, director of classification for the same agency, and a supervisor with the Sandia Corporation, Livermore Laboratory, Livermore, California. He is chairman of the Wood Energy Coordination Group and a member of the PNUCC Wood Energy Committee and the Governor's Wood Slash Committee. Mr. Durham has written numerous articles on biomass energy. He ved a B.S. in engineering from the U.S. Military Academy and a uate diploma from the National War College.

Panel 6 moderator Richard Durham

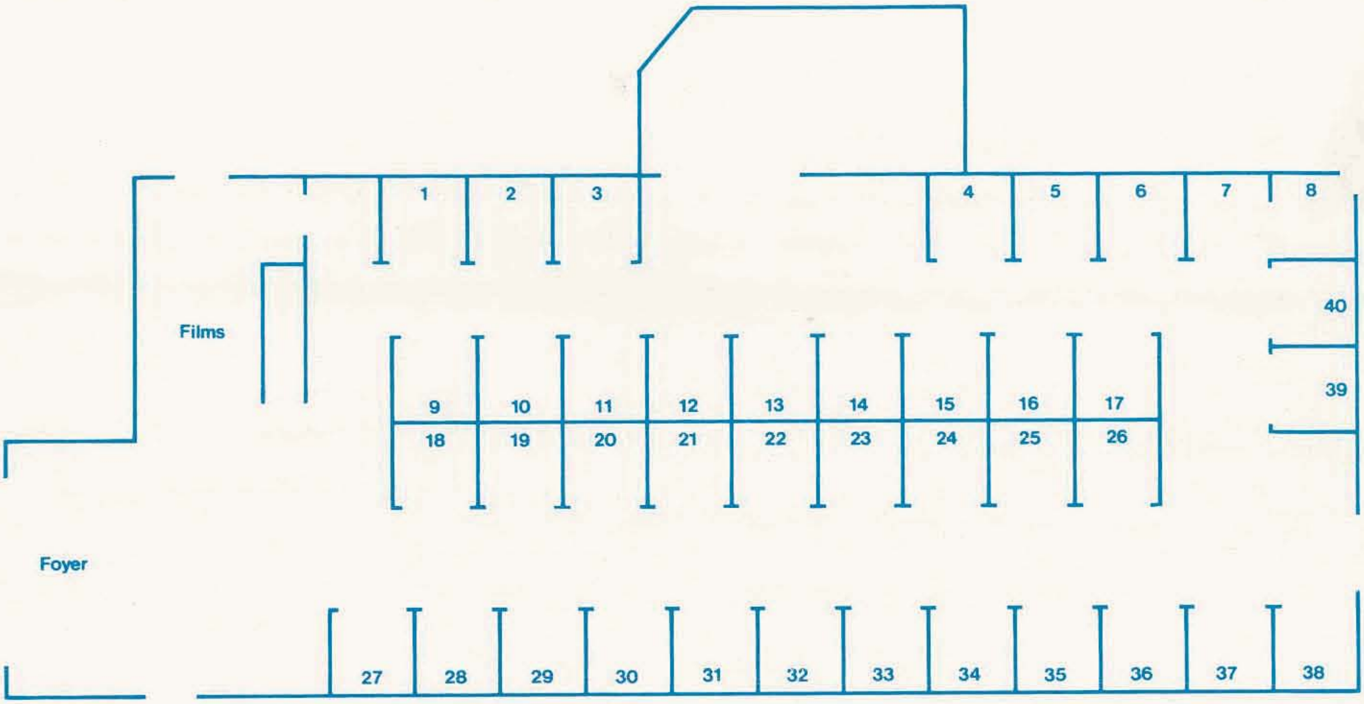


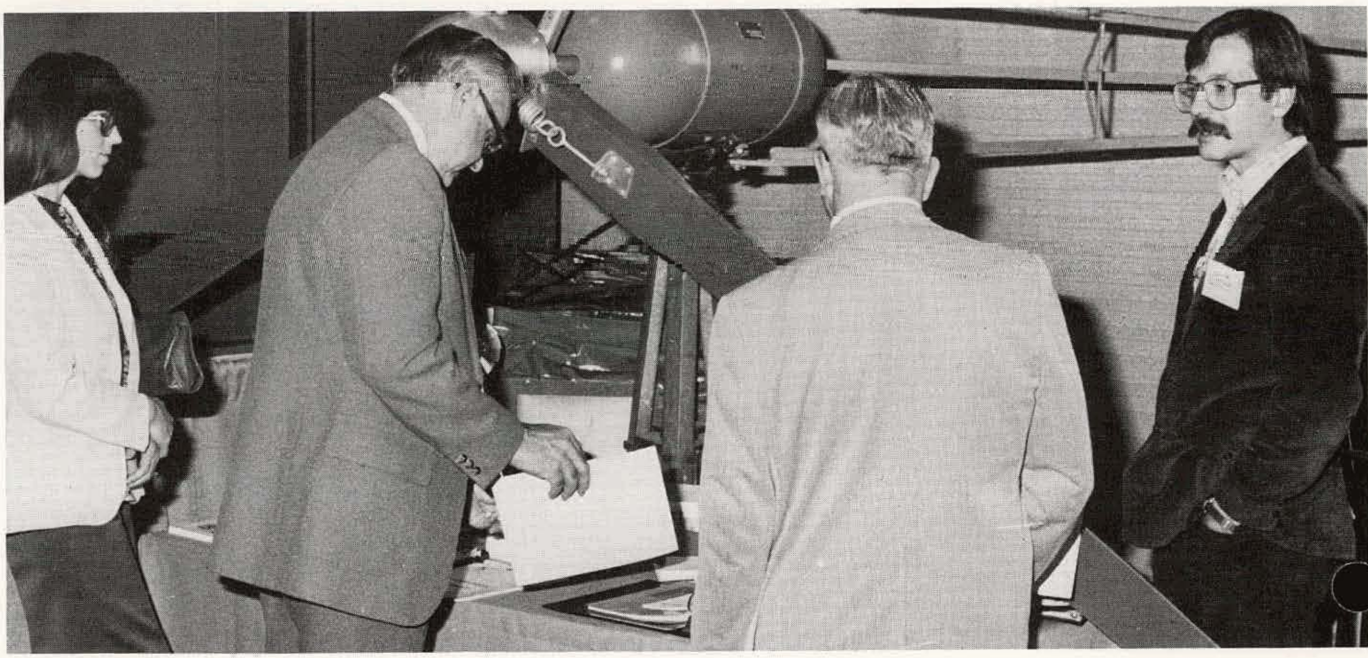
EXHIBIT CENTER

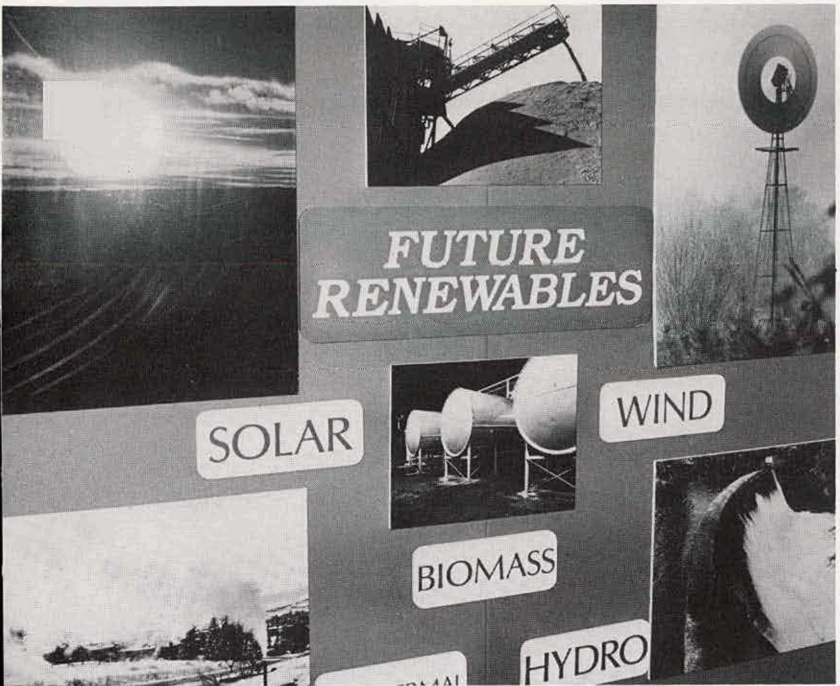
A separate exhibit center featured the following:

Special Project Areas, where facts were shared and questions answered relating to on-going projects in the region,

Contact Areas, where people interested in specific programs relating to the resources met and exchanged information and

Exhibits of various alternative and renewable resource hardware.





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The following films were shown in the Exhibit Center yer:

Wind Power
Produced by the *National Aeronautics and Space* Administration. 16 mm, 5 minutes.

Energy from the Wind
Produced by the National Aeronautics and Space Administration. 16 mm, 5 minutes.

Gusts of Power
Produced by the U.S. Department of Agriculture and the U.S. Department of Energy. 16 mm, 15 minutes.

Pigopolis
Produced by Industrial Media, Inc. 16 mm, 12 minutes.

Gift from the Earth
Produced by the U.S. Department of Energy. 16 mm, 27 minutes.

Water Follies
Produced by the Denver Water Department. 16 mm, 6 minutes.

Fuel Cell Power: The New Option
Produced by United Technologies. 16 mm, 15 minutes.

Backyard Alternatives
Produced by the Brumfield Family. 16 mm, 20 minutes.

Films on alternative energy resources may be borrowed free of charge from the following:

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U.S. Department of Energy
Film Library
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Oak Ridge, Tennessee 37830
(615)576-1285 or 1286 or 1287
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Public Information Office
Bonneville Power Administration
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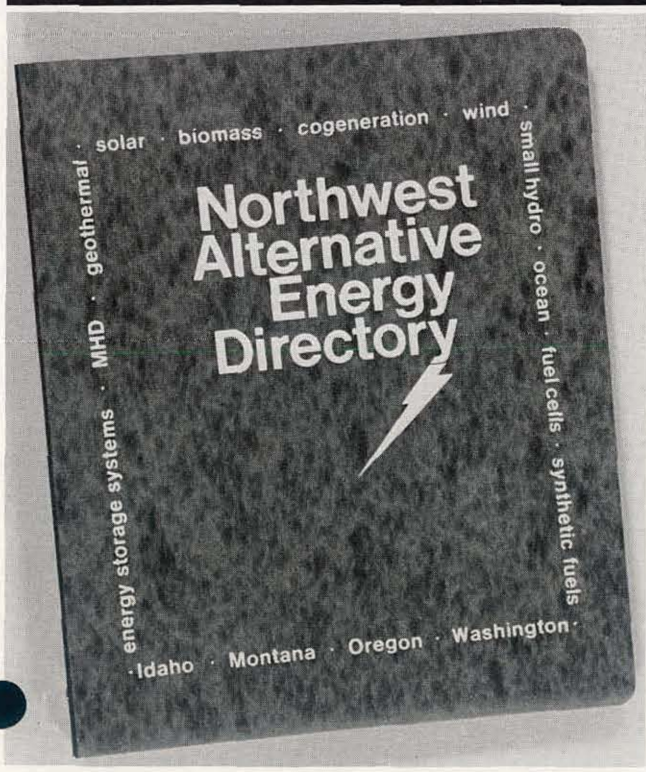
(503) 234-3361, Ext. 5131
FTS 429-5131



The Northwest Alternative Energy Directory is a compilation of agencies, organizations, information sources, and individuals who play a role in alternative energy resource development. The listings are organized by geographical area (State, regional, national) and by function (information, government, research and development, utility). The directory also contains a cross reference by energy resource and an index by agency. Copies are available upon request from Branch of Thermal Power-PRT, Bonneville Power Administration, *P.O. Box 3621, Portland, Oregon, 97208 (503/234-3361,* x5051).

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