1983

Northwest Conservation and Electric Power Plan

Meeting the region's electrical energy needs... with confidence, flexibility, and at the lowest possible cost

Northwest Power Planning Council

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April 27, 1983

To The People of the Pacific Northwest:

Three generations ago, the people of the region started building the largest hydropower system in the world. The resulting supply of low-cost power has contributed immeasurably to the quality of life and economic development in the Pacific Northwest. Now, the region must plan to meet future energy needs with conservation programs and resources that are 6 to 15 times more expensive than power from the existing dams. The challenge facing us is to support a strong growing economy while protecting our investment in the low-cost hydropower supply.

The Northwest Power Planning Council is charged with the responsibility of determining how much electric power the region will need and planning for the cheapest way to serve that need. The Congress directed the Council to complete the first regional conservation and electric power plan by April 28, 1983.

Adoption of this plan marks the beginning of the planning process, not the end. We now look forward to working with the citizens of the Northwest, Bonneville, and other federal agencies, utilities, state and local governments, Indian tribes, and businesses to ensure the successful implementation of this power plan and the Columbia River Basin Fish and Wildlife Program, which was adopted on November 15, 1982.

The Council is confident that the region can develop the resources needed to meet the region's future needs for electricity at the lowest possible cost.

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1983 **Northwest Conservation and Electric Power Plan** Volume I

Adopted Pursuant to the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (P.L. 96-501)

April 27, 1983

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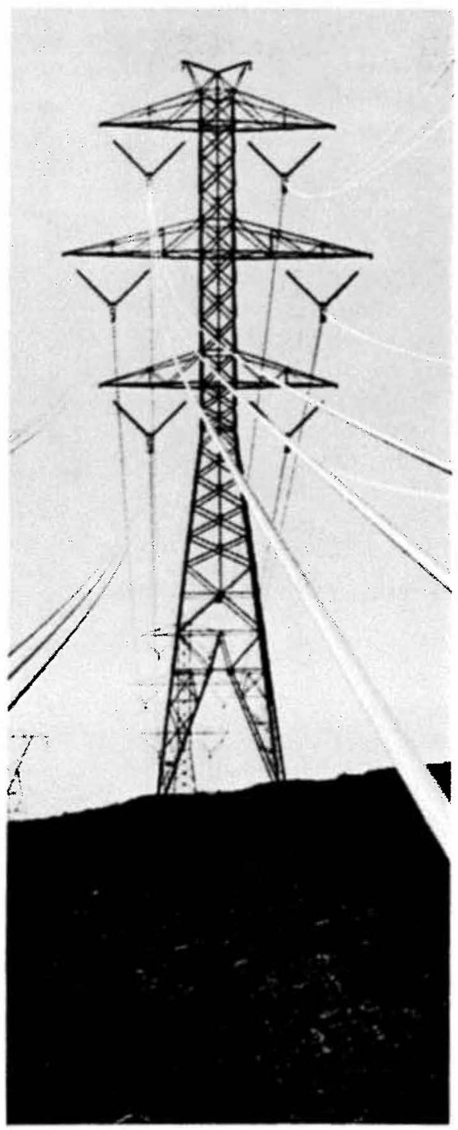
Foreword

The Northwest Power Planning Council was created on April 28, 1981 in accordance with the Pacific Northwest Electric Power Planning and Conservation Act (the Act). The Council is an interstate compact agency made up of eight members, two each from the states of Idaho, Montana, Oregon, and Washington. All are appointed by their governors and confirmed by their legislatures. The Council is not an agency of the United States government.

The Council was authorized by Congress and created by the Northwest states to encourage conservation and the development of renewable resources in the Northwest (1) to assure an adequate, efficient, economical, and reliable power supply, and (2) provide for broad public participation and consultation in the development of regional power plans and related fish and wildlife programs. (A detailed description of the Council's role is given in Appendix A.)

The Act directs the Council to "prepare, adopt, and promptly transmit to the Administrator [of the Bonneville Power Administration] a regional conservation and electric power plan." The Act also directs the Council to accomplish this task by April 28, 1983. This plan describes the strategy developed by the Council to meet the region's electrical energy needs over the next two decades with flexibility, responsibility, and at the lowest cost to the region.

To lay the groundwork for development of its strategy, the Council's initial meetings in 1982 were devoted to assessing the status of regional electric demand forecasting, resource and conservation programs, and other issues relevant to the Council's responsibilities. In the fall of 1981, the Council initiated six major studies needed to prepare this plan. Final reports totaling over 4,000 pages were completed in the summer of 1982. Information obtained from these reports was used by the Council to develop this plan.



The Council established a public involvement process to ensure that key issues were reviewed by a broadly representative Scientific and Statistical Advisory Committee, other interested parties, and the general public.

This plan does not create one additional kilowatt of energy in the region. To accomplish its purpose, the plan must be implemented by Bonneville and other federal agencies, the region's utilities, state and local government, private businesses, and the people of the Northwest. The Council, therefore, actively sought broad public review of the draft document which was issued on January 26, 1983. Seven days of public hearings were held in five locations throughout the region. The Council received 18,000 pages of comments from over 1,200 individuals, agencies and organizations.

This plan is the result of the evaluation and revision of the draft document based on all comments received in the Council's Portland office by March 21, 1983.

The Council adopted the Columbia River Basin Fish and Wildlife Program on November 15, 1982. The program, which provides for the "protection, mitigation and enhancement" of fish and wildlife in the Columbia River Basin, has been formally incorporated into this power plan as Volume III.

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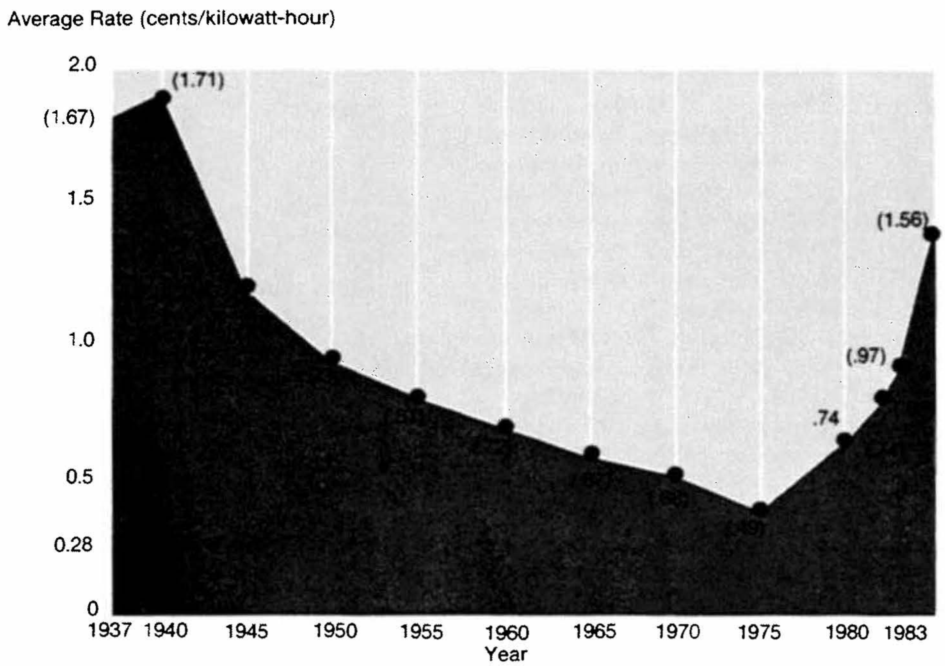
Introduction

Today, the Pacific Northwest faces a new challenge: to exert control over our energy future. The region has the responsibility to create a power plan that will meet with confidence a wide range of potential tomorrows at the lowest possible cost to the ratepayers of Washington, Oregon, Idaho, and Montana.

In response to the challenge, the Northwest Power Planning Council's two main goals are: (1) get the power the region needs, and (2) get it at the lowest possible cost.

The Council was authorized by the Pacific Northwest Electric Power Planning and Conservation Act of 1980 (the Act) and created by the four Northwest states to provide a new public forum for making decisions about our energy future and for determining the best resources for the Bonneville Power Administration as we head into the next century.



All figures based on 1980 dollars, adjusted for inflation.

Figure 1-1.
Bonneville Power Rates, 1937 - 1983

Energy Economics—Then and Now

Today's electric energy choices reflect a reversal from yesterday's economics of power. For years, the region had been blessed with low-cost electricity from the seemingly inexhaustible Columbia River system. The rapid economic growth of the region created a steady demand for more and more power. Because of economies of scale and growing sales of electricity to pay the costs, each new dam actually brought the cost of electricity down.

From 1940 to 1973, the wholesale rate for public utility customers of the Bonneville Power Administration dropped, when adjusted for inflation, from 1.7 cents to 0.5 of a cent per kilowatt-hour (see figure 1-1). The region's huge hydropower system on the Columbia, built when inflation and interest rates were low, provided the nation's cheapest electricity. From farm to factory, the region prospered during this hydropower era. With the cost of power dropping, "living better electrically" became the axiom of the times. Power planning in the 1950's and 1960's involved minimal risk of being wrong. If the supply of electricity exceeded demand, demand was certain to catch up soon. The far greater risk, or so it was perceived at the time, was to underbuild, to have demand for electricity exceed the supply.

By the mid-1960's, with most of the major hydropower sites developed, the region's utilities turned to thermal plants. The shift to coal and nuclear plants was one which other parts of the nation, not endowed with great flowing rivers like the Columbia and Snake, had made years before. For the Northwest, however, the transition to the thermal age was to become a most difficult one.

In 1968, with projections for consumption of electricity around 6 percent annual growth, the utilities laid out the first phase of the Hydro-Thermal Power Plan. The program envisioned building twenty nuclear plants and two new coal facilities. The concept, in part, was to use these plants to meet the base electric loads in the region, while the hydropower system would be used to meet the daily and seasonal peaks in demand.

Rapid growth was projected to continue for years ahead; therefore, the Hydro-Thermal Power Plan was based on the energy economics of the day. Nuclear reactors appeared to be cheaper to operate as base-load facilities because so much of their cost is in the building of the physical plant, not in the cost of fuel. Once a reactor is running, it makes little economic sense to operate it to follow the daily fluctuations in power demand. The hydropower system, on the other hand, could follow the hour-to-hour demand for electricity in the region.

Few had anticipated the cost of the thermal era transition. The cost of new coal or nuclear plants escalated by billions of dollars with power from these plants costing many times more than power from the existing Northwest dams. Figure 1-2 compares the average cost of existing hydropower dams, new conservation programs, and new thermal plants. As the cost of the new thermal plants increased, so did the value of the hydropower system. Although its output varies with annual rainfall and snowpack conditions, the hydropower system can generate thousands of megawatts for a tenth of what the electricity would cost from additional thermal plants. Furthermore, during high-water years there is enough cheap hydropower to allow other, more expensive resources to be shut down, thus saving ratepayers some of the cost of running thermal plants. A good example of this occurred in 1982. A combination of factors (high water, mild weather, and a sluggish regional economy) resulted in enough hydropower so that some thermal plants, particularly coal units, were simply shut down to save money. Given today's cost of building and operating any new plant, economics point toward getting maximum use out of the hydropower system while planning new resources that complement that system.

Between 1973 and 1983, after adjusting for inflation, the wholesale cost of electricity climbed from 0.5 of a cent to 1.56 cents per kilowatt-hour. This threefold rise in rates reflected emerging realities about energy economics. The concept of "the more you build, the less it costs" became "the more you build, the more it costs." Utilities were caught in a whipsaw—as rates went up, the demand for electricity fell, and so did projections for future demand. Each year since 1975, the long-range forecasts of the Pacific Northwest Utilities Conference Committee have dropped. The most recent projection is 2.0 percent per year. As these projections dropped, the risks surrounding power planning decisions increased first by millions, then by billions of dollars. For example, a one percent difference in growth rates over a ten-year period equals the energy difference of three large nuclear plants, costing billions of dollars and each taking more than a decade to complete. A one percent fluctuation in a long-range regional forecast is not that unusual, which means that the current construction time of a major plant surpasses the ability of the planner to determine whether that plant is actually needed.

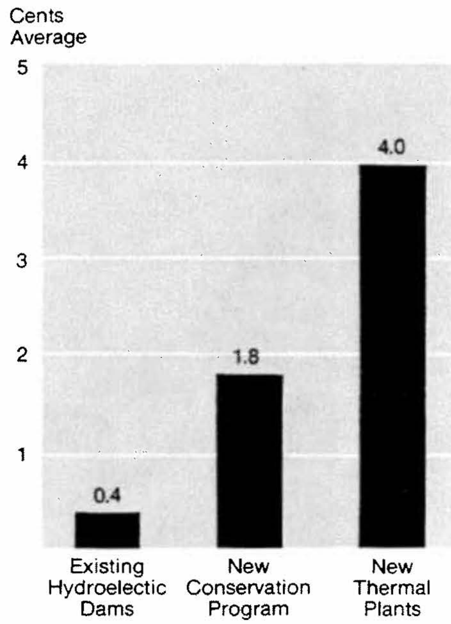


Figure 1-2.
Cost Comparison —
Hydropower, Conservation, and Thermal

Any forecast, no matter how sophisticated the process by which it was derived, has an inherent element of imprecision. No one can predict with accuracy the myriad of events that will determine the region's energy needs twenty years from now. As recent events have shown, there is a high cost in being wrong. The major challenge, therefore, is to reduce the probability and the consequences of being wrong.

A New Planning Strategy

Certainty about the future does not come from the technical sophistication of the methods used to create a forecast. Instead, it comes from the flexibility and confidence one has in the number and types of resources available to meet any given condition. As times and conditions change, so must the region's plans. The Council developed this plan with the following specific goals in mind:

- To provide an adequate supply of low-cost electricity;
- To select resources following the cost-effectiveness principles and priorities in the Act;
- To evaluate all resources from a total regional system perspective to ensure their compatibility with the existing hydropower system;
- To select resources with the least adverse impacts on the environment, or those whose adverse environmental impacts can be mitigated;
- To select resources that are consistent with protecting and enhancing fish and wildlife, and that mitigate power system impacts on fish and wildlife;
- To provide a reliable power supply that will meet any future load growth; and
- To develop a flexible strategy so that the plan can be modified as conditions change and new information becomes available.

Planning for Economic Growth

The Council recognizes the shifting nature of energy demand projections, and wants to bracket the region's energy future by setting the highest and lowest plausible electric load growth forecasts over the next twenty years. The Council is confident that the region's actual demand for electricity will fall somewhere within that range. This range, while avoiding a single "most likely" growth rate, establishes the plausible bounds of the region's growth and its accompanying energy needs.

The principal determinant of electric load growth in the region will be the economic growth the region experiences. An important indicator of regional economic performance is how well the Northwest growth compares to the nation. When developing the highest growth forecast included in the plan, the Council used the assumption that employment in the region would grow more than twice as fast as predictions for employment in the rest of the nation over the next twenty years. This growth ratio is even higher than the Northwest's most rapid five-year historical growth period which occurred between 1974 and 1979.

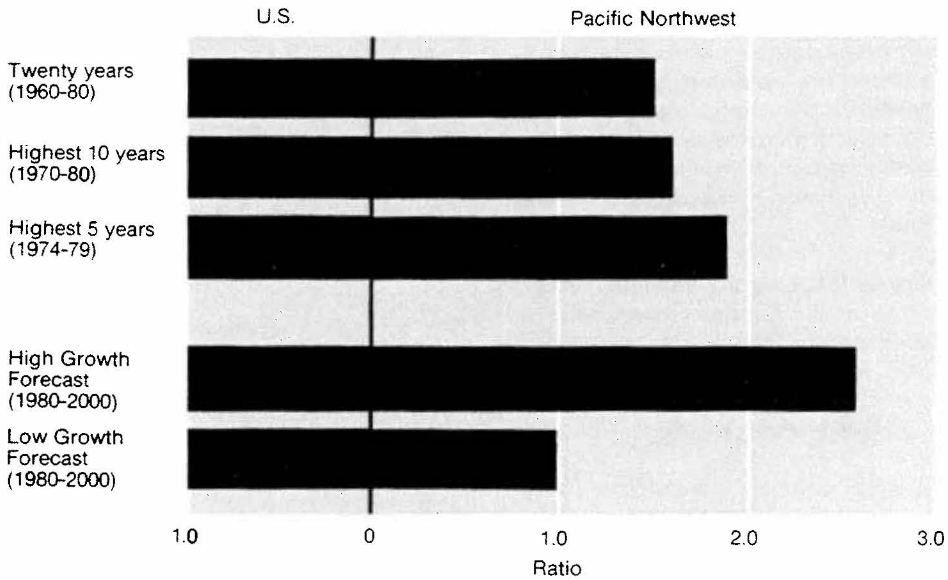


Figure 1-3.
Ratio of Pacific Northwest Total Employment to National Total Employment Growth Rates

Figure 1-3 compares the Pacific Northwest and national employment growth rates for three historical periods with the twenty-year forecast. In the high growth forecast, total regional employment would increase by more than 3.4 million between 1980 and 2002, as compared to the 1.5 million increase in jobs between 1960 and 1980. In the low growth forecast, total employment in the region would increase by 700,000 employees between 1980 and 2002. This rate assumes that the Pacific Northwest would grow as fast as national projections for the nation as a whole.

In terms of energy requirements, the low and high economic projections translate into a twenty-year range of 0.7 and 2.5 percent average annual rate of growth. In terms of energy resources, this means the region would have to add anywhere between 250 and 10,700 megawatts over the next twenty years in addition to resources currently under construction. (For comparison, the City of Seattle uses about 1,000 megawatts on the average.)

Planning With Flexibility

Another element of the Council's planning strategy is flexibility in the selection of resources. The Council's plan follows the cost-effectiveness criterion in the Act and emphasizes smaller resources with shorter lead times from the initial planning stages to the ultimate generation of electricity. For example, some resources, such as conservation programs, can be developed incrementally and implemented quickly. This means that conservation can be tailored to fit the region's pattern of energy growth.

Major generating resources require much more time from inception to completion. A new arrangement, called "options," would add flexibility to the scheduling of these resources. An option would allow a resource to move through the time-consuming but relatively inexpensive siting and design stages and to be placed in a "ready" condition. In that condition, the project could be scheduled (placed on hold or constructed) depending on the demand for electricity. Such options would become in effect an insurance policy that would allow the region to plan for high growth rates without prematurely committing to build to those rates.

Key Elements of the Plan

Although this plan responds to an uncertain future, it is not an uncertain plan. The Council has identified specific actions to be taken, and has provided a schedule for making decisions to accommodate future changes in electric energy supply and demand.

In this twenty-year plan, conservation is the cheapest resource for the region and it will play a major role in meeting future electric energy needs. If the region needs additional resources, the Council has identified potential hydropower resources that could be developed with a minimum of damage to fish and wildlife and the environment. To serve higher growth, industries would be encouraged to develop cogeneration facilities. Combustion turbines are included in the plan to serve unanticipated load growth. If the region experiences very high economic and population growth, or if conservation and renewable resources do not perform as well as expected, the plan includes new thermal plants in the resource portfolio for the late 1990's.

In recognition of the current regional surplus of electricity, the primary focus of the plan over the next two years is to develop and test conservation programs in all sectors of the economy so that these programs will be reliable and available when the region needs additional power.

The two-year action plan also begins laying the groundwork for other resources that may be needed in the future. These efforts include: (a) working with state and federal regulatory agencies to resolve potential problems associated with holding options on resources and with use of combustion turbines to meet unanticipated local growth; (b) research and demonstration programs to learn more about the cost and feasibility of renewable resources; and, (c) marketing assistance to encourage the installation of cogeneration facilities.

The plan includes policies to sell inside the region more of the low-cost interruptible power from the hydropower system, which would benefit Northwest businesses, industries, and agriculture. The plan also outlines a process to begin discussions with the California Energy Commission regarding a sale of firm surplus power that would benefit both regions.

The plan is divided into eleven chapters. Chapter 2 states the policies the Council has applied in developing this plan. These policies have guided the Council in the selection of resources and measures included in the two-year action plan.

Chapter 3 explains the Council's planning strategy, which emphasizes development of conservation programs and, for generating resources, the acquisition of options to improve flexibility.

Chapter 4 describes the Council's forecasts of demand for electricity and prices, including the underlying assumptions about the regional economy and the price of alternative fuels.

Chapter 5 presents a detailed description of the Council's twenty-year resource portfolio and a discussion of eight major issues addressed by the Council during the preparation of the plan. The chapter also explains the analysis used to select the lowest-cost resource portfolio, including a description of the important characteristics of the Northwest hydropower system, the reliability criteria used by the Council, and the role of combustion turbines in providing planning reserves for unexpected load growth.

The elements that were evaluated in the development of the resource portfolio are discussed in chapters 6 through 9.

Chapter 6 characterizes the existing resources in the Northwest and those that are currently under construction. These resources are then compared to the range of load forecasts to determine when new resources may be needed.

Chapter 7 summarizes the Council's analysis of the amount of cost-effective conservation that can be developed in each sector of the economy during the next twenty years.

Chapter 8 analyzes the energy potential from renewable and non-renewable resources. Renewables include electricity generated from hydropower, geothermal, wind, solar, and biomass. Non-renewables include gas-fired cogeneration, and electricity generated from coal and nuclear plants.

Chapter 9 describes the environmental impacts of all the resources that were considered by the Council in developing this plan. A separate section outlines the expected effects on fish and wildlife of the Council's resource portfolio.

Chapter 10 is the Council's action plan for the two-year period that follows adoption of this plan. This chapter is the most important because it contains actions to be taken by Bonneville, the Council, state and local governments, and utilities to build capability for acquiring conservation and other resources in the future. The Council regards these actions as vital for the region to be in a position to acquire the most cost-effective resources when the need arises.

Chapter 11 describes the process the Council will use to revise the plan. This chapter also explains briefly how the Council will review Bonneville's major resource proposals for consistency with the plan.

The use of some technical terms has been necessary throughout this document because any alternate choice of words would be inaccurate or too lengthy. A glossary is provided to describe those terms.

Volume II, available on request, contains additional technical appendices beyond the interest of the general audience. Additional detailed reports and analyses used to develop the plan have been included in technical exhibits, which may be examined at the Council's central office in Portland, at the Council's four state offices, and at Bonneville Area offices.

Volume III is the Columbia River Basin Fish and Wildlife Program which was adopted by the Council on November 15, 1982. The Council has incorporated the fish and wildlife program into this energy plan.

Monitoring Implementation of the Plan

It is important to understand that this plan is not "cast in concrete." It will be subject to continuing review and analysis by the Council, and is scheduled for revision every two years or as necessary to respond to more rapid changes in the region's needs.

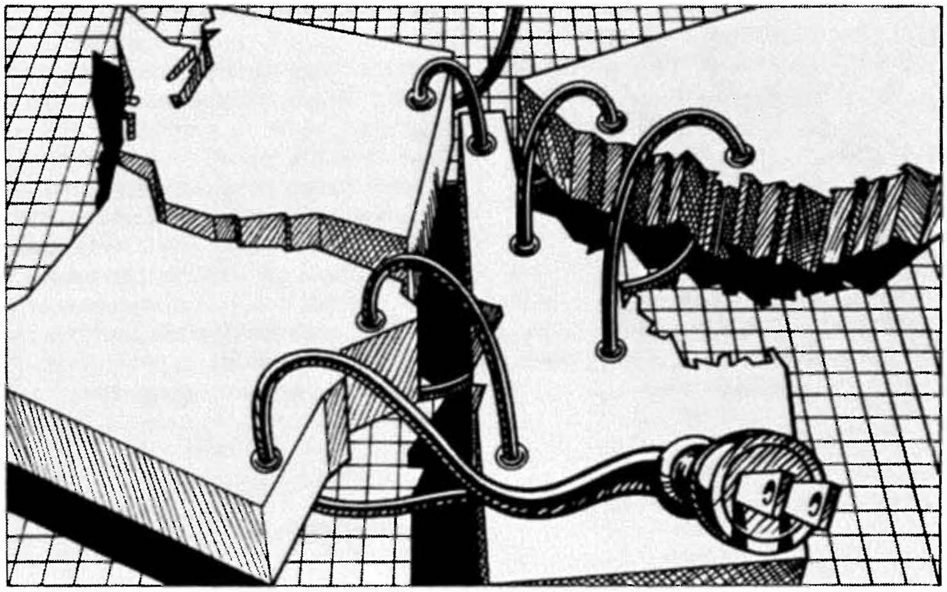
The success of the plan will depend on monitoring what is happening to electric power demand and determining how forecasts should be revised. A number of the conservation programs included in the plan represent newer, more aggressive approaches than any previous efforts in the region. The Council will need to verify the amount of energy that is being saved due to conservation as compared to that projected in the plan.

The Council will also examine the costs and schedules for the resources in the portfolio and other resources, as well as watch for changes in technology or development of new technology that might become a candidate for inclusion in the plan. Future developments that affect the cost-effectiveness of resources could necessitate changing their ranking and scheduling.

The Council is committed to revising this plan as necessary to meet the region's energy needs with confidence, flexibility, and at the lowest possible cost.

"the plan shall set forth a general scheme for implementing conservation measures and developing resources"

Chapter 2 Policies



This chapter explains the policies that have guided the Council in the development of this plan.

Need

All resources that are acquired by Bonneville must be needed to meet Bonneville's loads—buy only what is needed.

This plan is intended to provide Bonneville with the lowest cost mix of conservation and other resources throughout the twenty-year planning period. Resources should be acquired by Bonneville only if there is a need for power. That principle applies to the acquisition of conservation and renewable resources as well as to cogeneration and thermal power plants.

Even during periods of surplus, resource programs are needed to ensure that cost-effective, high-priority resources are available to meet future loads. To develop conservation in existing buildings, for example, administrative programs must be developed and programs must be phased in before the power is needed. New buildings will be in place for thirty years or more, and certain energy-efficient improvements can be installed only at the time of construction or equipment replacement. It is prudent, therefore, to ensure that new buildings are energy-efficient. Cogeneration resources also become available intermittently. A decision to install a new industrial boiler or replace an existing boiler is made primarily for business reasons, not for power production. If a cost-effective cogeneration unit can be installed at the same time, it may be in the best interests of the region and the ratepayers to acquire the resource. The terms of purchase can take into consideration the region's surplus power conditions through offers of marketing assistance and access to transmission lines.

Cost

All resources must be cost-effective—buy the cheapest resources first.

The primary goal of the Act and this plan is to ensure the ratepayers of the Northwest an economical power supply. That goal can be accomplished best through acquiring resources with the lowest incremental cost to the region's ratepayers. All acquisitions must take into consideration the resource's compatibility with the existing system, its environmental and fish and wildlife effects, the risks associated with large capital costs and long lead times, and other relevant concerns.

Surplus and Interruptible Power

Resource programs should be designed to accommodate surplus power conditions without hindering Bonneville's ability to meet long-term resource requirements at the lowest cost and in a manner consistent with the priorities described in this chapter. In evaluating resources, the Council has considered all costs directly associated with the resources over their effective lives, as required by the Act.

The current surplus of firm power offers the region a number of opportunities. Because new resources are not needed to meet loads now, conservation programs can be developed and tested to prepare the region to meet future loads inexpensively and consistently with the priorities of the Act. The region must also make every effort to sell its surplus power outside the region. Such sales can provide significant financial relief for Northwest ratepayers.

Also, the hydropower system often generates power in excess of firm loads due to streamflows above those critical levels used for planning purposes. Increased sales of this non-firm, interruptible power within the region can serve industries, irrigators, and municipalities cheaply while aiding the economy and reducing rates for all consumers.

Compatibility with Hydropower System

Each resource must be evaluated on the basis of how it will perform in conjunction with the region's enormously valuable hydropower system.

Some resources clearly outperform others under this test. Some conservation and cogeneration, for example, follow loads, and they are available during periods of low water—a good match with hydropower. Combustion turbines have low capital costs and high fuel costs, allowing them to be built for little cost and held in reserve for use during low-water conditions. On the other hand, some hydropower projects may only add to the surplus in the spring and be unavailable during the winter due to low flows.

In a region that produces most of its electricity from hydropower at a generation cost of only 4/10 of a cent per kilowatt-hour, every effort must be made to take maximum advantage of the hydropower system consistent with the goal of protection, mitigation, and enhancement of fish and wildlife.

Resource Priorities

Where resources have equivalent costs and equivalent environmental and fish and wildlife effects, they must be selected for acquisition in the following order:

- First, conservation;
- Second, renewable resources;
- Third, generating resources using waste heat or generating resources of high fuel conversion efficiency; and
- Fourth, all other resources (including conventional thermal resources).

Environmental Quality/Fish and Wildlife

Regional resource acquisition decisions must include consideration of environmental quality and the protection, mitigation, and enhancement of fish and wildlife. Any Columbia River Basin hydropower acquired for regional use must also be consistent with the Council's fish and wildlife program.

To the extent possible when planning unknown resources for an uncertain future, the Council has considered environmental quality and fish and wildlife. Specific resource acquisition decisions must also include all quantifiable environmental costs and benefits directly attributable to the resource. The Council has included in this plan its method for determining quantifiable environmental costs and benefits (see Appendix C).

Market Mechanisms

Resource acquisition programs should use existing market mechanisms and organizations as much as practicable. They should also impose a minimum of new administrative requirements. Resource developers already face a wide variety of legal and regulatory requirements. The region should make every effort to facilitate the development of resources that are needed to meet its demand for electricity. Implementation of this policy will improve the region's ability to select resources based on the most important factors: need, cost, and environmental considerations.

Incentives

Conservation is a resource, and it is subjected to the same need and cost-effectiveness standards as other resources. The primary tools available for achieving conservation are: incentives, regulatory standards, and rate designs. To give utilities and state and local governments as much freedom as possible, incentives should be favored. Incentives should be self-implementing—those who respond should benefit. Incentives should not be diluted simply to protect against rate impacts on those who do not respond.

If incentives do not prove to be sufficient to achieve the necessary conservation savings, more emphasis can be placed on regulatory standards and rate design.

Diversity

Resource acquisition programs should accommodate the diversity that exists within the region and encourage local initiative, ingenuity, and choice.

Program features need not be uniform throughout the Northwest. The diversity in climate, geography, economy, population, urban/rural character, and utility and local government structure call for sensitivity to local needs, which can be met best at the local level. Diversity is valuable in resource selection as well. The region should maintain a portfolio of diverse resources to avoid the uncertainties associated with relying on any one type of resource.

State and Local Government

State and local governments must have a full opportunity to participate in the implementation of this plan. This will require consultation, financial and technical assistance, and other support.

A number of programs, such as geothermal district heating projects, efficiency improvements in government buildings, land use and solar access standards, and voluntary conservation measures, will require the active involvement of state and local governments to succeed. Their support, and in some cases legislative action, also will be needed to adopt and implement the energy-efficient building codes included in the model conservation standards.

Consistent Policies

Developing the cheapest resources when needed requires consistent, simple resource acquisition policies and procedures, as well as reliable resource price projections. This is particularly important for developers of renewable resources, cogeneration, and other less conventional resources. The failure to follow such procedures will discourage developers and force the region to resort to less cost-effective and lower-priority resources.

"The purposes of this Act [are] ... to assure the Pacific Northwest of an adequate, efficient, economical, and reliable power supply"

Chapter 3
Flexible Planning Strategy

The Council's regional electric power plan provides a mixture of electric power resources: conservation, additional hydropower generation, cogeneration, combustion turbines, and conventional coal-fired power plants. All of these resources may be necessary to meet the region's electric needs over the next twenty years. Resources were selected based on their technical, economic, and environmental characteristics. The Council's primary concern is ensuring an adequate supply of electricity at the lowest possible cost to the region's ratepayers. To accomplish this, the Council has developed a comprehensive approach to regional power planning that evaluates the contribution of specific resources to system cost by analyzing the way resources work together over a wide range of possible loads.

The Council collected and analyzed great amounts of detailed data. The information was systematically evaluated using several computerized models simulating the region's electric power system. This analysis and the Council's consideration of non-quantifiable factors relating to resource costs, flexibility, availability, lead times, and environmental and fish and wildlife effects that cannot be mitigated, helped guide the Council's decision in selecting the resources finally included in the power plan.

The Council's approach emphasizes flexible resources and conservation programs that can be modified to meet changing demands for electricity. Some resources, like conservation programs, can be initiated quickly, and the rate of implementation can be adjusted over time to fit actual needs. On the other hand, major electric generating plants with long construction periods require critical decisions many years before the power might be needed. Therefore, long lead times increase the risk posed by the uncertainties inherent in energy planning. An investment in a long lead-time plant is warranted only when it is a much lower cost resource and the probability of needing that type of resource to produce electricity clearly indicates low probability of future demand falling short of the forecast.

These concepts of risk and uncertainty are well known to everyone faced with large capital investments in new plants or facilities that will only be profitable if the economy, markets, and other factors are favorable. All decisionmakers face the possibility that the future will not turn out as expected and the decision to invest may be costly.

The Council's decisions on new resources for the plan have many of the attributes of other business decisions. If resources can be acquired with shorter lead times, the uncertainties surrounding future conditions will be reduced. Lower capital costs and smaller resource sizes also can lessen the risk. The size of the investment is reduced when intermediate decisions are allowed on each resource addition. While smaller and shorter-lead-time plants are clearly better from a risk perspective, bigger long-lead-time plants could be good investments if the electricity they produce was cheap enough to offset the increased risks.

Based on these concepts of risk, resource lead time, size, and flexibility, the Council selected cost-effective resources to minimize the lead times and amount of capital at risk. The Council has developed a resource portfolio that has the diversity and flexibility to adapt to a wide range of future outcomes. This portfolio provides the region with the lowest cost, shortest lead time, and smallest incremental plant sizes that are cost-effective to ensure that the Council and the region will have the ability to change the plan in response to future needs.

Conservation—The Flexible Resource

Conservation is the most flexible resource because it has both a short lead time (once a program has been designed and tested it can be quickly scaled up or down) and it can be acquired in small increments, each of which begins generating (saving) energy immediately. Because there is not a lengthy period of siting, licensing, design, and construction for conservation, it can be quickly and easily modified to respond to changing conditions.

Bonneville's existing residential weatherization program is an excellent example. The program has been tested and proven (although the Council recommends some specific modifications discussed in the two-year action plan, chapter 10). In response to the current surplus, the program is being held at current levels of activity. If the region were expecting energy shortages, this program could be expanded by increasing marketing efforts and paying larger incentives. At current activity levels, the program can be preserved and maintained so that when higher load growth returns, the region can quickly increase the rate at which weatherization savings can be acquired.

Options—A New Approach for Power Planning

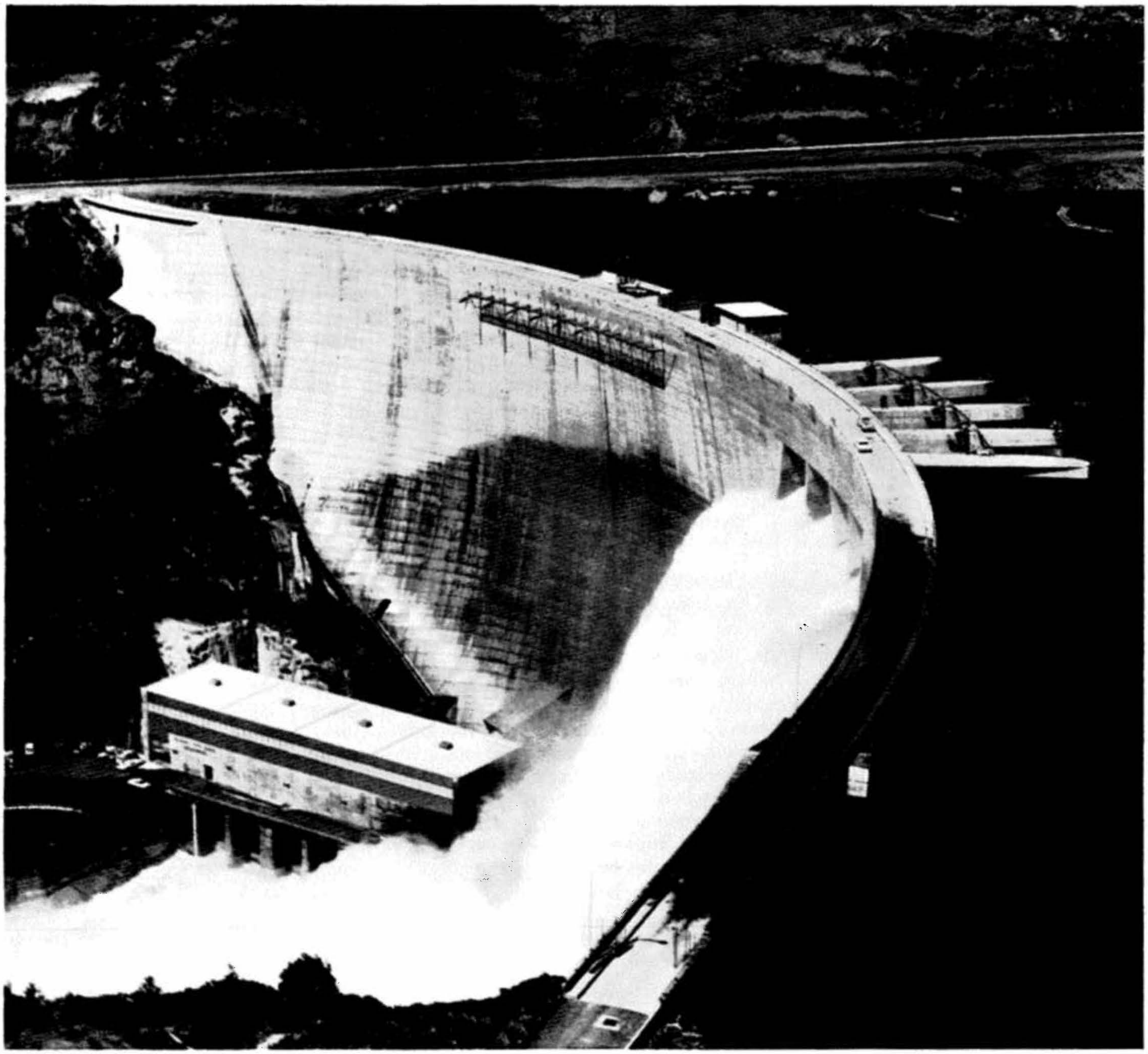
The Council developed a new approach to power planning to deal with generating resources. This approach involves shortening the period over which the need for power must be forecast for new resources. The forecast period can be reduced through an "option," a contract between a resource sponsor and the region, which allows the region to control the start of construction for resources which have received all necessary permits. To acquire an option, the region would provide financial assistance to a resource sponsor for the siting, licensing, and design of a generating resource. In exchange for this small investment, the region would gain the right to decide when conditions warrant beginning construction.

By having a fully licensed resource effectively on hold, the period over which electricity needs must be forecast is reduced to the resource construction period, which is often less than one-half of the total time that is currently needed. For example, the total lead time on a new coal plant is about ten years. The activities of siting, licensing, and design take from five to six years and are relatively low cost when compared to construction costs. An option on a coal plant could cost as little as $48 per kilowatt for siting, licensing, and design. At this point it would take five and one-quarter years to construct. If the probability of needing the resource is high and the resource is particularly cost-effective, then another option point is possible after ordering the boiler. This would cost a total of $180 per kilowatt and leave a construction time of four years.

The Council has been careful to select the cheapest resources possible while giving consideration to lead times and the size of the resource.

In addition to reducing resource investment costs and increasing flexibility of the resource portfolio, another primary benefit of the option approach is its significant potential for reducing environmental degradation. The longer large-scale generating plant construction can be postponed until need is more certain, the longer the accompanying environmental impacts can be postponed or avoided. The option approach guards against incurring environmental impacts of power plant construction before the region needs the energy to be generated by those plants. The options concept also favors developing resources with shorter lead times, and smaller-scale resources which often involve less severe environmental impacts.

The Council has planned for enough options and resources to meet a high level of economic growth. If the region actually experiences lower growth rates, some of the options would be delayed or even abandoned. This approach allows the region to match energy supply to actual demand and reduces the chance of overbuilding resources. An option contract would permit the region to decide when construction should begin.



There are three specific types of resource options:

- **Resource-banking**: A resource could be sited, licensed, and designed, but the construction phase would be put on hold.
- **Acquisition prior to regional need**: A resource could be acquired before the region needs the power, but the power could be sold outside the region at a price that recovers all costs of producing the electricity. Specific "callback" provisions would permit Bonneville to use the power inside the region when necessary.
- **Existing resource option**: In addition, there is another resource option that may be used in response to temporary resource needs—an existing resource whose output could be acquired by paying for its operating costs. (Examples are existing combustion turbines inside the region or excess generation in California or British Columbia.)

An option authorizes the region to construct, delay, or cancel the project as part of a cost-effective regional energy plan. The project sponsor would be compensated for the risk that the project might be rescheduled or terminated. An option is a form of insurance to the region, because it helps the regional planning process adapt to uncertain future loads. The preconstruction payments to the sponsor are similar to insurance premiums.

Using the Council's planning strategy, a resource might go through five steps:

1. **Option Planned**: The resource is identified as potentially needed, but no decision or financial commitment is necessary. Bonneville could begin developing incentives and requests for options, establishing criteria for selecting options, and resolving potential legal and technical questions. Based on the projected cost-effectiveness of and need for the resource and the costs of securing an option, differing option points may be appropriate for each resource.
2. **Option Initiated**: The Council and Bonneville determine that the resource may be needed in the future and Bonneville enters into a contractual arrangement to provide regional financial assistance for the siting, licensing, and design of a resource, in return for regional control of project timing.
3. **Option Secured**: All technical, legal, and administrative issues have been resolved and the resource is ready to move into the construction phase. At this stage, the construction of the resource could be delayed without affecting the ability of the region to move ahead on the project at some future date. Expected lifetime of the option will be determined by the Council at this time and the option will be scheduled for a comprehensive review when this lifetime expires. An option may be resecured after satisfying environmental and technical standards required to relicense the resource and site.
4. **Resource Acquired**: The Council and Bonneville determine that the secured option should be exercised based on current conditions and forecasts of demand. Under the resource acquisition provisions of the Act, Bonneville would purchase the resource and the project sponsor would move into the more expensive construction phase.
5. **Resource Completed**: The power is available to meet the obligations of the Bonneville Power Administration.

To describe graphically how the Council's decisionmaking process could work, figure 3-1 shows the energy that needs to be added in the high load forecast for 1983 through 2002. Also shown are four resources on which options are planned to be purchased. If the high load forecast should occur, the region would first initiate options on all resources and then build each of the resources as soon as siting, licensing, and design are completed. Options would be needed on the hydropower dam in 1984, the coal plant in 1988, and the cogeneration facility and the combustion turbine in 1992 so these resources could be available to meet the high growth forecast.

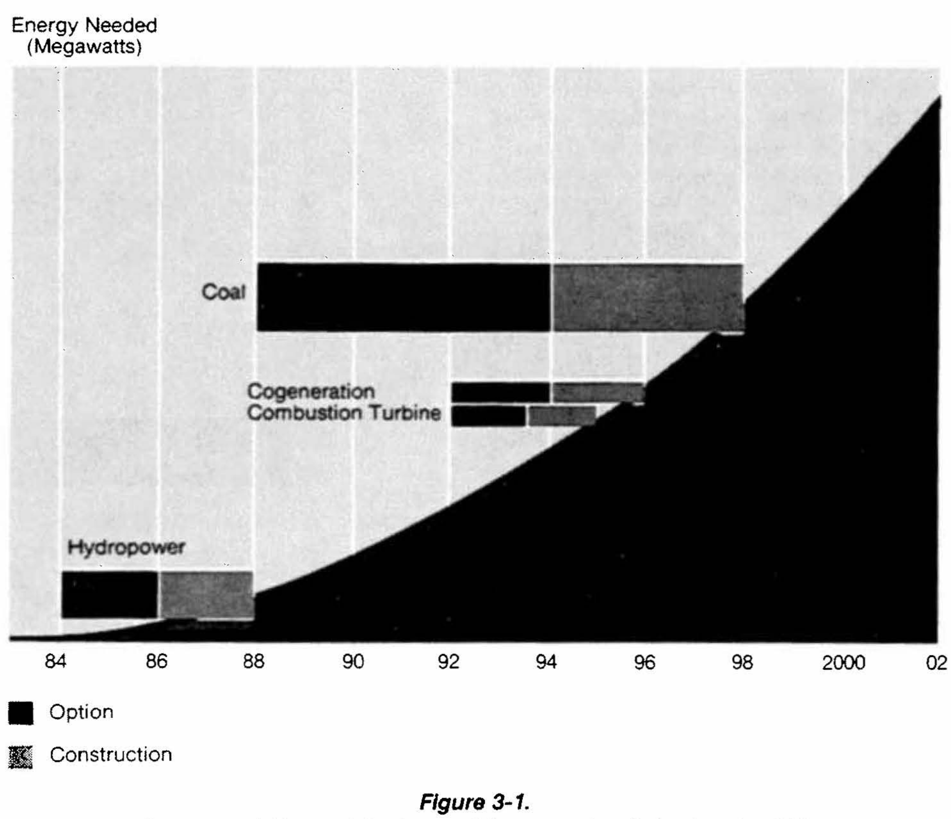


Figure 3-1.
Example of Planned Option and Construction Schedule in 1983

Figure 3-2 illustrates what happens if the Council makes a new forecast in 1985 and determines that the region is not growing along the previous high growth forecast. A new range, with a new upper bound forecast is established, and a new decision schedule results. In figure 3-2, the hydropower energy would not be needed until 1990. Since it takes approximately two years to build the dam, construction must start by 1988. The region would secure the option on the dam in 1986 after siting, licensing, and design have been completed; would hold the option for two years; and would make a decision to begin construction in 1988 if the region is experiencing high growth. In this example decisions to initiate options on the coal plant could be delayed until 1991, on the combustion turbines until 1993, and on the cogeneration until 1994.

Figure 3-3 illustrates a situation where the Council has made the same new forecast in 1985 and also determined that conservation programs and renewable resources included in the first plan are not performing as well as anticipated. As a result, the Council revised its portfolio downward by 2,000 megawatts and moved up decisions on alternative resources. In this case, the hydropower dam might be needed in 1988 to meet the high growth forecast. The option would be secured in 1986, followed by a decision to begin construction. A decision to initiate an option on a coal plant is needed in 1986 so the plant could be sited, designed, and built by 1996 if it were needed. Under the new decision schedule, options would be initiated on the cogeneration in 1989 and on the combustion turbines in 1988.

Initial Council studies have shown option costs to be inexpensive when measured as a percentage of total capital costs. The initial costs of siting, licensing, and design of a project are quite inexpensive compared to the construction costs.

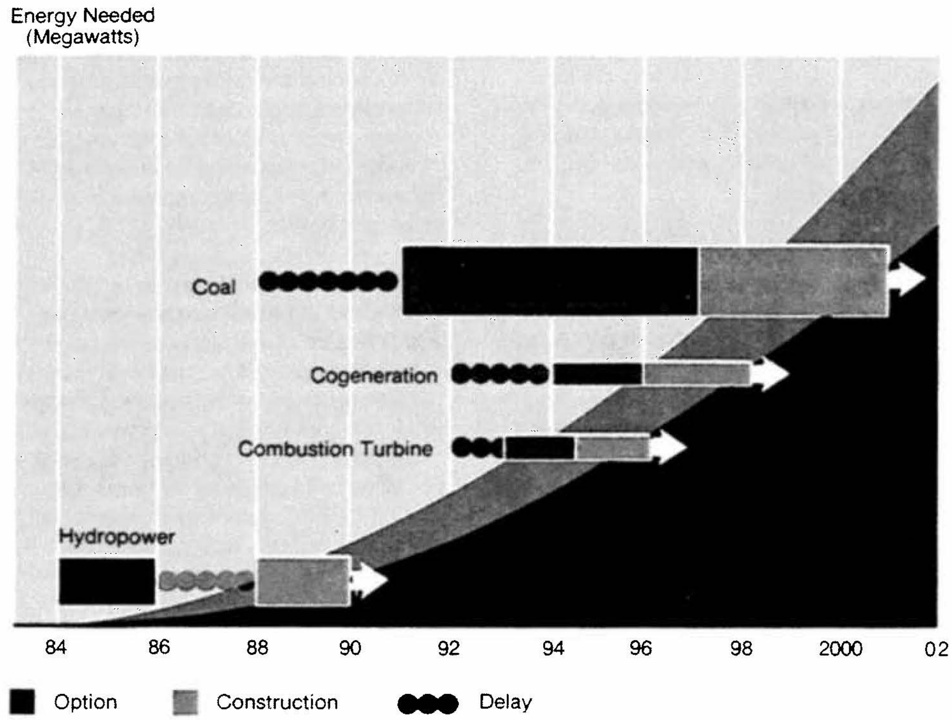


Figure 3-2.
Example of Planned Option and Construction Schedule in 1985

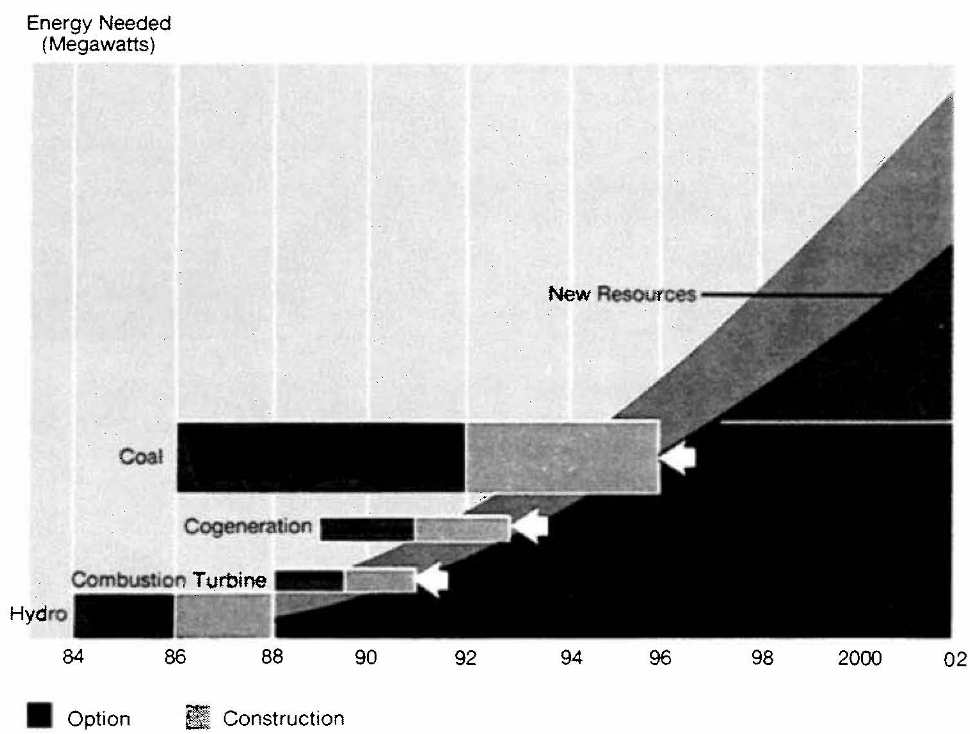


Figure 3-3.
Example of Planned Option and Construction Schedule in 1985
(Reduced conservation and renewable resources)

There are, however, significant differences in the cost of an option and the remaining construction lead times among resource types. Figure 3-4 shows the option and construction phases and their costs for five resources. (Costs shown for WPPSS 4 do not include sunk costs.) After the option phase, the coal plant takes only four years to complete while WPPSS 4 requires seven years. It is clear that an option on WPPSS 4 leaves the region exposed to seven years of changes in the energy growth forecast. For this reason, significant differences in risk remain, which should only be shouldered if the need for the power is fairly certain or if the nuclear plant could produce electricity at significantly lower cost to justify the risk.

Acquisition of resource options should incorporate an assessment of the risks of not being able to acquire an option. Since options are a form of insurance, the cost of insurance must be weighed against the potential risk of not being insured. Insuring against very low probability events is generally not sound business practice unless there are very high risks associated with being uninsured. So, too, must the application of resource options be subject to analysis of the probable load growth, the costs and lead times of the resources on which options are being acquired, the current options inventory, and the risks that might result if additional options are not acquired.

The options concept has great promise to provide the region greater flexibility in meeting its resource needs at the lowest risk and cost. To establish the practicality of this concept the Council, Bonneville, utilities, and resource developers must work to identify and resolve institutional, regulatory, and legal barriers to its successful operation. The energy siting agencies in Oregon and Washington have already demonstrated a willingness to incorporate key elements of the options concept into their procedures. During the next two years, the Council will expand its consultations with federal, state, and local governments, utilities, and resource developers to demonstrate the feasibility of acquiring options on generating resources.

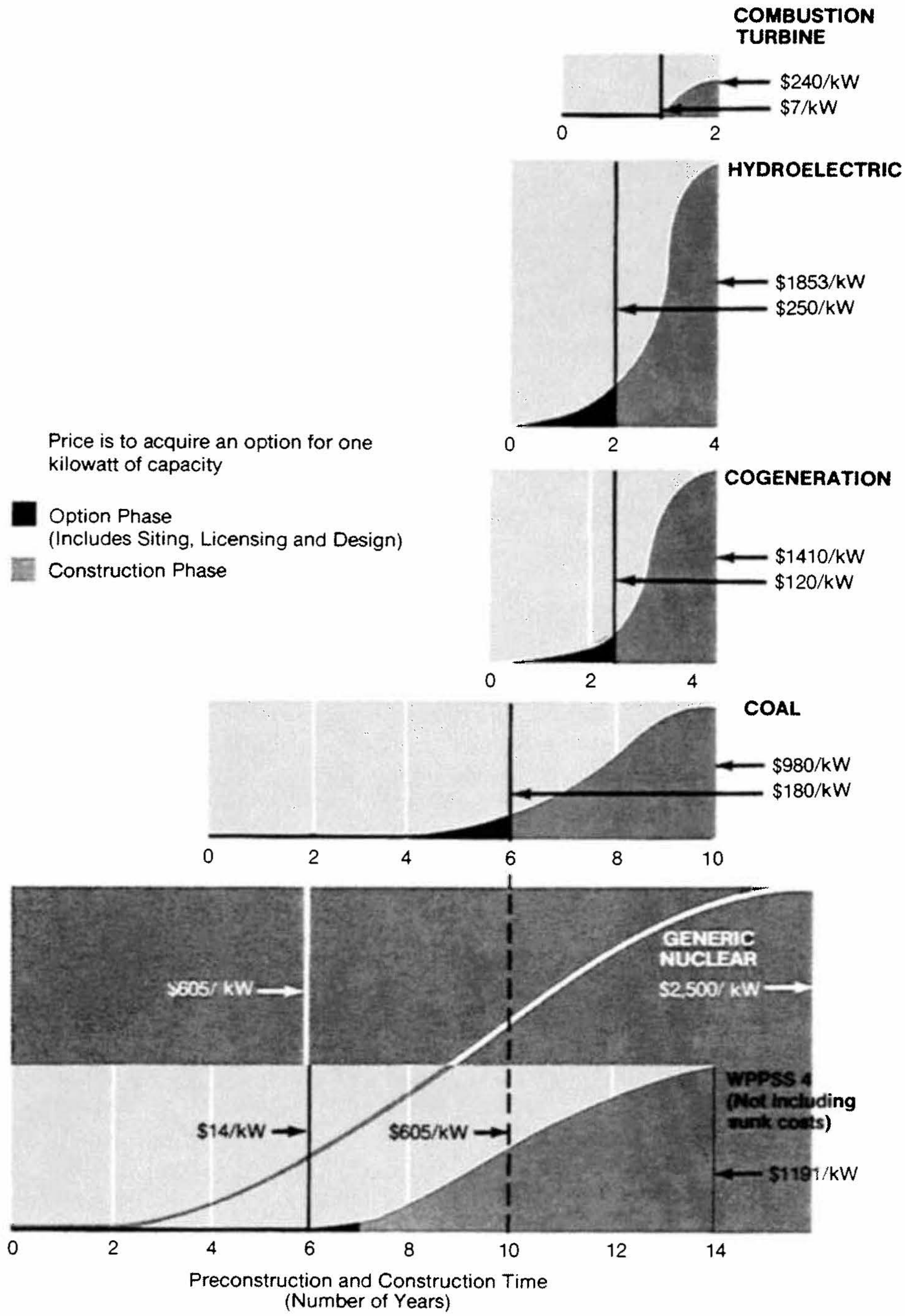


Figure 3-4.
Acquisition Schedules for Power Resources

Chapter 4
Forecast of Demand for Electricity

Forecasts of demand for electricity provide an important basis for the energy plan: a range of future needs for electricity. In addition, the demand forecasts play an important role in determining potential conservation resource availability and in determining future prices of electricity. This chapter describes the demand forecasts and their underlying assumptions.

The plan explicitly recognizes the uncertainty of future markets for electricity and treats that uncertainty in a creative and constructive way. An important part of this approach to planning in the face of uncertainty has been to recognize a wide range of economic possibilities for the Pacific Northwest. The alternative regional forecasts were developed within a range of national economic forecasts. In the high growth forecast, the regional growth in employment is 2.6 times an optimistic growth rate forecast for the nation, a relative growth higher than the highest five-year period since 1950. On the low side, the region could grow at a rate equal to a pessimistic forecast for the nation, a relative growth rate well below that of the past twenty years. The relative growth comparisons are illustrated in figure 4-1. The range has been defined so that regional planning does not constrain future regional growth, either through inadequate supplies of electricity, or through the excessive prices that would result from overbuilding.

Economic assumptions are the most important element in forecasting future demands for electricity. The Council has adopted and developed the best available energy demand forecasting models to determine the effects of alternative economic assumptions on growth in demand for electricity. Both the economic forecast range and the energy demand models were selected after an open process of public consultation and review, under the guidance of the Forecasting Subcommittee of the Scientific and Statistical Advisory Committee and other interested parties in the region.

An overview of the demand forecasting process is illustrated in figure 4-2. It shows that demands are determined by economic conditions, including the prices of fuel, and electricity. In addition, it is apparent that

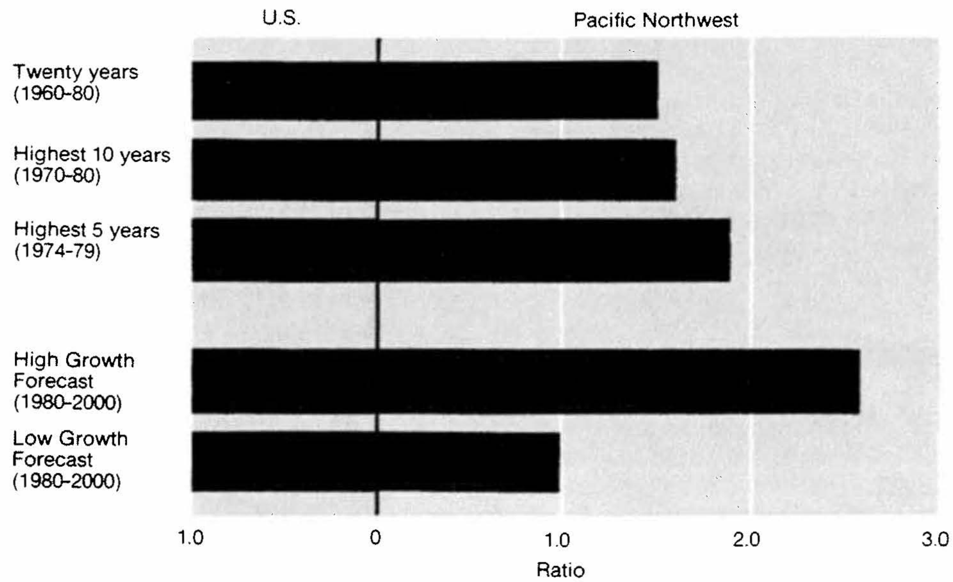


Figure 4-1.
Ratio of Pacific Northwest to U.S. Average Annual Employment Growth Rate

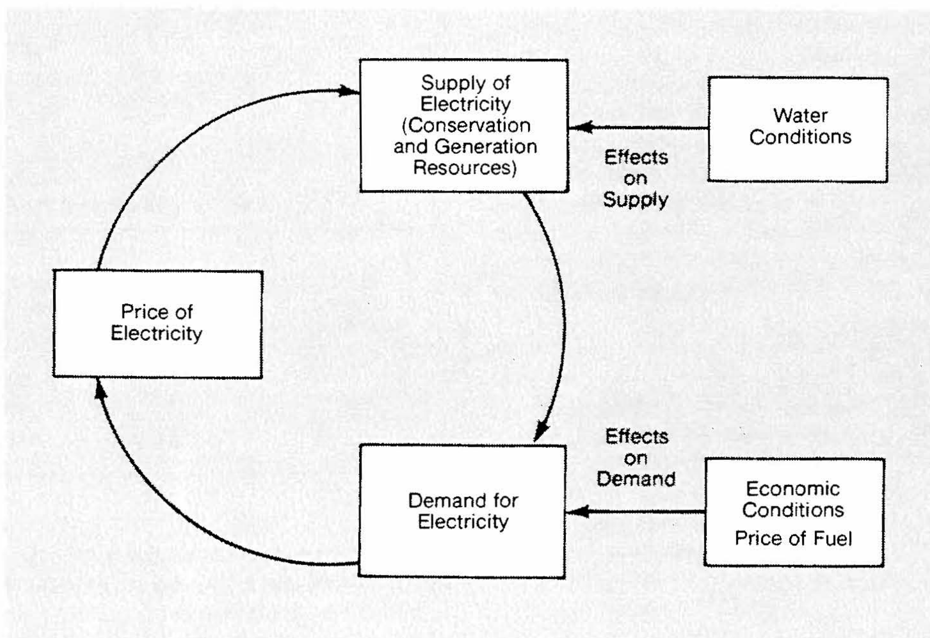


Figure 4-2.
An Overview of the Demand Forecasting Process

both the amount of demand and the specific resources chosen to satisfy that demand determine the price of electricity. Since the Northwest's supply of electricity is dominated by the hydropower system, water conditions are an important determinant of supply. The Council's forecast of demand for electricity reflects uncertainty in economic conditions, fuel prices, and water conditions.

Summary of Results

The plan includes a range of four alternative forecasts of demand based on different plausible scenarios of the Northwest economy. When no conservation programs were included, the Council's alternative sets of assumptions about the regional economy resulted in demand forecasts ranging from an annual growth rate of 2.5 percent in the high growth forecast to 0.7 percent in the low growth forecast. Two intermediate growth forecasts, medium-high and medium-low, predict annual demand growth rates of 1.5 and 2.1 percent. The range covered by these forecasts is wide. By the year 2002, there is a difference of nearly 8,400 average megawatts of demand between the high and low forecasts. When transmission and distribution losses are included, this implies that the high growth forecast would require 9,000 average megawatts more new resources than the low forecast.

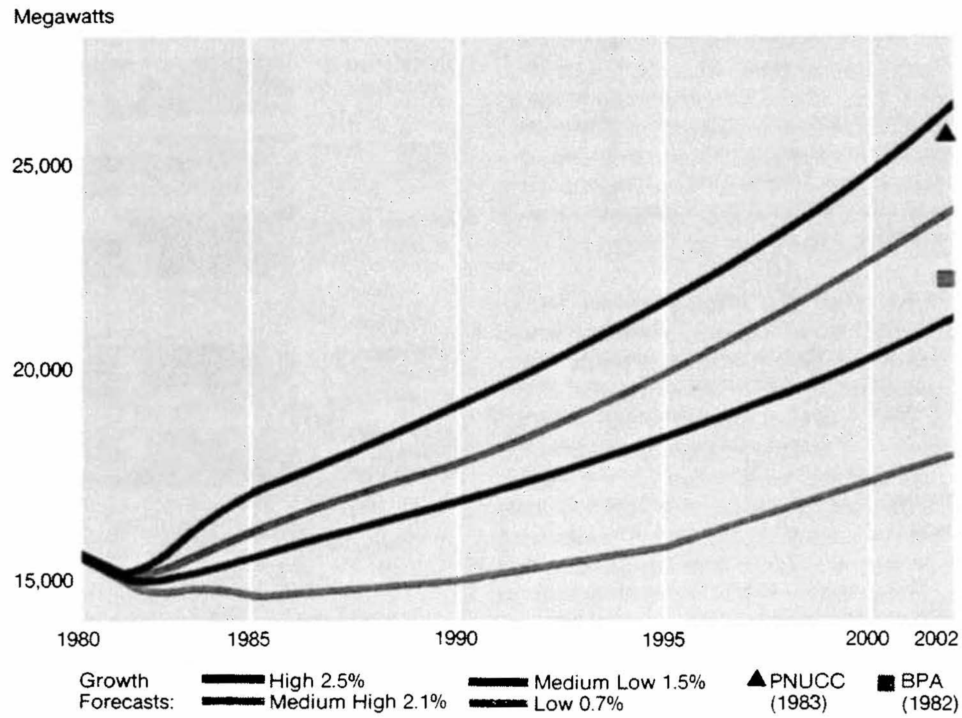


Figure 4-3.
Summary of Council's Demand Growth Forecasts

Table 4-1.
Forecast of Demand for Electricity and Price Projections

GROWTH FORECAST	DEMAND (Average Megawatts) 1981	2002	AVERAGE ANNUAL DEMAND GROWTH 1981-2002 (%)	INCREASE IN AVERAGE RETAIL PRICES ADJUSTED FOR INFLATION 1981-2002 (%)
High	15,524	26,245	2.5	80
Medium-High	15,524	23,797	2.1	50
Medium-Low	15,524	21,301	1.5	25
Low	15,524	17,834	0.7	5

Figure 4-3 displays the Council's four principal forecasts from 1981 to 2002. Table 4-1 shows the demand projections and the total percent increase of average retail prices of electricity adjusted for inflation. Satisfying each level of demand requires a combination of conservation resources to reduce the need for electricity and generating resources to produce electricity. The additional resources needed to meet the high growth forecast would increase the average price of electricity by 80 percent adjusted for inflation from 1981 levels. This means that the average prices expressed in 1980 dollars charged by investor-owned utilities and public agencies, weighted by their respective sales, would increase from 2.0 cents per kilowatt-hour in 1981 to 3.6 cents in 2002. If regional demand for electricity turned out to be at the lower end of the range, prices would be only 2.1 cents per kilowatt-hour in 2002.

Dramatic price increases from 1981 through 1984, primarily caused by thermal construction costs that already have been incurred, are present in all four forecasts. The 1985 prices shown in figure 4-4 are all near 2.7 cents per kilowatt-hour. With inflation added, 1985 rates would be about 3.7 cents per kilowatt-hour. As illustrated in figure 4-4, price changes after 1985 differ greatly depending on the need for new resources. These patterns reflect the fact that new resources are far more expensive than existing resources.

The price projections shown in figure 4-4 assume the resources selected in this plan, and therefore reflect the minimum cost of meeting either the high or low load forecast. A different mix of resources could increase the price projections. For example, if the conservation resource is not fully realized, the region will have to turn to more costly generating resources. If this happens, the prices that will occur will be significantly higher than these projections for both the high and low forecast.

Clearly, providing electricity for a high growth rate in the region is expensive. If the region's economy is indeed booming, it can well afford the additional expense, although fixed-income and low-income households

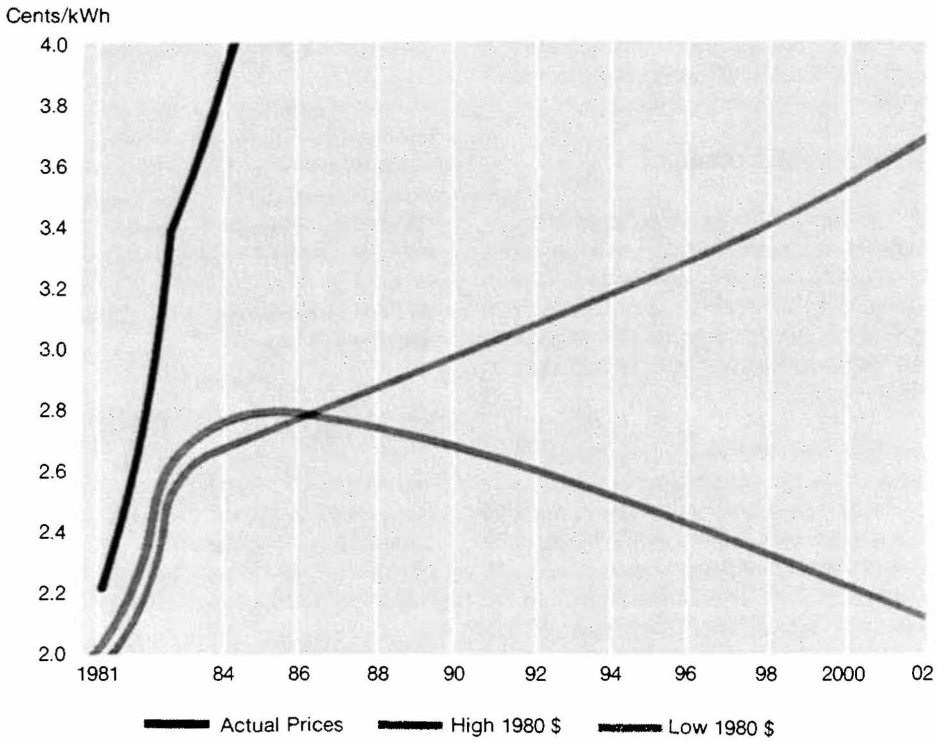


Figure 4-4.
Weighted Average Retail Prices, Adjusted for Inflation (1980 cents per kilowatt-hour)

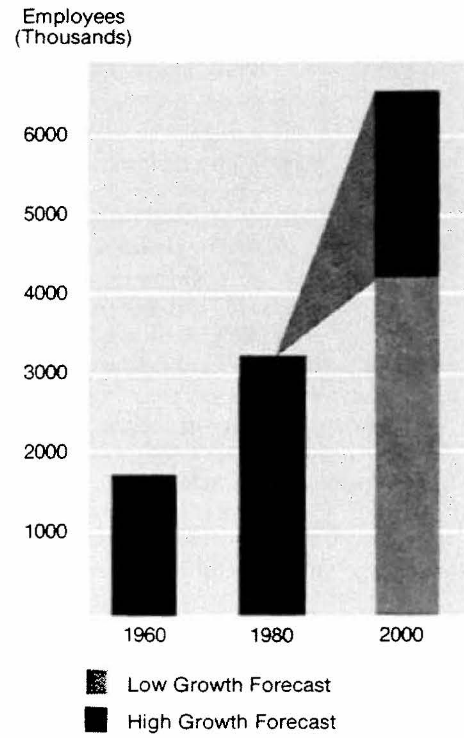


Figure 4-5.
Forecasts of Total Employment

would be hurt by this increase in their cost of living. It would be a costly mistake, however, to commit to high growth resources if that level of growth failed to materialize. The following sections describe the Council's forecasts and their underlying assumptions in more detail.

Economic and Demographic Assumptions

The Council's plan assumes that record high economic growth is possible for the region in the next twenty years and includes that possibility in planning. The plan thus ensures that the supply of electricity will not constrain economic growth. At the same time, however, building resources for economic growth that is uncertain can result in larger surpluses, increased prices, and adverse economic effects. The importance of economic forecasts, as well as their uncertainty, is at the heart of the Council's power plan.

The range of economic forecasts as measured by total employment is illustrated in figure 4-5. In the high economic forecast, employment in the Pacific Northwest doubles during the next twenty years, increasing by over 3.4 million between 1980 and the year 2002. This compares with less than 1.5 million additional employees in the preceding twenty years. The region's total employment grew at an average annual rate of 3.1 percent between 1960 and 1980. The high growth forecast assumes total employment would increase by 3.7 percent per year from 1980 to 2002, a record twenty-year growth rate.

The Council's economic forecasts recognize that the regional economy is closely tied to the national economy. Thus the range of regional economic forecasts is related to a range of national economic forecasts from Data Resources Incorporated. Those national economic forecasts have lower growth expectations compared to the past twenty years. Between 1960 and 1980, total U.S. employment grew at an average 2.1 percent annually; the forecasts range from 1.0 to 1.4 percent annually between 1980 and 2002. These forecasts reflect underlying changes in basic demographic patterns that are relatively certain. In addition, they reflect less certain predictions regarding, for example, government economic and regulatory policies, inflation, interest rates, and rates of productivity growth.

Historically, the Northwest economy has grown faster than the nation. Between 1960 and 1980, the region grew 50 percent faster than the nation. However, the Northwest economy appears to be at a turning point. The region's competitiveness could be seriously affected by recent increases in the price of electricity that will nearly eliminate a substantial advantage this region enjoyed in the past. Increases in transportation costs are also expected to affect the Northwest adversely. The outlook for traditional major industries in the region such as lumber, transportation equipment, and aluminum, does not include much growth beyond the peak employment levels of 1977 to 1980.

These conditions make the next twenty years' economic growth highly uncertain, resulting in a wide range of economic assumptions in the plan.

The Council's economic forecasts begin with evaluations of possible employment growth for individual manufacturing industries. Next, the implications of manufacturing sector growth for increased employment in supporting service industries are predicted. Using the total employment forecast, and an accompanying assumption about the share of the population that will choose to work, an estimate of regional population is derived. It is assumed that more rapid regional growth would bring better wages and more employment opportunities and result in a greater number of people working in a given population. The expected number of households is derived from population by assuming trends in the number of persons per household. It is assumed that a booming economy would encourage more independent households. Thus, the average number of persons per household is lower in the higher forecasts, and there are more households relative to the population.

The economic forecasts are discussed in greater detail in Appendix H (Volume II, available on request) and in the Council's issue paper on "Economic and Demographic Assumptions." The four forecasts are characterized briefly in the following paragraphs.

High Growth Forecast

The high growth forecast is based on a rapid recovery from the current recession, with the region's economy returning to long-term levels by the late 1980's. The long-term growth through 2002 is based on healthy, but not rapidly growing, traditional industries such as lumber and wood products, aluminum, transportation equipment, paper, and agriculture. Lumber and wood production is projected to maintain levels comparable to peak production experienced between 1977 and 1979. Employment in transportation equipment is 50 percent higher than 1980 levels by the year 2002. The proposed Alumax aluminum plant was recently postponed for an indefinite time. It is now assumed that the Alumax plant will not be built before 2002. However, all existing aluminum plants are assumed to return to full production. Electronics and other light manufacturing industries are assumed to grow rapidly, as are secondary activities such as trade and services. By the end of the century, the electronics industry is projected to employ more workers than any other manufacturing industry in the region, adding 140,000 new jobs to the existing 86,000 jobs in the industry.

Low Growth Forecast

In the low growth forecast, total employment in the region would increase by seven hundred thousand employees between 1980 and 2002—an implied regional growth rate of 1.0 percent per year, about the same rate as the low growth national forecast for the same period.

In addition to the lower twenty-year growth rates in the low growth forecast, the recovery from the current recession is assumed to be much slower. The region's economy would not reach its long-term growth levels until after 1990. Traditional industries are assumed to experience a longer adjustment period to the current recession than in the high forecast. The low forecast assumes that 30 percent of the current aluminum capacity remains idle. Lumber and wood products industries would recover to 1980 employment levels but would not return to recent peak employment levels during the next 20 years. Transportation equipment employment would fall to 20 percent below its recent 1980 peak employment by the year 2002.

For each of the employment growth forecasts, a consistent set of other economic and demographic indicators is also projected. These other factors include population, number of households, per capita income, and the mix of housing types. Each of these indicators plays a role in determining future demands for electricity in various sectors of the economy.

Intermediate Forecasts

Two intermediate economic and demographic forecasts were developed based on combinations of high and medium ranges and medium and low ranges of industry forecasts and other assumptions.

In the medium-high growth forecast, rapid growth in high technology and commercial industries is coupled with moderate levels of activity in traditional industries such as forest products and aerospace. This results in total employment growth of 2.9 percent per year, and population and household growth of 2.1 and 2.8 percent per year.

In the medium-low growth forecast, traditional industries experience low levels of economic activity while other manufacturing and commercial industries experience moderate growth levels. Total employment is projected to increase at a rate of 1.9 percent per year, with population and households increasing at rates of 1.4 percent and 2.0 percent per year.

Fuel Price Assumptions

Where other fuels may be substituted for electricity, the price of such fuels affects the demand for electricity. Although the direct effects on demand for electricity of a given fuel price change are small, the effects are felt in the three largest economic sectors (industrial, residential, and commercial). In addition, future fuel prices are highly uncertain.

To develop forecasts of alternative fuel prices, the Council adopted a set of assumptions that link retail prices of oil and natural gas to trends in world oil prices. Fuel price forecasts, therefore, rely on a range of underlying assumptions about world oil prices. Based on Council studies, four future possibilities were investigated. These cases were selected to provide upper and lower bounds for possible future fuel prices. In the lowest forecast, the world oil price (in 1980 dollars) drops from 30 dollars a barrel in 1980 to 20 dollars a barrel in 1985, and then increases to 25 dollars a barrel by 2002. In the high forecast, the world oil price returns to 1980 levels by 1985 and then increases rapidly, reaching 63 dollars a barrel by the year 2002. The assumptions for world oil prices for all four forecasts are illustrated in figure 4-6.

Demand Forecasts

The alternative economic and demographic assumptions described above were combined with the assumptions of various fuel prices to provide a starting point for the Council's analytic process. This section discusses the demand forecasting portion of that process, but the demand forecasts do not stand alone in the analysis; they require balancing demand, resources, and prices of electricity. A parallel process is the analysis and selection of the best mix of resources to meet uncertain future demands. Since resource selection and demand depend on each other, the analytic process must reconcile the two. The demand forecasting system translates the costs associated with a set of resources into prices of electricity for various Bonneville customer classes. The prices for each growth forecast are then used to adjust the respective demand forecasts. Adjustments are then made to resource requirements and, if necessary, the process continues until loads, resources, and prices are balanced in each of the growth forecasts.

Development of the Council's forecasting tools, like the economic and demographic assumptions, included broad public review and participation. The Council established the Scientific and Statistical Advisory Committee (SSAC) to help develop the plan. Members of the Forecasting Subcommittee of the SSAC represent private business, public and private utilities, state agencies, and academic institutions. The Forecasting Subcommittee worked with Council staff and contractors throughout the process, beginning with contractor selection in the fall of 1981, monitoring contractors' work through various stages, and providing valuable advice on methods, assumptions, tests, and documentation. These models were examined for validity by the Council. Using forecasting assumptions similar to those that actually occurred during the 1970's, the load forecasting system accurately replicated the load growth rates of the 1970's.

The demand forecasting system is designed to permit analysis by sector, state, Bonneville wholesale power rate pool, and climate zone. The primary sectors are residential, commercial, industrial, and irrigation. Washington and Oregon each have two climate zones; one east and the other west of the Cascade Mountains.

The starting point for the demand forecasts involves characterizing uses of electricity in each sector. Use in major applications and building types is estimated. Table 4-2 lists specific uses of electricity for the three major sectors included in the Council's forecasting models. Irrigation demand for

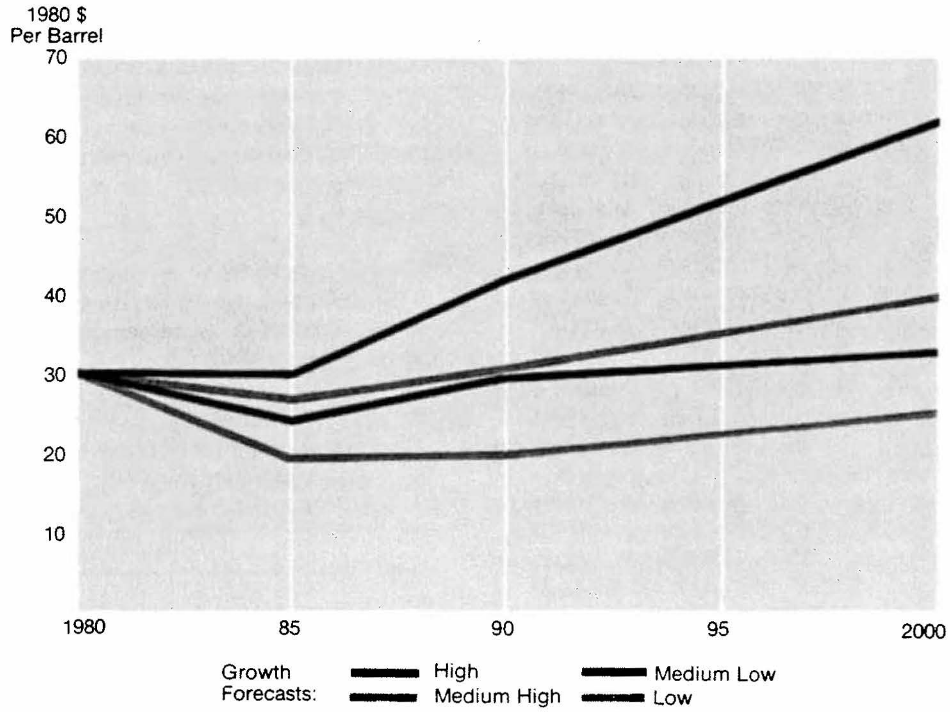


Figure 4-6.
World Oil Price Assumptions

Table 4-2.
Model Characteristics

RESIDENTIAL	COMMERCIAL	INDUSTRIAL (3 submodels)
Building Types	**Building Types**	**Industries with End Use Detail**
Single-Family (1-4 units)	Offices	Lumber
Multi-Family (5 or more)	Retail stores	Plywood
Mobile Homes	Warehouses	Particle Board
	Restaurants	Pulp
End Uses	Health facilities	Paper
Space heating	Grocery stores	Paperboard
Air conditioning	Elementary and secondary schools	Chlorine
Water heating	Colleges and trade schools	Phosphorus
Refrigeration	Miscellaneous	
Food freezing		**DSI Customers**
Cooking	**End Uses**	
Lighting	Space heating	**Other Industries**
Other	Air conditioning	by industrial category (2-digit SIC)
	Ventilation	
Housing Vintage	Water heating	
New	Cooking	
Existing	Refrigeration	
	Lighting	
	Miscellaneous	
	Building Vintage	
	By year of construction	

electrity is examined in less detail by the demand model.

In addition to separate demand models for the residential, commercial, irrigation, and industrial sectors, the Council's forecasting model includes a peak demand model, which produces estimates of total peak demand for electricity, and an electricity pricing model, which projects prices of electricity by sector and rate pool based on sales of electricity and resource costs.

An important result of the demand forecasts is that, even in the high forecast, demands grow more slowly than historical rates. This is true even before the effects of the Council's conservation programs are subtracted. Two important reasons for the decrease in demand growth relative to economic growth are large increases in prices of electricity and the existence of recently adopted energy codes for buildings. These factors account for much of the reduced use per unit in the residential and commercial sectors. In the industrial sector, most of the forecast growth is expected to occur in non-electricity-intensive industries. Direct Service Industries accounted for 15 percent of firm sales of electricity in 1981. Because the Northwest Power Act precludes future growth of the Direct Service Industries, a large share of regional demand will not grow during the forecast period. This lowers the growth in demand for electricity relative to total economic growth. Even within individual industries, significant shifts in energy use are projected in response to increasing prices and changing product mix. Specific patterns for the economic sectors are discussed in more detail later in this chapter.

Prices of Electricity

Demand forecasts start with economic, demographic, and specific resource assumptions and their costs. The pricing model converts the resource costs to prices of electricity that will vary depending on the particular resource strategy being evaluated. The pricing model mirrors current Bonneville and utility pricing practices. It also recognizes the complex requirements detailed in the Act which affect the pricing and allocation of Bonneville power and Bonneville's acquisition of generating and conservation resources.

As demand grows, the costs of the necessary additional resources are added to the forecast prices for electricity. The resource strategy determines what resources are used to meet the growth in demand for electricity. The cost of the resources in the strategy determines future prices of electricity.

The Council's forecast of average retail prices of electricity in the region, assuming the resource portfolio presented in the plan, is shown in table 4-3.

Table 4-3.
Weighted Average Retail Prices
Adjusted for Inflation
(1980 cents per kWh)

	LOW	HIGH
1981	2.0	2.0
1983	2.6	2.6
1985	2.8	2.7
1990	2.6	3.0
1995	2.4	3.2
2002	2.1	3.6

The 1985 electricity prices are slightly lower in the high forecast, even though prices are much higher in the high forecast by 2002. This is because the thermal generating investments contributing to increased costs are essentially the same in both forecasts before 1985, but in the low forecast, these costs will be recovered through fewer kilowatt hours of electricity sales.

The Council's total demand forecasts for all sectors of the economy were summarized in figure 4-3. The 1981 use of electricity for each sector is shown in figure 4-7, and forecasts for each demand sector are described in the following sections.

Residential Demand

The residential sector accounted for 34 percent of regional firm sales of electricity in 1981. Residential sector demand is influenced by many social and economic factors such as fuel prices, per capita income, and the choices of efficiency of energy-consuming equipment available to consumers (available technology). However,

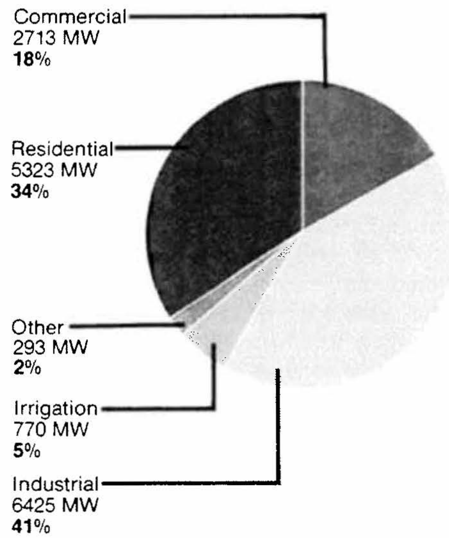


Figure 4-7.
Demand for Electricity by Sector, 1981

the most important factor is the number of households, as reflected in the structure of the residential sector demand model; the basic unit of this model is the individual household. The composition of the sector's use of electricity is reflected in the model's structure. Figure 4-8 illustrates the historical proportions of residential use of electricity. The model predicts the growth in the number of households; their choice of housing type; the amount of electricity-using equipment the average household owns; choices of fuel for space heating, water heating, and cooking; the level of energy-efficiency chosen; and the energy-using behavior of the household. These choices are influenced in the model by energy prices, equipment costs, per capita incomes, and available technology.

The projections of residential demand for electricity cover a wide range. In the absence of conservation programs, projected residential demand increases from 5,323 average megawatts in 1981 to 9,643 megawatts in the high growth forecast and to 6,053 megawatts in the low growth forecast. As shown in table 4-4, the average demand growth rate ranges from a low of 0.6 percent per year to a high of 2.9 percent.

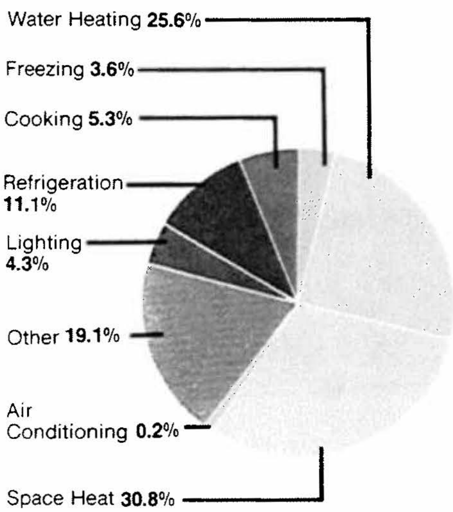


Figure 4-8.
1981 Residential Use of Electricity by Application

Table 4-4.
Residential Demand for Electricity

GROWTH FORECAST	1981	DEMAND (Average Megawatts) 1990	2002	AVERAGE ANNUAL DEMAND GROWTH 1981-2002 (%)
High	5,323	6,652	9,643	2.9
Medium High	5,323	6,111	8,458	2.2
Medium Low	5,323	5,843	7,232	1.5
Low	5,323	5,167	6,053	0.6

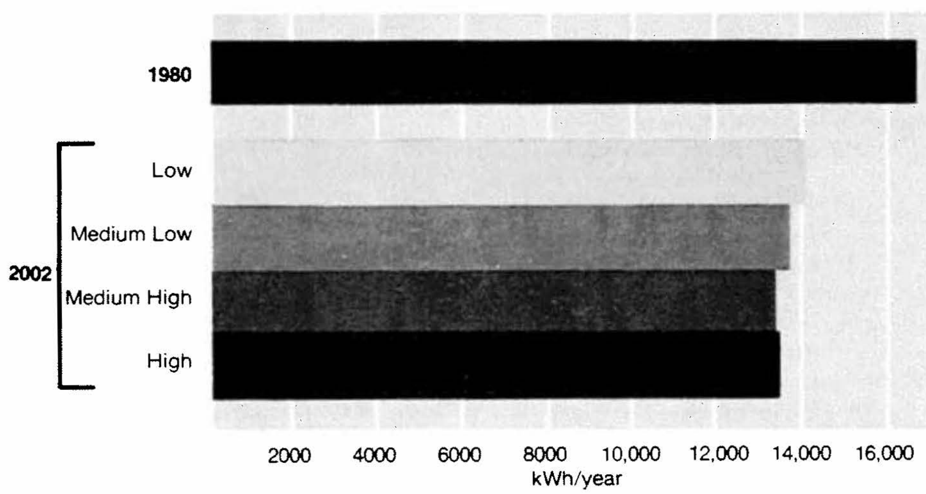


Figure 4-9.
Projected Annual Use of Electricity per Household in 1980 and 2002 by Growth Forecast— Without Changes in Building Codes

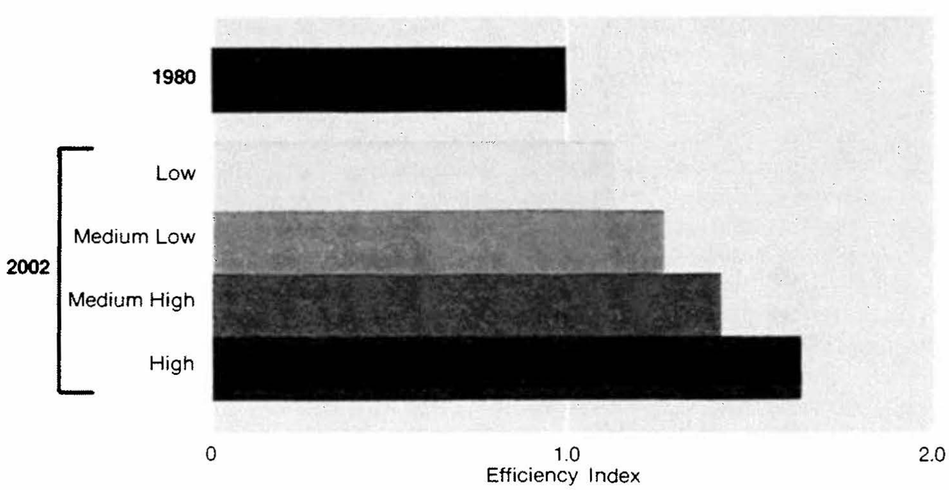


Figure 4-10.
Projected Thermal Efficiency of Electrically Heated Single-Family Houses— Without Changes in Building Codes

Although total residential use of electricity increases in all four growth forecasts, use per household decreases significantly. Figure 4-9 shows that this decrease in use per household is quite stable across the growth forecasts, ranging from 15 percent below 1980 levels in the low growth forecast to 19 percent in the medium-low growth forecast. The projected increases in total use despite these reductions in average household use reemphasize the importance of the increasing number of households in determining total use.

The most important influence leading to reductions in use of electricity per household is the projected change in efficiency of houses and energy-using equipment in all of the growth forecasts. Partly as a result of (1) building codes already in effect, (2) price increases, and (3) the introduction of the more efficient equipment into the market, the amount of electricity necessary to provide the same standard of service decreases in every forecast. This change varies by housing type, type of electric use, and growth forecast, but two examples help illustrate the trend. As shown in figure 4-10, the average thermal efficiency of electrically heated single-family houses improves by between 15 and 64 percent in the various growth forecasts without any changes in existing building codes. The change is less in lower-growth forecasts because of smaller increases in prices of electricity and other fuels and also because of lower population growth. Lower population growth means that the supply of housing that exists in the year 2002 will have a smaller proportion of recently built, more thermally efficient houses. Figure 4-11 shows the projected increase in efficiency of electric water heaters between 1980 and 2002.

Finally, the degree to which people use electrical equipment can be expected to change in response to prices of electricity, the efficiency of the equipment, and incomes. The most familiar example of such a change is in thermostat settings—energy use can be changed with no investment in equipment simply by accepting a different level of service (in this case a different temperature) in the house. Similar economy measures are possible for most energy uses. In spite of increased prices of electricity, a combination of energy-efficiency improvements and income increases are projected to result in more use of space heating (increased thermostat settings, heating rooms previously closed off, and using less substitute fuels such as wood, etc.) by the year 2002. Modest reductions in water heating use are projected.

This discussion of electrical equipment use was based on demand for electricity before the Council's proposed conservation programs. The effects of these programs are fairly predictable. Projected residential sales of electricity would grow at slower rates, and the use of electricity per household would decline faster because of the increased thermal efficiency of homes and water heaters estimated in the Council's conservation studies. The effects of these efficiency increases would be somewhat diminished, however, by greater use of space and water heat brought about by the cost savings from improved efficiency.

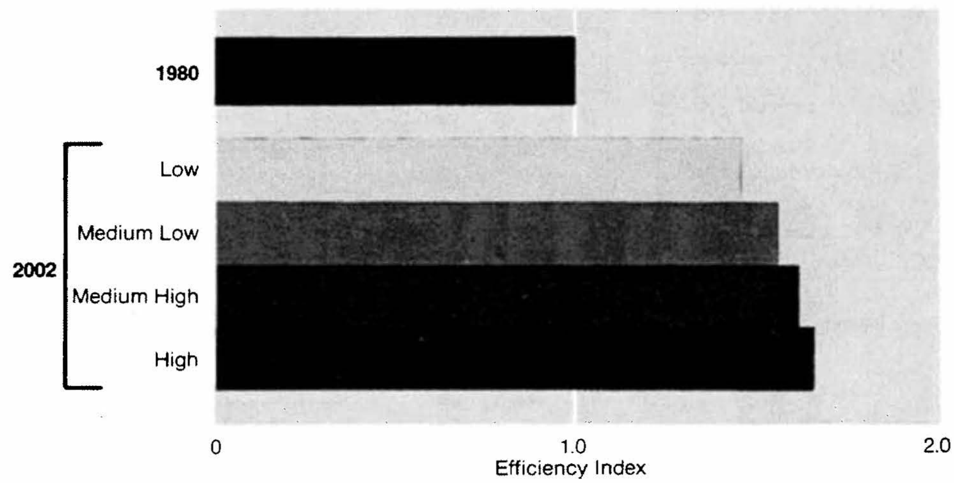


Figure 4-11.
Projected Energy Efficiency of Electric Water Heaters—Without Changes in Building Codes

Commercial Demand

Commercial demand for electricity accounted for 18 percent of firm sales of electricity in 1981. Commercial sector electricity demand, like that of the residential sector, is influenced by many factors such as fuel prices and available technology. There is one fundamentally important factor on which energy use projections can reasonably be based: the total floorspace of the buildings in the commercial sector. The commercial sector demand model projects the amount of commercial floorspace and then predicts fuel choice, efficiency choice, and the use of the energy-consuming equipment necessary to service this floorspace. These choices are based on investment factors, fuel prices, and available technology. This study separates commercial sector energy use by building type, application, and fuel type. Historical demand for electricity by the commercial sector for various applications is shown in figure 4-12.

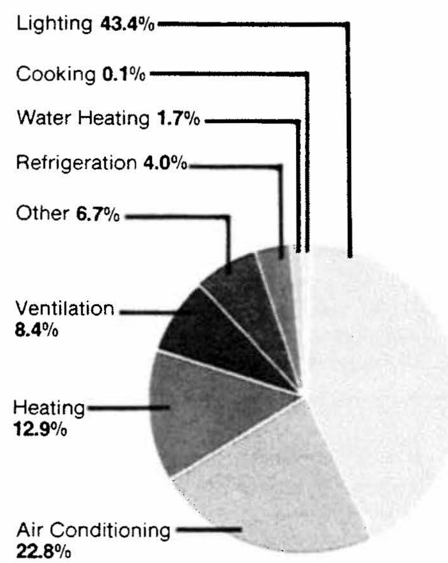


Figure 4-12.
1981 Commercial Sector Use of Electricity by Application

Projections of commercial demand for electricity vary widely. In the low growth forecast, commercial demand for electricity increases from 2,713 megawatts in 1981 to 3,254 megawatts by 2002. In the high growth forecast, it reaches 5,908 megawatts. As shown in table 4-5, the average rate of growth of demand ranges from 0.9 to 3.8 percent. The size of this range is due principally to the range of employment projections in the commercial sector (floorspace projections are based on employment). Examining some components of these projections gives a clearer picture of the developments that would produce these totals.

Use of electricity per square foot of floorspace, shown in figure 4-13, decreases in all growth forecasts. As in the case of use per household in the residential sector, the amount of decrease in use per square foot is quite similar for all forecasts, ranging from 9.7 percent in the high growth forecast to 8.2 percent in the low growth forecast.

The fraction of commercial floorspace which is air conditioned is projected to increase in all forecasts, with greater increases occurring in the higher-growth forecasts. Under these conditions, the use of electricity per square foot could be expected to increase without offsetting changes in the efficiency and intensity of equipment use. In each growth forecast there are changes in efficiency that vary with building type and type of application. Figure 4-14 shows the change in average efficiency of electrical space heating in commercial buildings between 1980 and 2002 for each of the four growth forecasts. Efficiency improvement is substantial, ranging from 36 percent in the low growth forecast to 64 percent in the high growth

Table 4-5.
Commercial Demand for Electricity

GROWTH FORECAST	DEMAND (Average Megawatts) 1981	1990	2002	AVERAGE ANNUAL DEMAND GROWTH 1981-2002 (%)
High	2,713	3,586	5,908	3.8
Medium High		3,123	5,011	3.0
Medium Low		2,854	4,030	1.9
Low		2,418	3,254	0.9

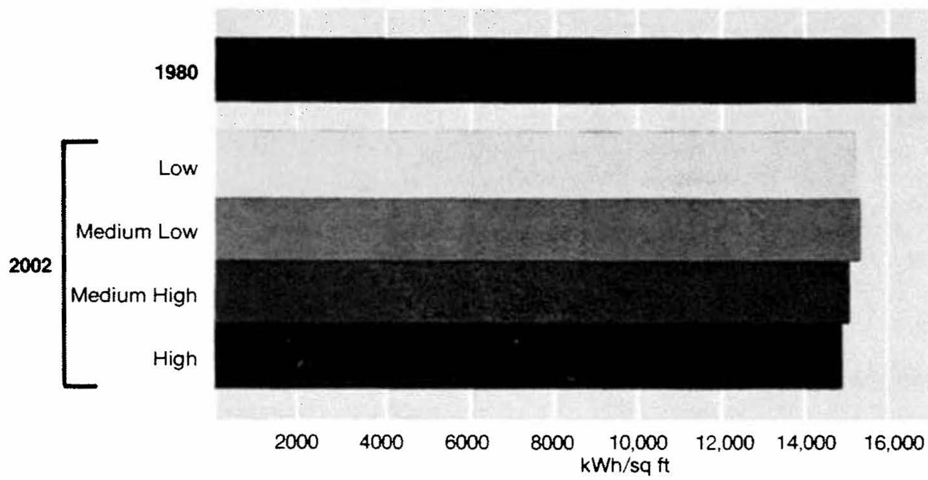


Figure 4-13.
Commercial Sector Average Annual Use of Electricity (per square foot)—Without Changes in Building Codes

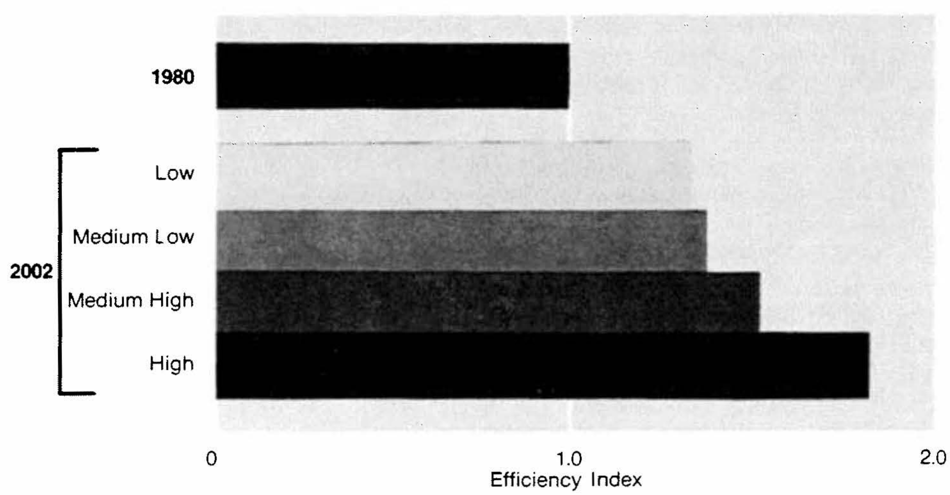


Figure 4-14.
Projected Efficiency Index of Electric Space Heat in Commercial Buildings—Without Changes in Building Codes

forecast. Similar improvements in lighting efficiency are projected, as shown in figure 4-15. Intensity of use adjustments also vary with building type, application, and forecast. Generally, these changes are small—improvements in equipment efficiency will tend to compensate for increased prices of electricity. The actual cost of maintaining a given intensity of use changes very little and in some cases even decreases.

These projections do not take into account the conservation programs included in this plan, but are based on existing building codes and market response to increased energy prices. The Council's programs will reduce overall demand for electricity, reduce demand per square foot, and improve equipment efficiency. Conservation savings estimated in the Council's conservation analysis will be reduced by increases in the intensity of electric use since the programs will decrease operating costs, to make the use of electricity more attractive.

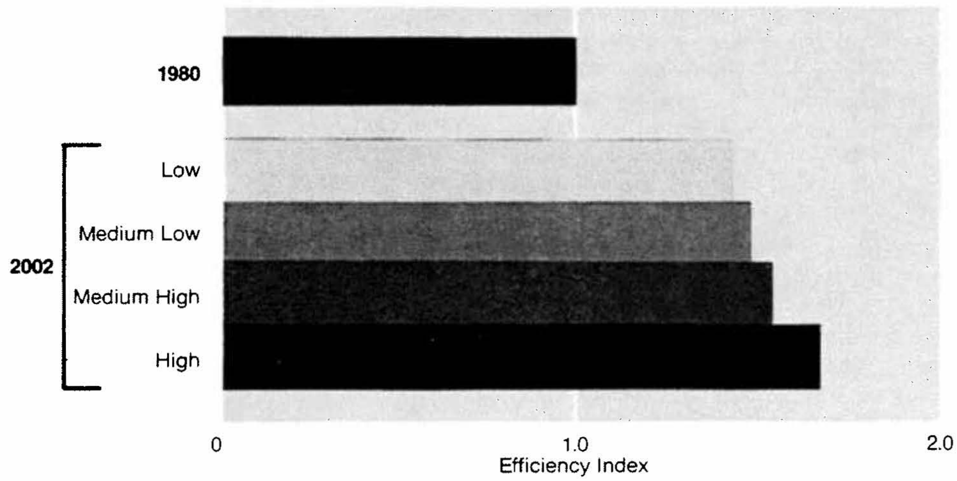


Figure 4-15.
Projected Efficienty Index of Lighting in Commercial Buildings—Without Changes in Building Codes

Industrial Demand

In 1981, the industrial sector accounted for 41 percent of firm electricity sales in the region. Thirty-seven percent of industrial demand was sales to Bonneville's Direct Service Industrial (DSI) customers. An additional 43 percent was sales to major electricity-consuming industries, including lumber and wood products, pulp and paper, and chemicals. Together, these two groups accounted for 80 percent of industrial consumption of electricity.

The concentration of sales in only a few industries and the distinction between DSI and non-DSI customers led to the adoption of a three-pronged modeling strategy. DSI consumption of electricity was forecast separately, based on an assumed return to their firm contract demand in all but the low forecast. Demands for the large electricity-consuming non-DSI's (lumber, paper, and chemicals) were forecast using a detailed demand model known as the key industries model. Load forecasts for the remaining industries were developed using an econometric model, referred to as the minor industries model.

Forecasts of demand for electricity for the non-DSI sector depend on projections of production by industry and on prices of electricity. The minor industry forecast also depends on assumptions concerning fuel prices.

The high and low forecasts of industrial sector demand for electricity are shown in table 4-6. Growth in firm industrial demand for electricity is projected to range from 0.6 percent per year in the low growth forecast to 1.7 percent in the high growth forecast. Two intermediate forecasts show demand growth rates of 1.5 percent and 1.6 percent per year.

In the four forecasts, the growth rates for components of the industrial sector vary among industry groups. All forecasts project that demand for electricity in the minor industries will increase at a faster rate than in the key industries or DSI customers. This results from the projections of economic growth in which electronics, plastics, and other manufacturing industries grow faster than such traditional industries as lumber and wood products, pulp and paper, and chemicals. Figure 4-16 shows the percent of industrial consumption of electricity by industry in 1980 and as projected for 2002 in the high and low growth forecasts. Industrial consumption increases dramatically for the minor electricity-consuming industries since they are projected to increase production at a faster rate than the key industries or DSIs in all growth forecasts. As shown, the industrial consumption accounted for by the DSIs decreases in all forecasts because firm sales are assumed to be limited to Bonneville contracts.

Table 4-6.
Industrial Demand for Electricity (Firm Sales)

INDUSTRY CATEGORY	DEMAND (Average Megawatts) 1981	2002 LOW	2002 HIGH	AVERAGE ANNUAL DEMAND GROWTH 1981-2002 (%) LOW	HIGH
DSI	2,405	1,956	2,668	1.0	0.5
Key Industry	2,740	3,282	4,102	0.9	1.9
Minor Industry	1,280	2,013	2,442	2.2	3.1
Total	6,425	7,251	9,212	0.6	1.7

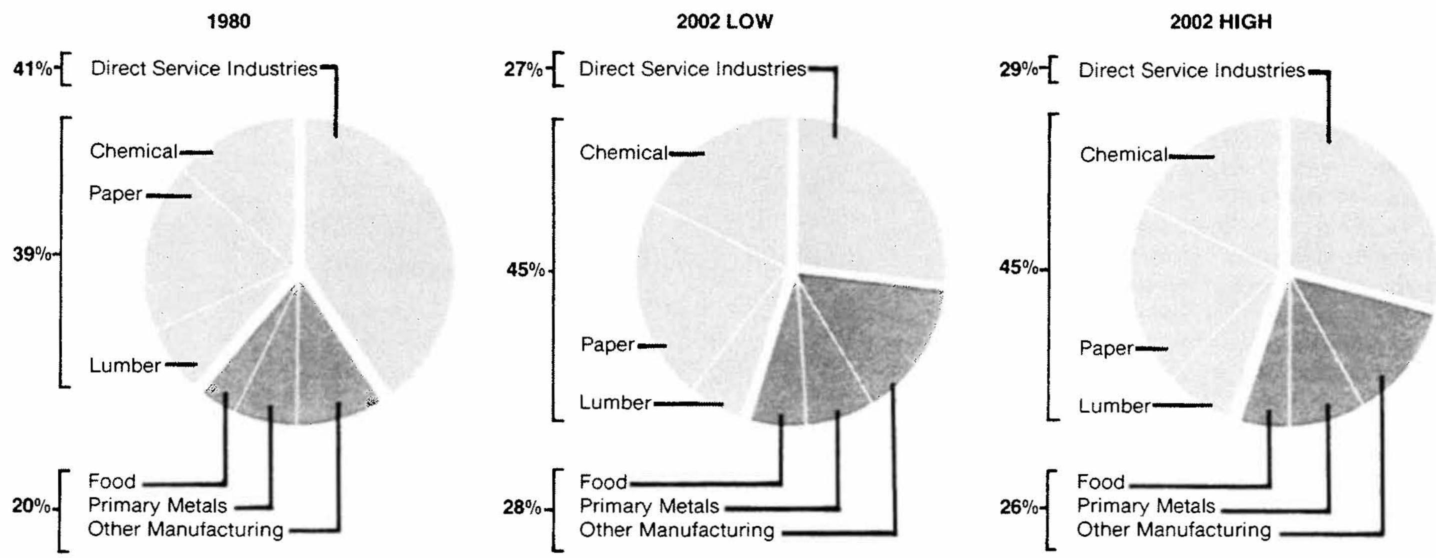


Figure 4-16.
Composition of Industrial Firm Sales

The DSI component of industrial demand assumes that the Alumax aluminum facility is indefinitely postponed in all forecasts. In the high, medium-high, and medium-low forecasts, it is assumed that all existing aluminum capacity remains in the region. In the low forecast, 30 percent of existing aluminum capacity is assumed to shut down, which accounts for the considerably lower DSI share of total industrial consumption in the low growth forecast.

The share of industrial electricity consumed by the lumber and wood products industries is projected to decrease in all forecasts. The chemicals industry, on the other hand, is projected to increase its share, primarily because of growth in the chlor-alkali and miscellaneous chemicals industries. The pulp and paper industry's share increases in the low forecast but changes very little in the high growth forecast.

Irrigation Demand

Irrigation loads represent approximately 5 percent of total firm loads in the region. The amount of electricity used for irrigation depends on factors such as number of irrigated acres, weather conditions, topography, and pumping lifts, as well as prices of electricity. The model used by the Council assumes a growth in demand for electricity for irrigation that would occur if prices of electricity remained constant, and then modifies that growth based on projected prices. The projections, shown in table 4-7, range from an average annual growth rate of 2.1 percent in the high growth forecast to 1.2 percent in the low. The two intermediate forecasts were based on the same assumptions regarding growth in the absence of price increases. The difference between these forecasts is due to the higher prices of electricity implied by the medium-high forecast.

Role of Demand Forecasts in Resource Selection

The demand forecasts presented in this chapter are based on a traditional concept of demand—assuming certain economic conditions and prices of electricity, then forecasting how much consumers would purchase. These are forecasts of "price effects" demand. Because the Council's plan treats conservation as a regional resource, this forecast of demand for electricity, which includes only the amount of conservation consumers would choose to purchase based on the average price they pay for electricity, does not provide an adequate basis for planning. Treating conservation as a regional resource requires that the Council's resource portfolio include all conservation that is cost-effective to the region, whether purchased by Bonneville or by individual consumers. The total amount of conservation that is cost-effective to the region is greater than the amount that consumers would purchase. This is partly because the long-run incremental cost of electricity to the region is higher than the average prices of electricity faced by consumers.

Table 4-7.
Irrigation Sector Electricity Sales Projections

GROWTH FORECAST	1981	DEMAND (Average Megawatts) 1990	2002	AVERAGE ANNUAL DEMAND GROWTH 1981-2002 (%)
High	770	902	1,200	2.1
Medium High	770	865	1,146	1.9
Medium Low	770	867	1,163	2.0
Low	770	722	994	1.2

To provide the appropriate basis for resource portfolio analysis, a second demand concept is required. This demand forecast includes all potential demand for electricity that could be satisfied with conservation or with generating resources. This forecast is called "frozen efficiency" demand because it assumes no increase, beyond 1983 levels, in the efficiency of energy-consuming equipment that could be subject to conservation programs. By making resource portfolio decisions based on "frozen efficiency" demands, all regionally cost-effective conservation potential can be identified, whether it will be purchased by consumers or Bonneville. In addition, using "frozen efficiency" demand as a basis of resource planning avoids the problem of counting the same conservation actions as both price response and conservation program effect. This helps to ensure comparable treatment of conservation and other potential resources.

A third demand concept is required to forecast prices of electricity. For determining prices of electricity, all costs, including conservation costs, and actual sales are needed. Therefore, a "sales" forecast is developed by incorporating conservation programs into the demand forecasting models. "Sales" forecasts evaluate the interaction between conservation programs, prices of electricity, and other determinants of demand.

The three concepts of demand (price effects, frozen efficiency, and sales) are illustrated for the high and low forecasts in figure 4-17. The difference between the frozen efficiency forecasts and the sales forecasts indicates the total reduction in demand expected from achieving all regionally cost-effective conservation. The difference between the price effects and the sales forecast illustrates the extent to which regionally cost-effective conservation exceeds what consumers would purchase at the same prices of electricity.

Once demand forecasting predicts a range of possible future energy needs, the next step is to design a portfolio of resources that is flexible enough to meet any of those needs. The next chapter describes how that portfolio was developed, and explains the different factors that were considered during its development.

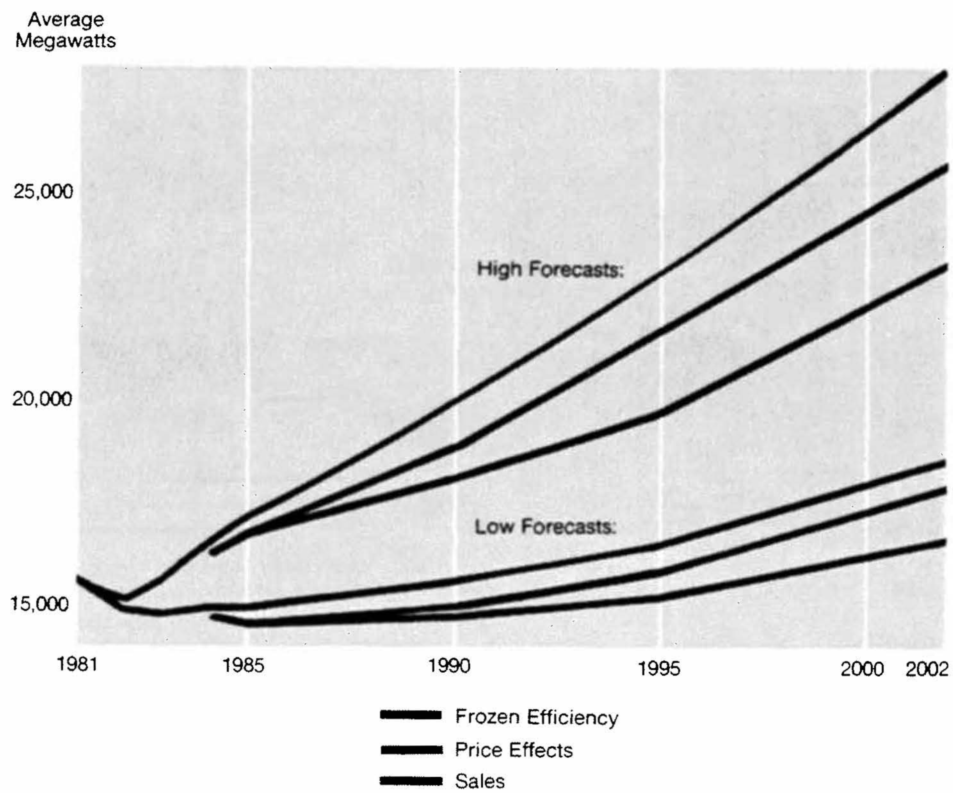


Figure 4-17.
Alternative Demand Concepts

"the plan shall include ... a forecast of power resources estimated by the Council to be required to meet the Administrator's obligations"

Chapter 5 Development of the Twenty-Year Plan

Chapter 4 described the broad range of possible energy needs the region may experience during the next twenty years, including record employment growth that would exceed the growth rate experienced during the past twenty years. The resource portfolio presented in this chapter has the ability to provide enough resources to meet a broad range of future regional electrical needs, including the high growth forecast, without significant risk of overbuilding resources.

This chapter first describes the cost-effectiveness perspective and the resource portfolio chosen by the Council, including the option and resource schedules for each of the four demand growth forecasts and a description of the conservative assumptions built into the plan. This is followed by a description of the eight major issues faced by the Council in determining that resource portfolio.

Electricity is supplied today via a complex system of generation plants and transmission lines. New resource additions, therefore, must be analyzed from a system perspective; that is, how well they would work with each other and existing resources. This chapter next reviews how this system analysis was conducted, beginning with a characterization of hydropower generation, the backbone of the regional power system; continuing with the discussion of the proper role of combustion turbines; and ending with a review of the specific process used to analyze the Council's portfolio.

Cost-Effectiveness Perspective

The Act requires that the Council give priority in this plan to resources it determines to be "cost-effective." The Administrator is required, when acquiring major resources, to acquire only those resources which are consistent with the plan. If he finds a resource to be consistent with the plan, he is not required to make any finding of his own about cost-effectiveness.

"Cost-effective" is a comparative test. A resource is cost-effective only in comparison to other resources. There is no absolute "cost-effectiveness." A resource is cost-effective if it produces power at an "incremental system cost" less than another resource. "Incremental system cost" must include some costs which are not included in the "cost of acquisition" to the Administrator: e.g., environmental costs; and the cost-effectiveness ranking must include the 10 percent advantage for conservation. Cost-effectiveness also includes considerations of the risk that is associated with large capital commitments and long construction lead times.

The Council has adopted a perspective which views the "system" as the ratepayers of the region. The Council's cost-effectiveness test is to minimize the total costs borne by the region's ratepayers, both directly and through their utility rates. This can be called a "regional perspective" or "regional cost-effectiveness."

An alternative perspective which the Council considered but did not adopt could be called the "utility perspective" or "utility cost-effectiveness." With this perspective the test of cost-effectiveness is to minimize Bonneville's revenue requirements alone rather than the total costs of providing electric service to the ratepayers.

The Council chose to measure costs from the perspective of the ratepayers as a whole for a variety of reasons. First, this perspective offers the simplest measure of costs. The Council is not faced with the difficult decision about what the "offering price" of a resource would be to Bonneville. For instance, the Council measures conservation cost as the total cost of installing a conservation measure, regardless of who pays what portion of the cost of the measure—the ratepayer directly or the ratepayer acting through the utility.

Second, the cost to all regional ratepayers as a group is a close approximation of the cost to the region as a whole. If the region chooses the electric resources that minimize its total cost, economic resources like capital will be used with maximum efficiency.

Third, the Council found it necessary to draw up a regional twenty-year plan, and found the interest of the region's ratepayers to be the most appropriate viewpoint for conducting this analysis. The Council cannot accurately predict in 1983 what portion of the region's demand growth will be placed upon the Administrator throughout the twenty-year planning period. It is possible under Bonneville's contracts with its customers that nearly all of the region's demand growth could be placed upon Bonneville, and hence the Council's twenty-year plan must include provision for meeting that growth. Viewing resource costs, therefore, as regional ratepayer costs is appropriate.

Resource Portfolio

The Council investigated a wide variety of resources to develop this power plan and to identify the most cost-effective resources that could be added to the existing power system. Based on these studies the most cost-effective resources are conservation and hydropower in the low and medium-low forecasts. Cogeneration, combustion turbines, and coal-fired steam-electric power plants would be added in the medium-high and high forecasts.

Conservation, as defined in the Act, means "any reduction in electric power consumption as a result of increases in efficiency of energy use, production, or distribution." It is important to note that this does *not* mean doing without. Conservation as used in this plan does not require any change in lifestyle or the level of economic activity. The conservation actions called for in this plan allow consumers to retain lifestyles, but to consume less electricity in the process. Furthermore, conservation is treated in this plan as a resource. This means that the Council has taken great care to analyze conservation as a substitute for additional electric generation. Throughout the discussion that follows, conservation is included as an additional supply of electricity rather than as a reduction to the demand growth forecast. This ensures equal treatment of conservation with all other resources. Thus, conservation, like other resources, will only be "acquired" if it is cost-effective. A specific resource strategy that identifies a preferred combination of resources and a schedule for adding them to the existing system has been developed for each of the four growth forecasts shown in figures 5-1 through 5-4.

If the low growth forecast (figure 5-1) should occur, the Council plans to meet the demand with conservation alone.

As higher growth occurs, the Council plans to meet the demand by adding more conservation, then hydropower, cogeneration, combustion turbines, and coal.

The plans for the resources necessary to meet the demands of the other three forecasts are shown in figures 5-2, 5-3, and 5-4. The selected mix of resources is readily seen by comparing these figures.

This plan accomplishes two very important objectives. First, it contains the lowest cost mix of resources taking into consideration fish and wildlife and environmental impacts. Second, this resource strategy will provide needed planning flexibility through the maximum use of flexible (small and short lead time) resources and the controlled use of options. This strategy assures the region an inventory of resources that will meet even the highest demand growth. It also maintains the flexibility to avoid committing large sums of money for resources that would not be needed, or would be needed much later, if regional demand for electricity should be low.

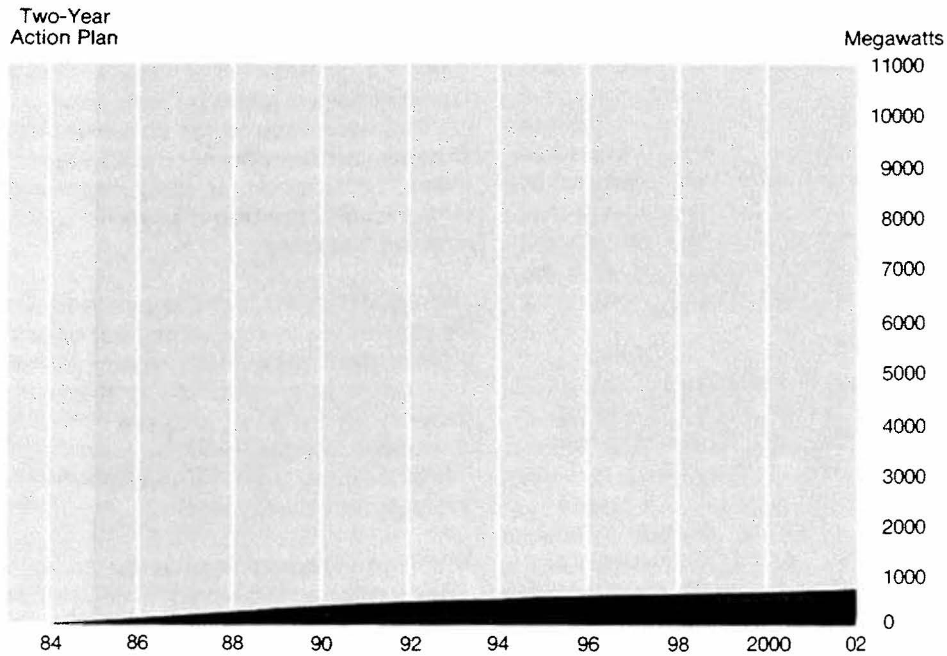


Figure 5-1.
Low Growth Forecast Resource Mix

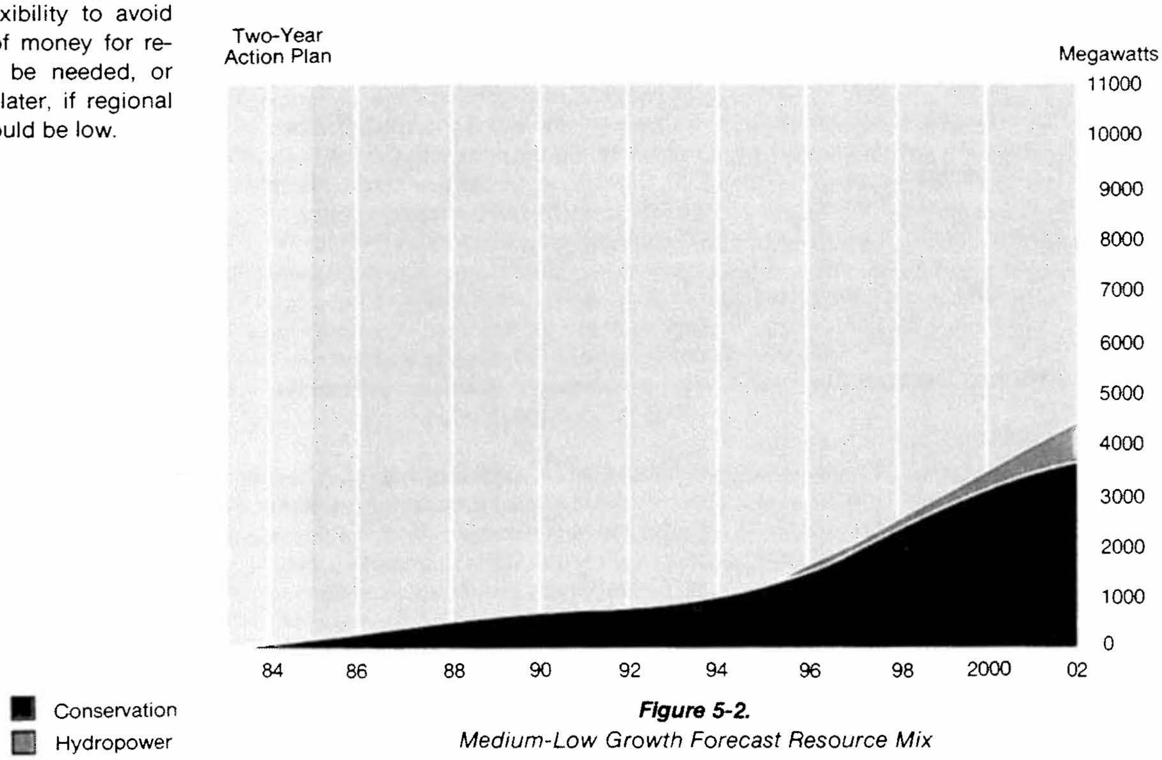


Figure 5-2.
Medium-Low Growth Forecast Resource Mix

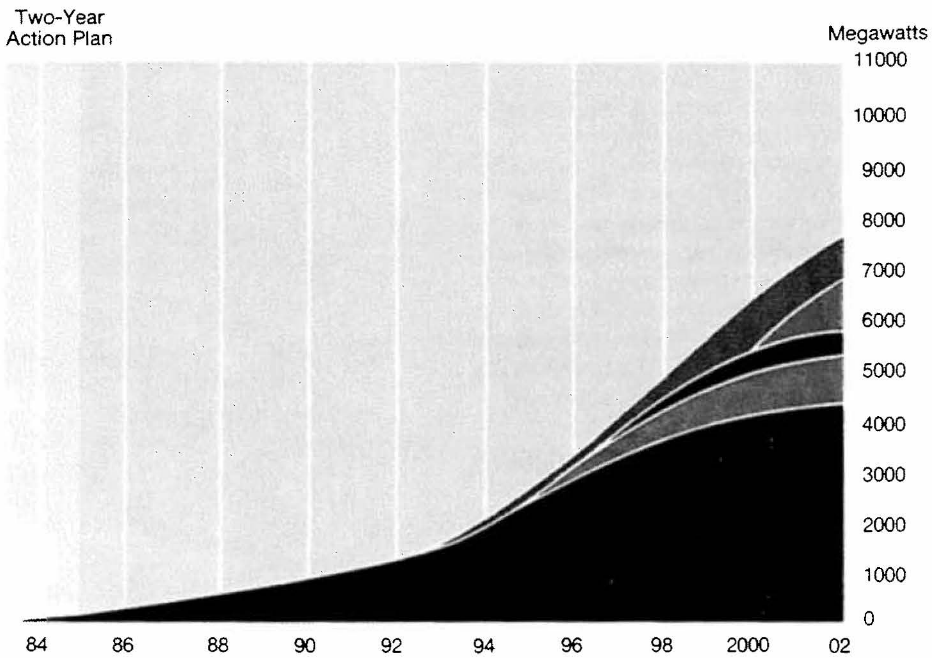


Figure 5-3.
Medium-High Growth Forecast Resource Mix

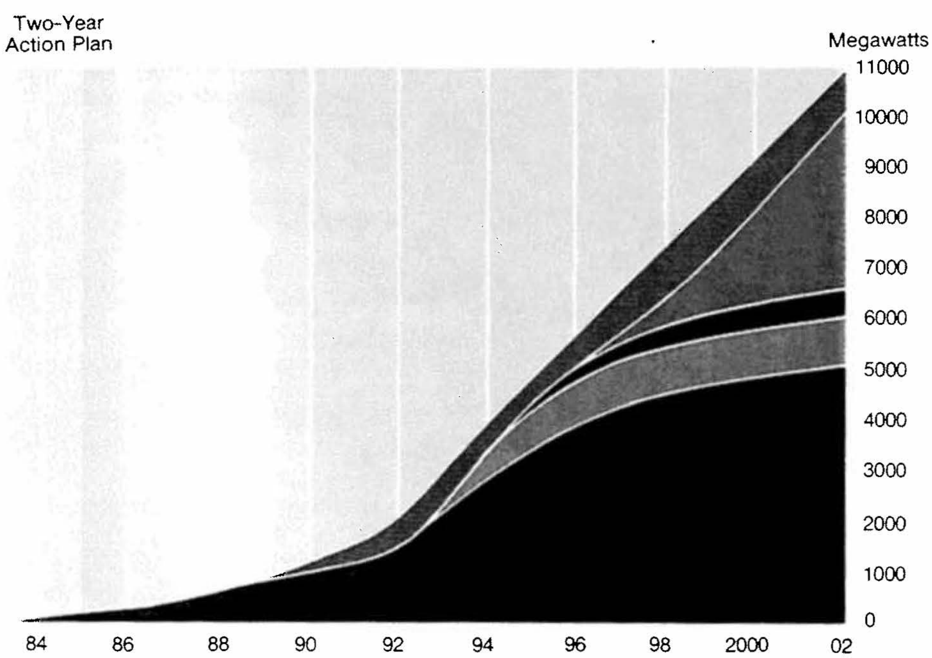


Figure 5-4.
High Growth Forecast Resource Mix

- Conservation
- Hydropower
- Cogeneration
- Coal
- Combustion Turbine

The decision schedules necessary to ensure that the resources in this plan can be constructed in time to meet developing loads are shown in figures 5-5 to 5-8. The vertical width of the bars in these figures represents the amount of energy (megawatts) provided by the various resources in the portfolio. The horizontal length of the bars illustrates the timing of decisions for acquiring options on and construction of individual resources. Following the option and construction phases the resources enter into operation. These figures only show the decision points for those resources that are actually built.

Figure 5-5 depicts the decision schedule under the low growth forecast. The new resources in this case are made up entirely of conservation, and because conservation lead times are very short, the option and acquisition decisions can be made very near to the point at which the energy is actually required.

In the low growth forecast, the Council's model standards and conservation programs are started in all sectors during the next two years. These programs are pursued for five years achieving the 1988 targets specified in the two-year action plan (chapter 10). After the first five years, the conservation programs are suspended and only the model conservation standards continue through 2002. The construction of new houses and commercial buildings to the tighter standards creates a slight increase in conservation savings from 1988 through 2002. In the medium-low case (figure 5-6), all of the available conservation programs are developed and some hydropower is added. The effect of the longer lead time for hydropower can be seen.

- Optioning Phase
- Construction Phase

- Conservation
- Hydropower
- Cogeneration
- Coal

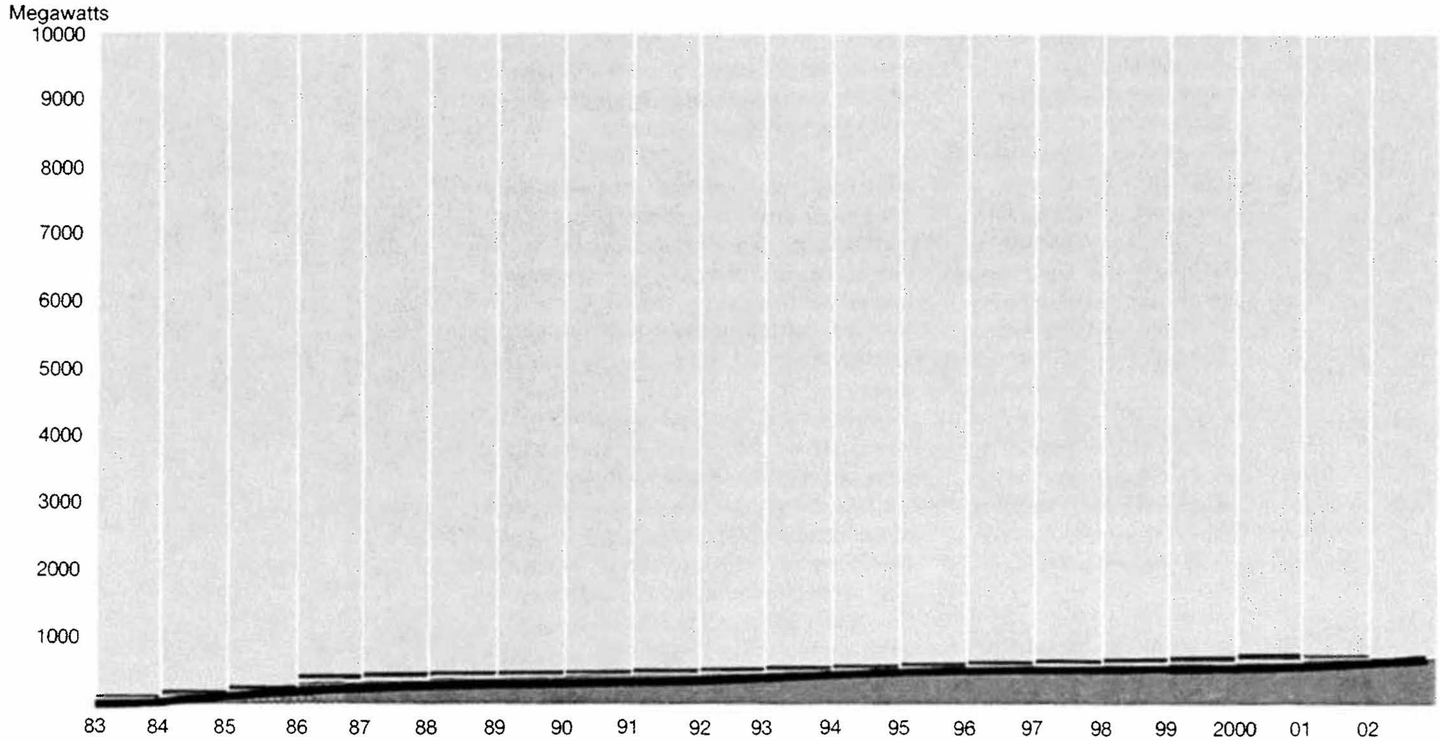


Figure 5-5.
Option/Construction Schedule (Low Growth Forecast)

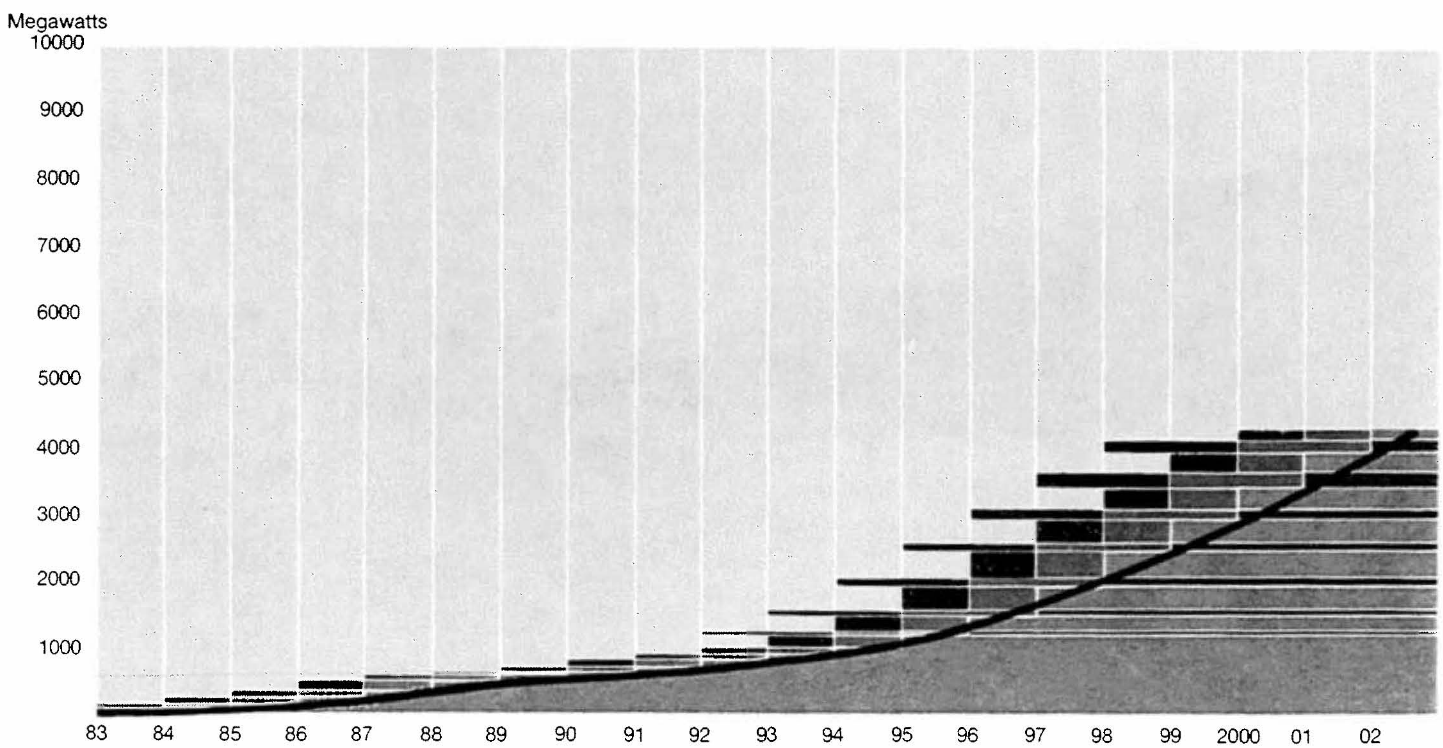


Figure 5-6.
Option/Construction Schedule (Medium-Low Growth Forecast)

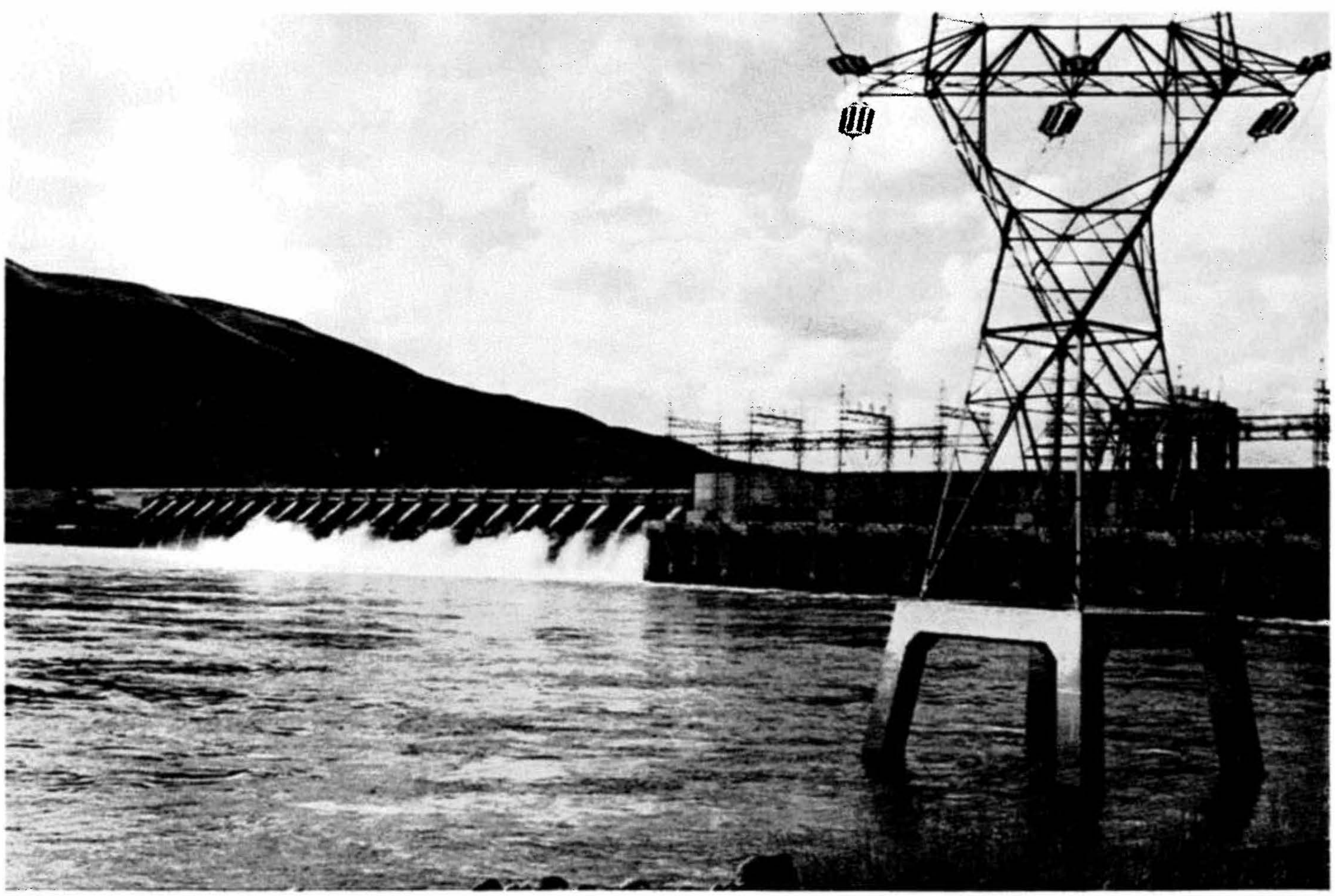
The medium-high and high cases (figures 5-7 and 5-8 respectively) both require the addition of higher cost thermal resources in the form of cogeneration, combustion turbines, and coal plants. The dramatic impact of the long lead time for coal as compared to other resources can also be seen in these figures. For example, in figure 5-8, the long lead time requires an option decision in 1988 for the first coal plant needed to meet loads in 1998, much earlier than the option-decision points for the conservation, hydropower, cogeneration, and combustion turbines that are needed before the first coal unit. The lead time requirements of the coal plants would cause the acquisition of an option earlier than other resources, but this should only be viewed as insurance against high demand growth, not as a replacement for shorter-lead-time resources that are more cost-effective.

The resource schedules show the initiation of conservation programs. Not shown but included in the two-year action plan are options on six hydropower sites. These actions are necessary to build the capability of new conservation programs and to demonstrate the options concept.

In future revisions of this plan, the resource schedules shown in these figures will change due to changes in demand, resource costs, options, and construction schedules. In addition, the Council expects that new low-cost technologies will become commercially available during the next twenty years. The Council will modify its portfolio to ensure that it continues to contain the lowest cost mix of resources to meet the region's demand for electricity. If future demand forecasts are reduced, some of the resources shown in figure 5-8 would not be needed and options would not be acquired on these resources. This eventuality, of course, assumes that the demand forecasts are revised prior to the time when an option decision is scheduled.

■ Optioning Phase
■ Construction Phase

□ Conservation
□ Hydropower
□ Cogeneration
■ Coal



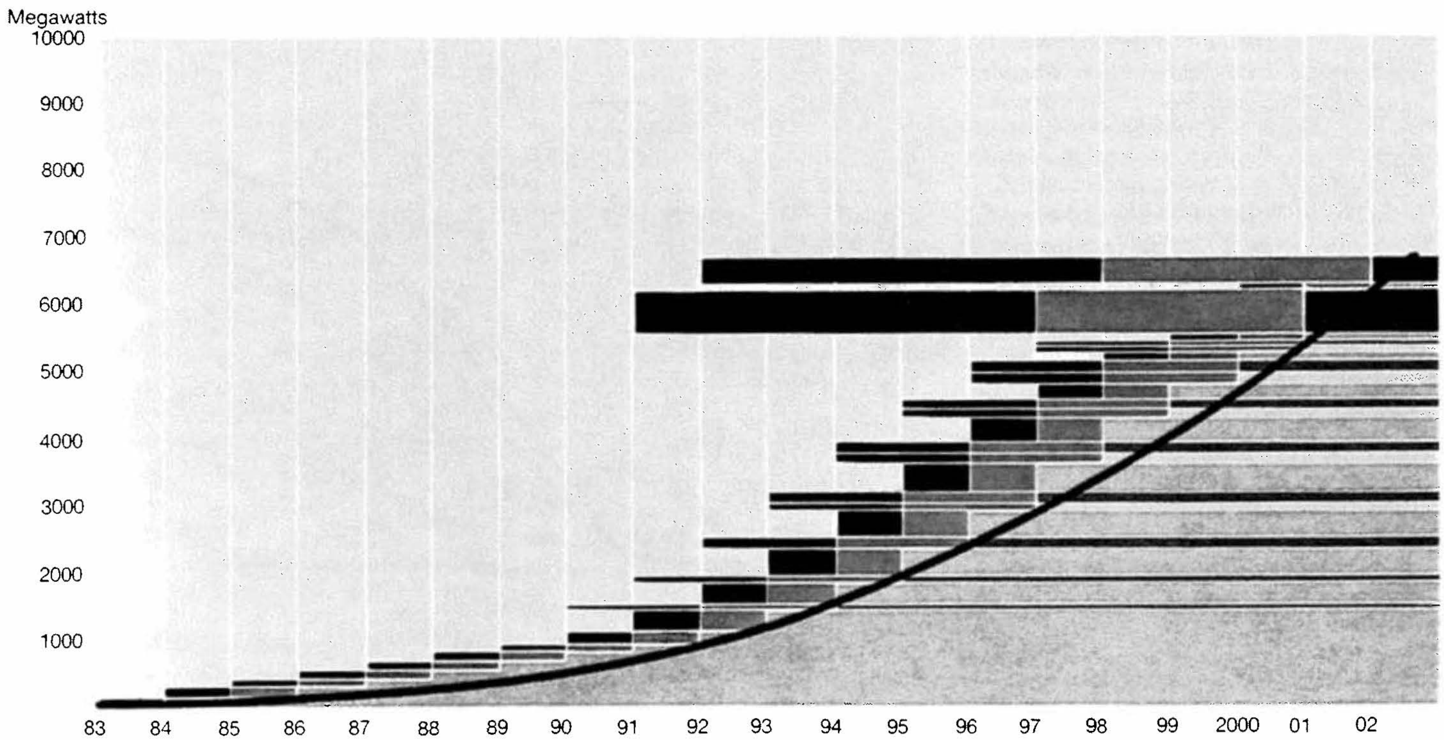


Figure 5-7.
Option/Construction Schedule (Medium-High Growth Forecast)

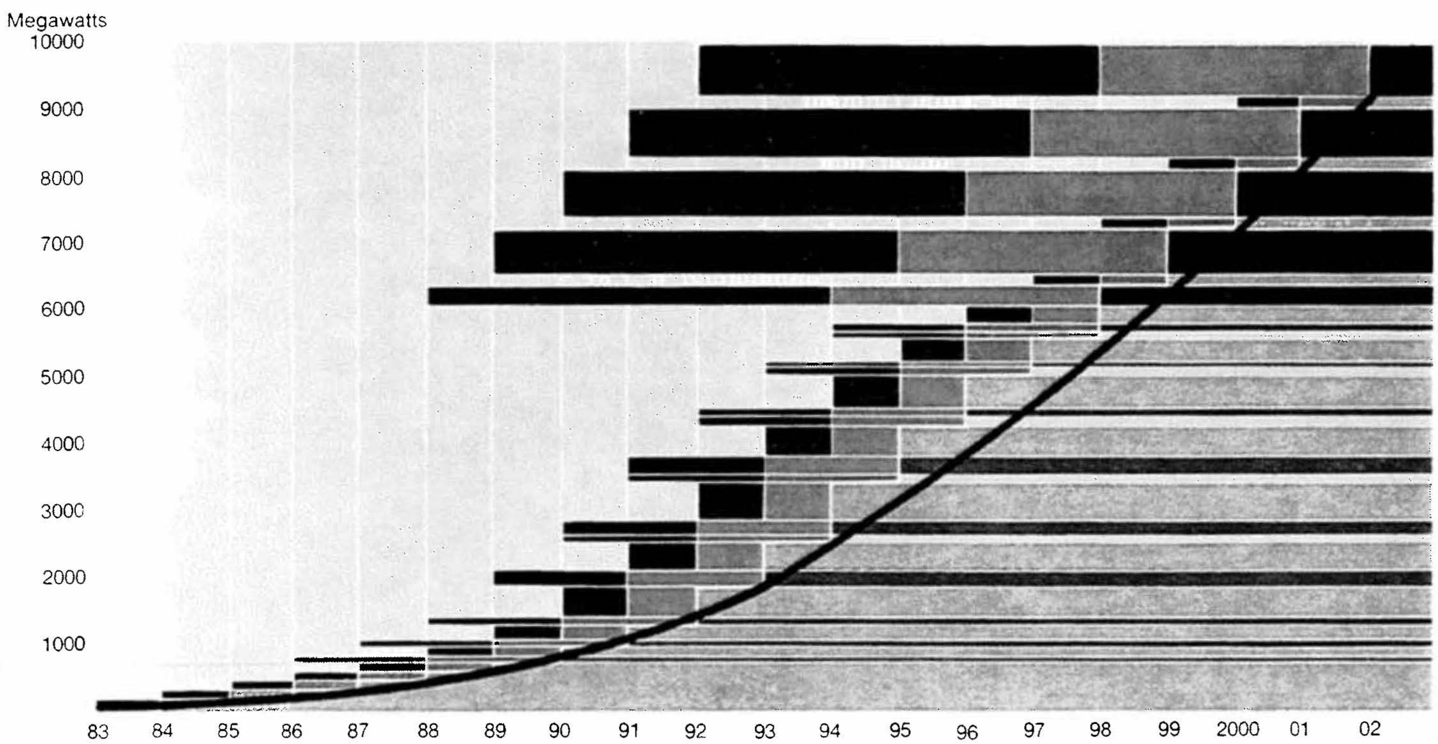


Figure 5-8.
Option/Construction Schedule (High Growth Forecast)

Until an appropriate inventory of resource options is available, the region needs to purchase options on the resource schedule for the high growth forecast. This ensures that the region has the ability to convert options to resources if the high growth forecast should occur. Resource options should be acquired according to the schedule shown in Figure 5-8 until an inventory of options is created that can provide sufficient energy to meet a high rate of demand growth. The longest lead time resources will require no more than seven years to construct. Therefore, the inventory of options needs to be sufficient to cover seven years of high demand growth. Due to the current surplus, no thermal resource options are needed until 1988. The options inventory will need to be replenished as options are exercised or as they are eliminated by technological obsolescence or regulatory changes.

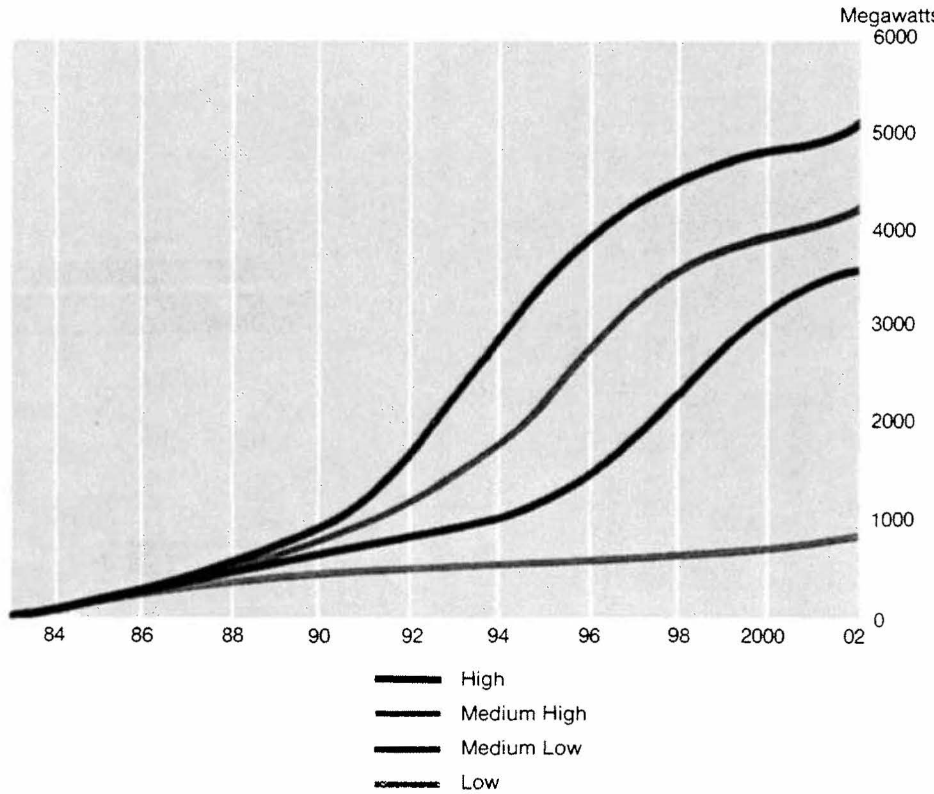
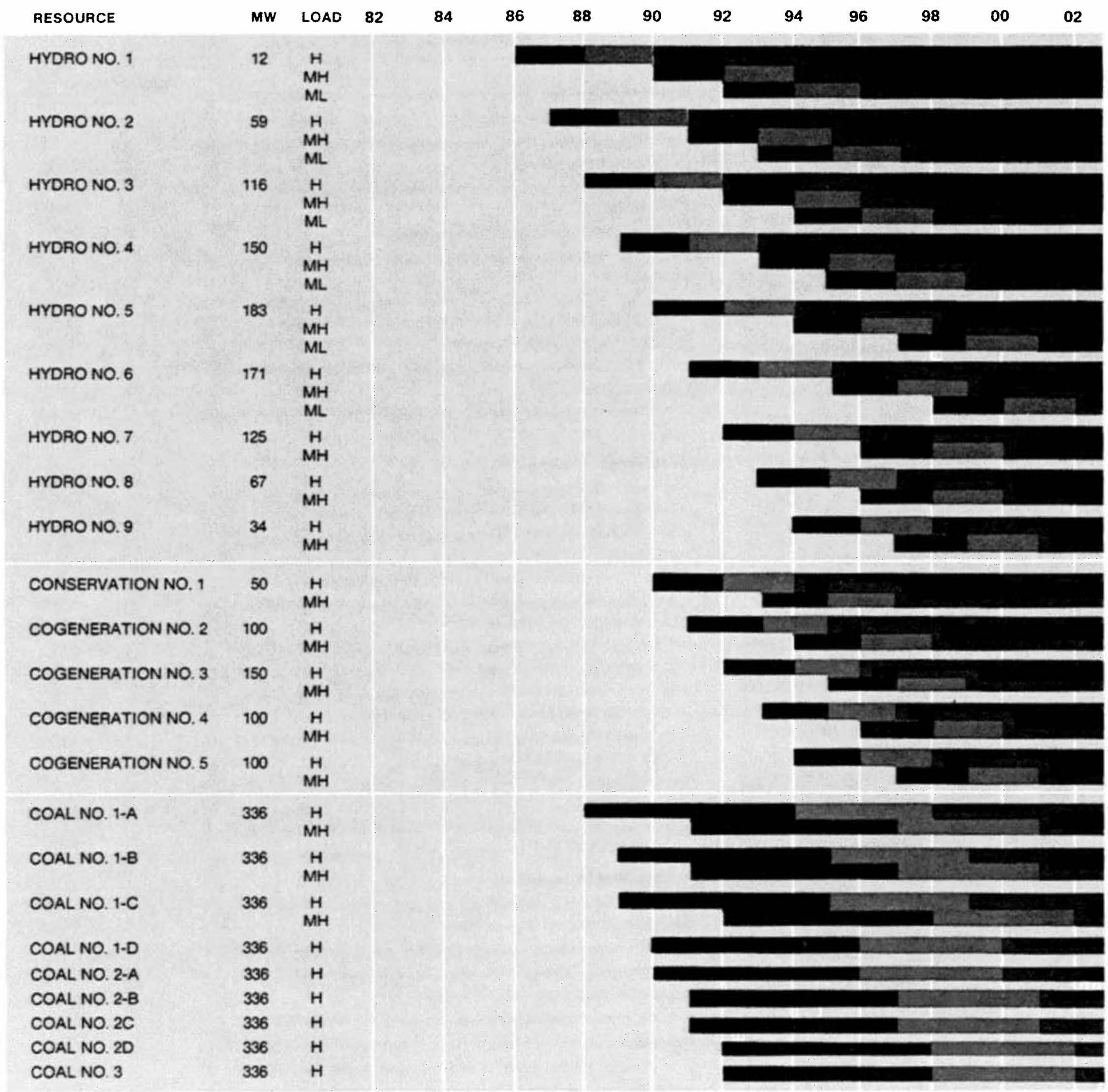


Figure 5-9.
Conservation Achievement

Figure 5-9 illustrates the major emphasis and effort that the Council and the Act have placed on conservation programs and shows four rates of conservation achievement. If the low growth forecast actually occurs, conservation programs will generate less savings because there will be fewer people, houses, and buildings, and therefore, a smaller total amount of electricity consumed. In the high growth forecast, large numbers of new houses are built and rapid growth occurs in commercial businesses. These greatly increase the potential conservation savings that the Council plans to make available by implementing conservation standards and programs aggressively. The conservation program schedule shows that very little conservation is acquired in the next two years because the region has surplus power. During that period, the Council plan calls for the development and testing of programs to build capability in the residential, commercial, industrial, governmental, and agricultural sectors.

Figure 5-10 shows the three phases (option, construction, and operation) of a resource under the Council's plan. Only generating resources are shown, because conservation programs begin immediately and can be added incrementally each year. They



■ Option
▩ Construction
■ Operation

Note: Conservation programs are to be developed immediately in all sectors. See the Two-Year Action Plan, Chapter 10.

Figure 5-10.
Generating Resource Schedule

can be implemented quickly (or slowly if demand is not growing as expected). Figure 5-10 provides a guide for making option and construction decisions for each growth forecast. As all resources are not included in all four forecasts, only relevant resources are listed on the schedule. For simplicity of presentation, similar resources have been lumped into nine hydropower and five cogeneration groups. These groupings imply nothing about the number and size of the actual projects that may result in the approximate amounts of energy generation shown.

This schedule also shows that if high demand growth actually occurs, an option on the first coal plant should not be started until 1988. On the other hand, if demand grows closer to the medium-high forecast, the schedule requires the first coal plant option to be initiated in 1991.

Resource Uncertainties

An important question raised during the public comment period was whether the resource schedules in this plan could meet the power needs in the high growth forecast. Several groups stated that decisions to begin thermal plants might be needed during the next two years if conservation and renewable resources fail to perform as well as anticipated. Other groups commented that the Council had underestimated the amount of conservation and renewable resources and that no additional thermal plants would be needed to meet the twenty-year high growth forecast.

The Council based its analysis of energy needs and conservation and renewable resources on the best information currently available. This analysis included a number of conservative assumptions that would tend to overestimate the demand for electricity and underestimate the amount of conservation and renewable resources available. Table 5-1 lists the Council's conservative assumptions. The Council was not able to estimate the effect of all of these issues, but those that could be estimated total between 6,500 and 9,000 megawatts. If the Council had used less conservative assumptions, no additional thermal plants would be needed in the twenty-year plan.

Table 5-1.
Conservative Assumptions Used in the Plan

	MEGAWATTS BY 2002
Possible Load Forecast Reductions	
1. All DSIs operate at full contract demand in the high forecast in spite of doubled real prices	800-1,400
2. Plan includes less stringent commercial lighting standard than could be applied	540
3. Plan includes no effect of inverted rates	300
4. Plan includes no additional use of wood heat in electrically heated homes	120
5. Plan includes simultaneous high levels of industrial activity in all non-DSI industries in the high forecast at the same time as high electric and other fuel prices	NE
6. Plan based on low estimated price elasticity in the agricultural and industrial sectors	NE
7. Plan assumes no lasting fundamental changes in the economy due to the current recession	NE
Possible Resource Additions	
1. Plan has only moderate estimate of cogeneration potential in pulp and paper industry and other gas-fired cogeneration	Up to 1,800
2. Transmission and distribution efficiency improvements are not included	250
3. Less stringent criterion than critical water could be used	1,000
4. Cost-effective hydropower is limited by assumption of 50-year life rather than potential 100-year life	300
5. Technology improvements in generation or conservation technologies are not included	NE
6. New non-hydropower renewable resources such as wind, solar, geothermal, district heating are not included	NE
7. New energy storage that could convert non-firm energy to firm energy is not included	NE
8. Resources specifically developed in response to PURPA are not included	NE
9. Resources that are not commercially available in the Northwest now are not included	NE
Possible Conservation Additions	
1. Plan includes only 500 megawatts of industrial conservation at an average cost of 2 cents per kilowatt-hour	1,000
2. Plan includes no zone heating of buildings and no night setbacks	200
3. Plan has no increase in hydropower energy available from water saved due to agricultural conservation	165
4. Plan did not assume use of most efficient appliances	1,000
5. Plan assumes commercial buildings built stricter than code	440
6. Plan assumes no use of most efficient water heater heat pumps	160
7. Plan does not include new building code for mobile homes	NE
8. Cost-effectiveness of conservation was calculated on a pre-tax basis, and did not take account of net effect after tax deduction of interest expense	NE
9. Allowance was made in the modeling for utilization adjustments up to 10% above 1979 amenity levels, such as indoor temperature	320
Total additional resources or load forecast reductions	6,695-8,995

NOTE: NE indicates "not estimated"

The Council also evaluated the effect of overestimating the amount of conservation and renewable resources that would be available during the next twenty years. The Council's sensitivity analysis removed 1,700 megawatts of these resources in the high growth forecast and determined that the first decision to begin siting, licensing, and design of a thermal plant would occur in 1986. Therefore, the Council has concluded that it has at least three years to gather additional information about future power needs and supplies before a decision to commit regional ratepayers' funds is needed. The Council will review the need and timing of an option on a thermal plant during the 1985 revision to this plan.

Major Issues of the Power Plan

The development of this plan required the consideration of numerous issues. This section highlights the Council's decisions on the eight major issues that emerged from public comments and Council debate. The issues were:

- Cost of the plan;
- Treatment of growth forecast uncertainties;
- Current surplus of firm energy;
- Marketing interruptible energy in the Northwest;
- Quantity and cost of conservation;
- Quantity and cost of new hydropower;
- Use of combustion turbines; and
- WPPSS 4 and 5 compared with generic coal plants.

Cost of the Plan

The Council has selected the lowest cost mix of resources to meet future energy needs and developed a planning strategy that is designed to minimize the risk of overbuilding or underbuilding resources. The actual cost of the plan over the next twenty years will depend on how much electricity is needed. If the region's energy growth follows the high forecast, a number of new resources, including expensive new thermal plants, would be needed and retail rates, adjusted for inflation, would increase by 40 percent between 1983 and 2002. Under the low growth forecast, the region would develop less than a third of its potential low-cost conservation and rates would actually drop 20 percent over the twenty-year period, after adjusting for inflation.

The region currently has a surplus of electricity. In recognition of this fact, this plan calls for the gradual development and testing of new conservation programs for all sectors of the economy so that these programs will be ready when the power is needed. These efforts are scheduled to begin slowly so they do not add unnecessarily to the surplus.

The Council estimates that the conservation programs in the two-year action plan will increase average retail rates by 3/100 of a cent per kilowatt-hour in 1985.

Treatment of Growth Forecast Uncertainties

The second issue facing the Council was the treatment of uncertainties in the demand forecast. To resolve this issue, the Council developed a planning philosophy that provided for explicit recognition of the uncertainty of demand forecasting and incorporated this philosophy into the selection of resources. This required an extensive process and resulted in development of the range of economic and demographic projections used in this plan. Many individuals and organizations contributed to the process through responses to a Council questionnaire, written comments on issue papers, and public comment at Council meetings. The Council's range forecast encompasses the plausible high and low needs over the next twenty years. The Council's mix of resources is designed to adapt to whatever demand growth occurs.

Current Surplus of Firm Energy

The third major issue faced by the Council was how to deal with the current surplus of firm energy. The Council's analysis shows an unavoidable surplus occurring even with the high demand growth forecast, and a longer and larger surplus if only the low demand growth occurs. The Council made three major decisions regarding the current surplus.

First, the Council decided to proceed with a new, more stringent building code for residential and commercial buildings. Buildings built throughout the rest of the 1980s will have lives considerably longer than the current surplus, especially if demand growth is in the upper half of the range. Because retrofitting conservation is much more expensive than installing it at the time the building is built, and in some cases is not structurally feasible, it is far more cost-effective to implement a new building code in this first plan. Moreover, since one of the main elements of demand growth is the number of people coming into the region and the new buildings built to accommodate them, conservation through building codes automatically follows demand growth. Energy savings will be low with low demand growth and high with high demand growth.

Second, the Council decided to pace the development of other conservation activities to the need for the energy. For this reason, the plan provides low initial penetration rates for conservation programs to retrofit buildings and programs for the other sectors are designed, tested, and developed so that they can be accelerated when the end of the surplus is imminent. The pace of actual conservation activities will be based on the need for the energy.

Finally, the Council supports current regional efforts to sell the firm surplus to California utilities. The Council will consider modifications to this plan if the sale of firm surplus power, with appropriate callback provisions, is concluded. The Council believes that the Northwest could benefit from the sale of firm surplus power. In addition, there may be circumstances where it would be appropriate to accelerate the development of conservation and other resources for sale to the Southwest until the power is needed in the Pacific Northwest.

Marketing Interruptible Energy in the Northwest

The large variation in annual and seasonal quantities of energy available from the hydropower system occurs because of the limited storage capability of the system's reservoirs. The result is large amounts of either generation or spill during the spring runoff in most years. When the system is spilling, non-firm power is often sold to California at very low rates, currently 0.9 of a cent per kilowatt-hour. California uses this cheap power to displace much more expensive gas- and oil-fired generation. Unless reservoir storage capability is increased or additional markets for interruptible power are developed in the Northwest, a large amount of very valuable cheap electricity will continue to be either lost or exported to the Southwest.

As part of this plan, the Council expects Bonneville to actively develop additional markets within the region for this spilled or low-price energy. Possibilities include installing electric boilers in commercial and industrial locations that now use fossil-fueled boilers and providing interruptible service to irrigated agriculture. Electric boilers currently appear to be the most promising. The Council estimates that between 900 and 1,400 megawatts of interruptible electric-boiler load could be developed. Because the Council's estimate focused mainly on the forest products industry, this figure probably does not identify the entire potential in the region. The Council recognizes that the Direct Service Industries of Bonneville currently rely on non-firm energy (combined with borrowed DSI firm energy) for 25 percent of their loads, about 900 megawatts at full operation. These existing loads lack dual fuel capability. The Council does not mean to imply that this service should be subordinated to new interruptible uses.

A major hindrance to developing the in-region value of this additional load is the first cost of the boiler installation itself. While not large in absolute terms (approximately $1.2 million to install a 20-megawatt electric boiler), the current economic recession makes the cost high for individual companies.

There are several ways to reduce the burden of this first cost. Bonneville could offer the boiler owner a very low price on firm surplus power for the first year or two to induce the owner to install these boilers in the region. This would be firm surplus power Bonneville has available after all its customers have been supplied and for which there is currently no market. It is estimated that a 1.0 cent per kilowatt-hour rate for the whole year could pay back the boiler investment in two years. After that, the boilers can operate competitively on the various non-firm power rates depending on the cost for other boiler fuels. A second approach would be for Bonneville to make non-firm energy available to boiler loads with a greater degree of firmness than is normally associated with such energy. A third alternative, whose feasibility and legal aspects need careful investigation, would be for Bonneville to invest directly in the boiler installation, if this would result in a net benefit to the region's ratepayers.

Efforts to market interruptible energy within the region are entirely consistent with the proposed sale of the region's firm surplus, and neither effort is a substitute for the other. The effort to develop additional methods for keeping the economic benefits of low-cost non-firm energy in the region should proceed immediately.

Quantity and Cost of Conservation

The fifth major issue the Council faced was the need to determine the quantity and cost of conservation in each sector of the economy. The Council used a combination of detailed analyses on individual conservation actions and the demand forecasting models to estimate the energy savings per action, the cost of installation, and the human factors and habit changes that can be expected after conservation measures are installed. Following extensive consultation and public comment, the Council determined that 5,150 megawatts of conservation should be available at an average cost of 1.8 cents per kilowatt-hour in the high growth forecast. Of course, savings would be less in other forecasts because fewer buildings would be built. No conservation measure in this plan exceeds 4.0 cents per kilowatt-hour.

An important determinant of the amount of conservation that can be developed is the assumption of penetration rates (how much of the available conservation will actually be implemented). The Council has set high penetration rate targets for three reasons. First, conservation is valuable—it is the cheapest resource available to meet future needs and it has minimal environmental effects. Second, the region has twenty years to achieve the Council's targets; this will provide sufficient time to work out any problems that may arise. And third, the Council has a number of tools, ranging from incentive programs that can finance all or part of conservation measures to regulations that are enforced with rate surcharges. This plan relies heavily on incentives, but the Council is prepared to modify programs, if necessary, to ensure the development of this valuable resource.

The Council received hundreds of comments on the appropriate level of financing for conservation measures. The Council has provided the flexibility to set financing levels for conservation measures that achieve the Council's conservation savings at the lowest possible cost to Bonneville ratepayers, up to or above the full cost of the conservation measure, if necessary. The Council has designed the program to improve the efficiency of existing houses to ensure that conservation benefits are equitably distributed throughout the population. The program calls for financing levels that will achieve penetration rates among renter-occupied and low-income households that are at least proportionate to their share of the total number of electrically heated households. The low-income program will provide 100 percent of the actual cost of the conservation measures installed.

The Council has also identified an alternative to the Bonneville method for calculating the payment for conservation savings in existing houses. Subject to further study, it appears that this alternative to the Bonneville method may result in a more equitable distribution of conservation payments across the region. The Council intends to circulate the proposed method for public comment. Based on the testimony received, the Council will consider amending this plan to incorporate the revised method.

Quantity and Cost of New Hydropower

Sixth, the amount and cost of new hydropower resources was an issue that had to be decided. The Council selected hydropower resources that are believed to be low-cost and that generate most of their energy when needed (in the fall and winter). The Council's analysis also considered fish and wildlife and environmental considerations. This resulted in a selection of 1,150 megawatts of new hydropower generation. This figure represents less than 10 percent of the new hydropower potential in the region. This resource is estimated to cost less than 4.0 cents per kilowatt-hour. The 1,150 average megawatts of hydropower under average water conditions represent 920 average megawatts assuming critical water conditions.

Use of Combustion Turbines

The seventh major issue involved the selection of combustion turbines to provide shorter lead time, low-capital cost insurance against rapid increases in the demand for electricity. Additional analysis is needed to determine whether combustion turbines can operate cost-effectively when the load is known with certainty. On a planning basis, however, to cope with uncertainty in the growth forecasts, adding up to 2,800 megawatts of new combustion turbines would reduce the expected cost of electricity.

After much discussion and several analyses presented to the Council by the Pacific Northwest Utilities Conference Committee (PNUCC), the Intercompany Pool, and Bonneville, the Council selected 1,050 megawatts of additional combustion turbines as appropriate planning reserves for unusually rapid future demand growth.

Also included in the Council's consideration of the role of combustion turbines were their environmental impacts. Because of the unique role combustion turbines are expected to play in the Council's resource portfolio, the Council believes that the associated environmental impacts are minor. Combustion turbines are expected to reduce or avoid the need for early construction of large thermal plants.

WPPSS 4 and 5 Compared with Generic Coal Units

The Council's demand and resource analysis indicates that even if the region's demand for electricity grows along the high growth forecast, no additional large thermal plants beyond WPPSS 1, 2, and 3; Colstrip 3 and 4; and Valmy 2 will be needed in the region until at least 1998. As a result, no decision to initiate an option, and no expenditure of Bonneville funds, would be needed until 1988 to help finance the design, licensing, and siting of a coal plant. If the medium-high growth forecast occurs, a new thermal plant would not be needed until 2001. No additional thermal plants are needed in the medium-low or low growth forecasts during the planning period. The Council believes that it is highly unlikely that the region will be able to achieve the high growth rate for the next twenty years.

A major element of the Council's flexible planning strategy is a comparative risk analysis of various resources. In general, the region should avoid using high capital cost resources that have long construction times to serve highly unlikely demands. A resource that takes a long time to build exposes the region to a greater risk that demand projections will drop while the plant is being built. A resource with lower capital costs and a shorter construction period allows the region to make the major financial commitments closer to the time the energy is actually needed.

The Council compared the construction times of WPPSS 4 and 5 and generic coal plants, and found that the partially built WPPSS plants require 7 years of construction including remobilization, while coal plants require 4 to 5-1/4 years to complete after an option is secured, depending on how much the region is willing to pay for the option. The construction time for coal plants is 4 years.

The Council believes that the region should choose a resource with a shorter construction time over a resource with a longer construction time, unless the longer construction time plant is significantly cheaper. Long construction periods and large capital commitments involve loss of flexibility and high levels of inherent risk. That risk is acceptable only if there are clear, significant economic advantages demonstrated by the high-risk alternative.

The Council conducted a detailed comparison of the costs of WPPSS 4 and 5 with generic coal plants, using a variety of assumptions about key variables. The Council's analysis indicates that neither coal nor completion of WPPSS 4 and 5 had a significant cost advantage. (See Appendix G, Volume II, available on request.)

Therefore, *if* the region needed to make a decision regarding a thermal resource at this time, the Council would select a coal plant on a planning basis because of its shorter construction time, smaller unit size, and lower risk exposure. However, no decision is needed at this time and no Bonneville funds should be expended to initiate an option on a thermal plant.

The Council recognizes that conditions may change and new information may be developed before a decision to initiate an option is needed. Regulatory uncertainties exist for both coal and nuclear plants, and the cost and availability of all resources may change.

In the next revision to this plan, the Council will re-examine future energy needs and the performance of existing conservation and resource development programs to determine whether additional resources are needed in the late 1990's. The Council will also re-evaluate alternatives to meet future energy needs including coal and nuclear plants, additional conservation and renewable resources, and new technologies that may become commercially available.

The Council also recognizes that some components of this plan are outside of the Council's and Bonneville's control. The model conservation standards for new and existing residential and commercial buildings and regulatory changes needed to support the options concept depend on the actions of federal, state, and local governments for implementation. If these entities fail to act, then additional energy options would be needed.

System Analysis and Cost-Effectiveness

A key element in evaluating resources is how they perform with the existing hydropower system. This section begins with a background discussion of how the hydropower system works and the planning criteria used to ensure compatibility with the region's existing resources. Following that, the process of analysis which the Council went through to develop the resource portfolio will be explained beginning with a discussion of the role of combustion turbines in the plan. This explanation will include a brief description of the computer models employed and the results of those models.

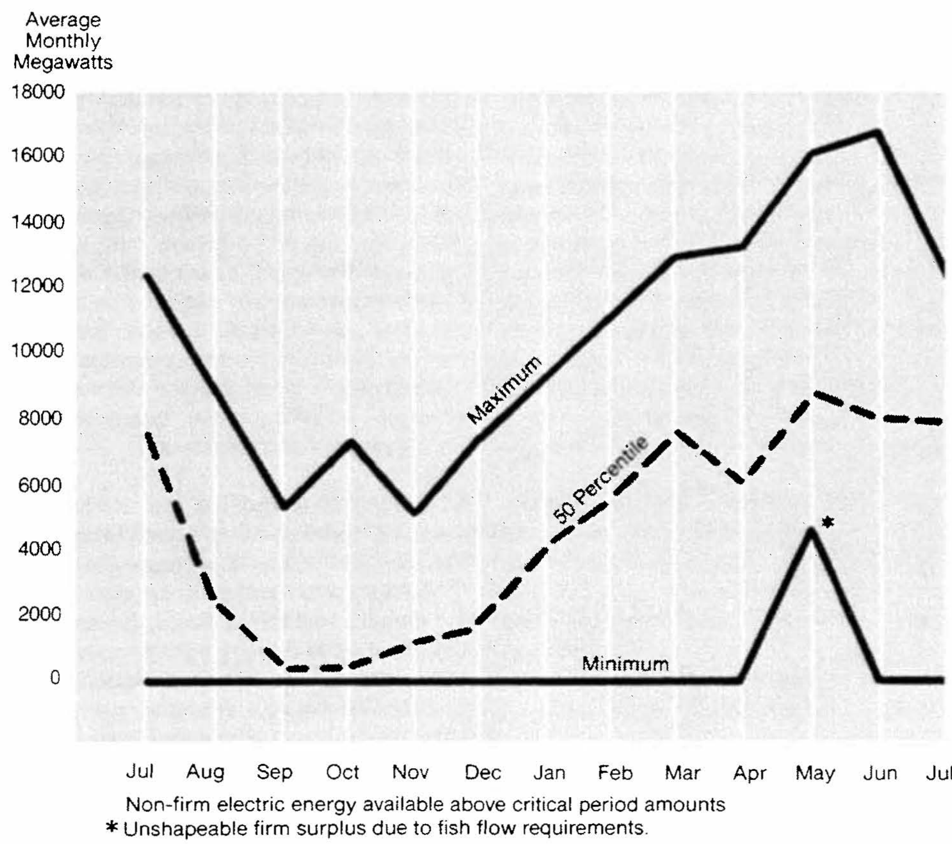
The Hydropower System

The Pacific Northwest electric power system is dominated by hydropower, making it unique in the United States. The hydropower system now produces approximately two-thirds of the region's total electric energy. Even if demand grows along the medium-high forecast, hydropower would still produce half the region's electricity at the end of the century.

There are two key characteristics to the Northwest hydropower system. First, there is a large variation in the amount of electricity that can be generated, depending upon the amount of rainfall and the snowpack that accumulates in the region each year. The annual output of the hydropower system during an "average" year is approximately 3,300 megawatts more than the 12,350 megawatts in a drought year. During a good year, output can be as much as 6,600 megawatts greater than during a drought year. "Critical year" and "critical water" planning assume that the hydropower system will produce no more energy than it did during the worst actual conditions of the 102 years for which records are available. These worst conditions are either the four-year period from 1928 through 1932 or the more severe, but shorter two-year period from 1943 to 1945. These conditions are expected to recur about every 45 years. Energy available above that critical level is called "non-firm" or "secondary" energy. While multiple dry years occur infrequently, conditions are close enough to critical about one year out of five for a long enough period of time to require careful water management by system operators. During these periods, almost no non-firm energy is available.

The second characteristic is that the variation within a typical year can be even greater than the difference between a drought year and a wet year.

A large part of the hydropower system water supply comes from the snowpack in the upper Columbia and upper Snake river basins, in the mountains of British Columbia, Montana, and Idaho; but less than half of even the average snowmelt can be stored in the system's reservoirs. This means that large portions of the total annual water supply come during the spring runoff of May, June, and July. Most of the water from the melting snow must pass through the turbines or over the spillways, because it cannot be stored for use in the following fall and winter when loads are higher unless additional system storage could be developed. There is relatively little non-firm energy available in the fall, while much larger amounts are available in the spring. Figure 5-11 shows the amounts of electric energy at various availability levels above the critical period quantities over the 102-year historical record for which data are available. The variability of the hydropower system has major effects on the economics of other existing and new resources because it influences the way they operate.



This diagram is read as follows: In November, for example, the minimum amount of non-firm energy is 0 MW, although the maximum was about 5,000 MW in November, at least 50% of the time there will be less than 1,000 MW. In March, on the other hand, the 50% line is up to about 7,000 MW.

Figure 5-11.
Non-Firm Energy Availability

There are several uses for this non-firm energy. For example, one-fourth of Bonneville's Direct Service Industrial customer load is supplied with non-firm energy (in conjunction with borrowed DSI firm energy in the fall) as its sole source of supply. The DSIs use about 900 average megawatts of available non-firm energy during normal operations. Non-firm energy also is used to displace output from thermal generating projects both in and outside the region. Displacement within the region allows the higher cost Northwest thermal power to be marketed in California.

Generation Reliability Criteria

Because the hydropower system is so variable, the primary issue in analyzing system reliability is the choice of appropriate water condition against which to plan resources. The region has traditionally used the critical water standard. This issue has been raised because of the observation that an "average" year has 3,300 megawatts more hydropower energy available than does a critical year. However, the 3,300 megawatt average may be composed of 0 megawatts in the fall and early winter and 6,600 megawatts in the spring and summer. The excess cannot be transferred from spring to fall, except for approximately 1,000 megawatts which may be safely "borrowed," according to current practice, in the fall against the next spring's runoff.

The Council does not intend to plan for any shortages. Its plan does not require changes in lifestyle or business practice. However, the Council encourages continuing state curtailment plans to allow an orderly reduction in demand in case of unlikely interruptions in supply caused by generation, transmission, or distribution outages. The Council plan deliberately includes resources to meet all demands for electricity that are even remotely likely to happen. The resource portfolio, including the ability to acquire options on resources and bring them into operation as demand for electricity develops, is intended to achieve the same reliability as the current system.

Because of the current surplus of firm electric energy, the large amount of conservation resource potentially available to the Northwest, and the extremely unlikely possibility that the demand under the high growth forecast will occur, the Council has not felt the need in the first plan to investigate taking risks (of empty reservoirs) with the hydropower system beyond the risks associated with current critical water planning. These issues will be investigated further in the future.

All resource analyses for the Council portfolio were based on critical water and resources were balanced to meet loads against that critical water standard, except when firm surpluses are projected. Further discussion of reliability and the hydropower system is presented in Appendix B of this volume.

Energy Analysis Not Capacity Analysis

The hydropower system has an additional important characteristic for resource analysis. Due to historical factors (such as expectations about the future included in the Hydro-Thermal Program in the 1970s), the hydropower system currently has a high ratio of installed peaking capacity to firm electric energy capability. Water is fuel for a hydropower system and the total amount of fuel available to the system is much more of a limitation on the amount of demand that can be met than the size and number of the generators (peaking capacity). To meet a greater instantaneous demand, more water can almost always be run through the turbines, but the total amount of water in the system is often limited. As a result, the region will almost always be short of energy resources before it is short of peak capacity resources. For this reason, the primary focus in resource analysis for the Council's portfolio has been adaptability to meet seasonal and monthly energy demands rather than instantaneous peak requirements of the system.

Combustion Turbines

Combustion turbines, fired by natural gas or oil, have unique characteristics that could allow them several roles in the plan. Currently, about 300 megawatts of combustion turbine and combined cycle energy are committed to regional firm demand by utilities. An additional 500 megawatts are potentially available from existing units as energy reserves for the region.

The role of combustion turbines can be analyzed with two questions in mind: (1) What is the most economical level of combustion turbines appropriate for system operation, and (2) how can combustion turbines be used in planning as a hedge against higher than expected rates of growth occurring in the region?

To answer the first question, one must consider the unique characteristics of the Northwest hydropower-based system and the way other resources integrate with the hydropower system. The cost-effectiveness of individual resources can only be determined by considering how they integrate with the entire system.

The earlier discussion of the hydropower system noted that the flexibility of the system allows approximately 1,000 megawatts of additional demand (above the critical period hydropower system capability) to be met during the fall and winter months, without risking empty reservoirs before the spring runoff. This flexibility can be called "provisional draft" of the reservoirs, because it borrows water from the spring runoff based on the expectation that the region will be able to meet demands and refill the reservoirs. If low runoff occurs, however, the borrowed water is needed to meet demands and has to be repaid by using high-cost resources that had been kept in reserve. These resources would have been used in the fall if the provisional draft had not taken place.

There are two major competing uses for this provisional draft of system reservoirs: the first is to work together with low-capital cost, high running cost resources such as combustion turbines by backing them down and saving the fuel cost. The second is to directly meet part of the demand of the DSIs of Bonneville. The DSIs currently have one-quarter of their demand ("the top quartile") served by a combination of provisional draft in the fall and non-firm energy in the spring. The top quartile demand is, at full operation, approximately 900 megawatts. This demand is excluded from the firm demands for which firm resources can be planned under the requirements of the Act.

Under current operating constraints, the total amount of provisional draft is limited to the 1,000 megawatts described above. The constraints take two forms. The first is risk to the power system of empty reservoirs prior to the first operating year's spring runoff. The second is increased probability of failure of the reservoirs to refill. The reservoir owners and operators, such as the Corps of Engineers and the Bureau of Reclamation, have other obligations in operating their reservoirs such as fish and wildlife, recreation, and irrigation which can be impaired by failure to refill.

The Council has not examined either the economic effects on the power system or the non-power effects of relaxing current constraints on provisional drafts. Furthermore, while preliminary analysis indicates that approximately 1,000 megawatts of oil/gas generation (including the 300 megawatts of existing combined cycle and combustion turbines) may be cost-effective on an operating basis (with 100 percent certainty of the demand in conjunction with provisional drafts and non-firm energy), the question of service to the top quartile of the Direct Service Industries would remain. Because of these problems, the Council does not currently recommend including combustion turbines in the plan to provide electricity on a regular basis.

There is a clear distinction, however, between a resource that is justified when the demand to be met is known with certainty (cost-effective on an operating basis) and one that is justified when the demand to be met is highly uncertain or has a low probability of occurrence (cost-effective on a planning basis).

In planning, one is faced not only with water supply uncertainties but also with uncertainties associated with future demand for electricity. Combustion turbines have short construction lead times (18 months) compared to coal plants (48 months). Thus, if a planning agency were willing to plan for or hold options on combustion turbines to meet uncertain, but possible future demand growth, it could wait longer to see whether demand materialized. If demand did grow rapidly, combustion turbines could be built to avoid resource shortfalls over the 30 (48 minus 18) months additional time required to bring a coal plant on-line. Once combustion turbines were built to cover such an emergency, they could become standby resources—they could provide interim service if the region experiences unusually rapid demand growth. In this role the region could use combustion turbines on a regular basis to verify the need to begin construction of new resources. If demand for electricity did not materialize, nothing would be built and the region would be much better off than if generating facilities had been built in anticipation of the demand.

Recent history emphasizes this point. If, instead of proceeding to construction of the WPPSS nuclear units the region had instead acquired an option on coal or nuclear plants and had *planned* to build interim combustion turbines if demand materialized, neither the nuclear units nor the combustion turbines would have been built and the region would have paid only the cost of holding an option on the coal or nuclear plant and the cost of an option on the combustion turbines.

The Council estimates that the probability that demand will exceed the Council's medium-high growth forecast in the late 1990's is low, about one chance in five. The Council also estimates an even smaller probability, about one chance in fifty, that demand will be within 1,000 megawatts of the Council's high growth forecast. In this circumstance, and given the short lead times and relatively low commitment costs, the Council has determined that combustion turbines should be included in the plan as a planning reserve for unexpected demand growth. If that growth develops, combustion turbines can be used as an interim resource while additional thermal generation is built to meet the demand.

Because the Power Plant and Industrial Fuel Use Act generally prohibits use of oil or natural gas in new power plants, the Council will seek exemptions to use new combustion turbines for meeting unanticipated demand growth until other resources can be brought on-line. This use is consistent with Federal law.

System Characteristics and Planning

The unique characteristics of the Northwest hydropower system require particular attention to integrating new resources with the existing system. The cost-effectiveness of any resource can only be determined by the way it operates within the existing system. For instance, the cost-effectiveness of new hydropower projects is heavily influenced by whether they are primarily fed by rainfall or by snowpack. Small hydropower projects are generally uncontrollable resources, in the sense that their output cannot readily be increased or decreased in response to demand and cannot be stored for later use when demand for electricity is higher and resources are lower. The small hydropower project, whose major output comes in the spring at the time when the system is most likely to have a large surplus of low-cost non-firm electric power, is less valuable than a resource with similar average energy whose main output comes at a time when the system is more likely to be able to meet firm demands with it.

In preparing this first regional electric power plan, the Council developed and followed a systematic process for evaluating the cost-effectiveness of resource alternatives. This process evaluated the ability of each set of resources to adapt to uncertain demand growth. This plan includes those resources which could best provide for the region's electric energy needs at the lowest possible cost over a range of future demands. Figure 5-12 illustrates the fundamental steps in the Council's system analysis. The process began with three primary data collection and analysis activities.

First, the Council developed comprehensive conservation supply data that made consistent estimates of the maximum existing regional conservation potential as a function of the cost of the individual conservation measures.

Resource supply data were developed at the same time as conservation supply data. The Council developed a very large resource information base to provide a consistent basis for estimating the costs and technical characteristics of each generating resource that would be available to the region. From this information base, similar resources are ranked in order of their expected cost. The Council developed a third kind of information, the twenty-year demand forecast of possible future electric power needs within the region, adjusted to eliminate potential double counting of conservation resources as described in chapter 4. Recognizing the large number of possibilities with respect to future demand for electricity, the Council departed from typical past efforts that focused on developing a single most-likely demand forecast. Instead, the Council developed a range of possibilities that varied from a forecast of the most rapid growth that could be expected under very unlikely economic conditions down to a low-growth forecast which was also unlikely. The Council assigned probabilities of occurrence to the resulting four final growth forecasts based on the economic and demographic factors underlying the four forecasts and the Council's judgment.

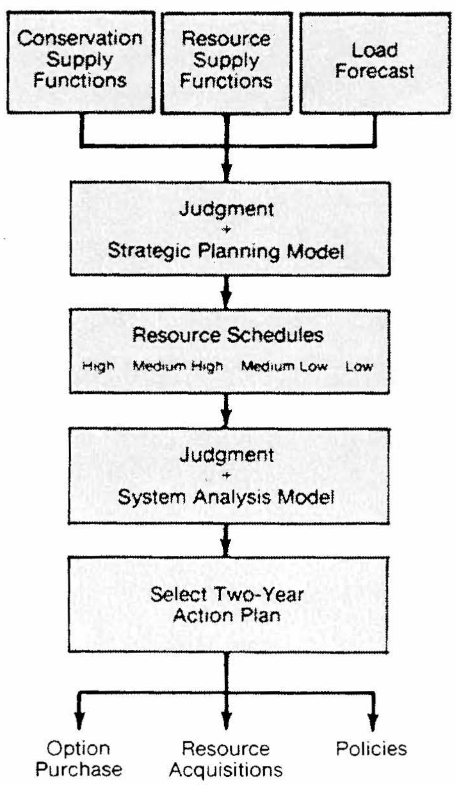


Figure 5-12.
System Analysis

As shown in figures 5-13 and 5-14, the Council's judgment is that the high and low forecasts are equally unlikely and it is even less likely that actual demand will exceed the high forecast or fall below the low forecast. The medium-high and medium-low forecasts, and all levels of demand between them, are much more likely to occur. The probability distribution is best approximated with the straight lines shown in figure 5-14. The probability of being between the low and medium-low demand forecasts is about 33 percent, between the medium-low and the medium-high about 45 percent, and between the medium-high and the high about 22 percent.

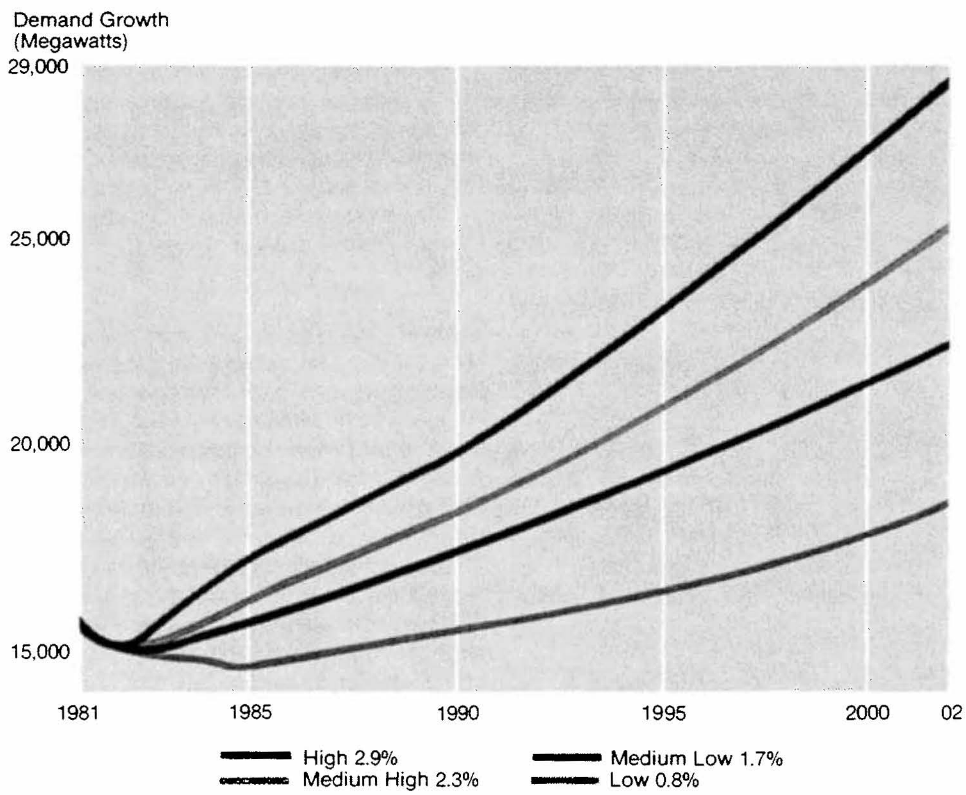


Figure 5-13.
Range of Growth Forecasts
(based on "frozen efficiencies," see figure 4-17)

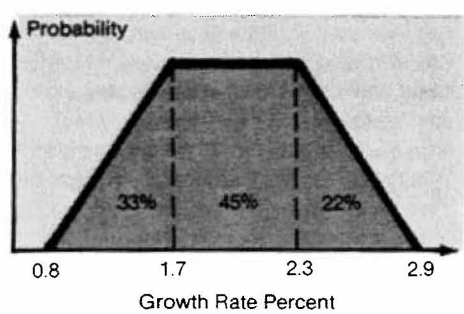


Figure 5-14.
Growth Forecast Probability

The resource assessment involved three specific steps. First, the Council screened resource types based on their costs, operating characteristics, and potential availability to the region. This preliminary analysis eliminated certain resource types, such as solar photovoltaic, geothermal, and wind generation, because of inadequately developed technology or relatively high costs. Research and development programs for some of these resources are recommended later in the plan. The second and third steps of the analysis are more complex and used computer models.

Earlier in this chapter, hydropower system uncertainties were described. Major thermal plants also demonstrate significant uncertainties—especially plant availability (the amount of time they can be operated, excluding maintenance and forced outages) and the dates when new plants start producing power.

Because the Council must deal with uncertainty in looking at future demand for electricity and electric energy resources, two major computer models have been used. Each model deals with particular aspects of uncertainty in planning and operating the system.

The strategic planning model is a linear programming optimization model that examines all the possible sets of electric energy resources over twenty years, over all four possible demand for electricity estimates, and over four representative water conditions. The model selects from those sets of resources the amount, timing, and combination of electric resources that will minimize the total cost of building and operating the system to meet demand. The strategic planning model is used to pick the set of resources to be analyzed in greater detail.

The model for detailed analysis of how new resources integrate with the existing system is called the system analysis model. This model was prepared by a joint team from Bonneville, PNUCC, and the Intercompany Pool, with additional development work by the Council. This is a detailed model that simulates the Northwest power system. It simulates the operation of any chosen set of resources. The system analysis model explicitly treats the uncertainty in new thermal plant arrival time, thermal plant availability, hydropower availability, and monthly and annual short-term demand variations around a given demand for electricity.

In the second stage of the analysis, conventional resource supply curves and conservation supply curves for the remaining resource types were combined with the demand forecasts using the strategic planning model and the Council's judgment to produce several resource portfolios for further analysis using the system analysis model.

Beginning with the results from the strategic planning model, the Council evaluated several portfolios of resources producing electricity. Among the alternatives examined were several portfolios using less conservation and small hydropwer than the portfolio produced by the strategic planning model. These and other alternative analyses confirmed the strategic planning model's selection of conservation as the cheapest resource and yielded the set of resources meeting the four demand forecasts at the lowest cost.

Figure 5-15 shows the final cost curve for the resource portfolio described in the plan. All system analysis studies were done at the same level of reliability to ensure compatibility of costs. Figure 5-15 shows that in the low growth forecast, the total net present value of building and operating the system would be about $8 billion. In the high growth forecast, this cost would increase to about $41 billion. These amounts include the costs over the lifetimes of all plants in the study, which could be as much as 50 years from now for plants put into service in the year 2002. The net present value of costs of these resources over just the next twenty years ranges from $5 billion in the low growth forecast to $20 billion in the high growth forecast. The rate impact of these costs was discussed earlier in chapter 4.

In general the Council sought the mix of resources that provided the lowest possible cost curve as shown in figure 5-15. Considerations other than cost were included in the Council's selection of the "best" portfolio. These considerations included risk, unmeasurable environmental impacts, and legal or regulatory constraints.

The Council's judgment is that the costs of this portfolio are as low as possible at all four demand forecasts, taking into account appropriate insurance against future uncertainties. This plan provides the region with the ability to meet a range of possible growth rates for electricity while acquiring resources that will provide that electricity at the lowest cost.

Construction schedules for individual resources in each resource portfolio were

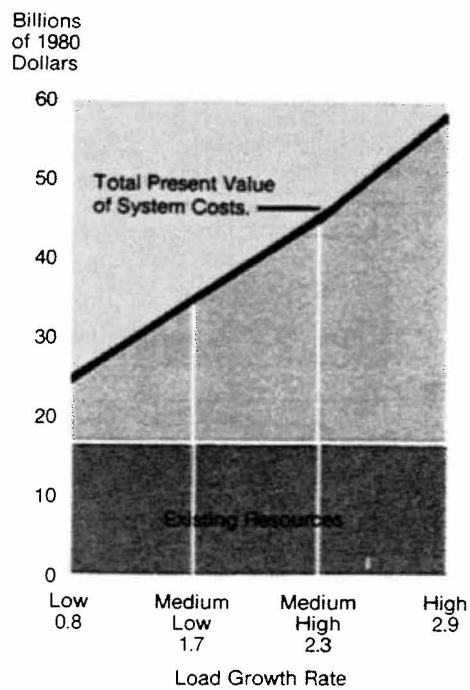


Figure 5-15.
Resource Portfolio Cost Curve

adjusted to balance against the four demand forecasts. All portfolios were analyzed using the system analysis model. The analysis yielded curves showing each portfolio's additional system costs (in total present value over the life-cycle of all resources in the study) under each of the four demand states.

Figure 5-15 illustrates the expected present-value costs of the Council's portfolio if a particular demand growth occurs. The analysis also produces estimates of the uncertainty that exists in this cost curve. This uncertainty results from varying hydropower conditions, delays in thermal plant construction, and thermal plant forced outages. The Council developed a method of combining these cost curves with the probabilities of demand for growth of electricity shown in figure 5-14. The details of this method are presented in the Technical Exhibits to this plan.

The results of combining the uncertainties in the estimates of resource portfolio costs with the uncertainties of the demand forecast are shown in figure 5-16. In this figure, the horizontal axis is present value of system costs in billions of 1980 dollars. The vertical axis plots the number of times a particular system cost was observed out of 5,000 combinations of possible resource portfolios and growth forecasts. The greater the frequency, the more likely the region would actually experience that level of cost.

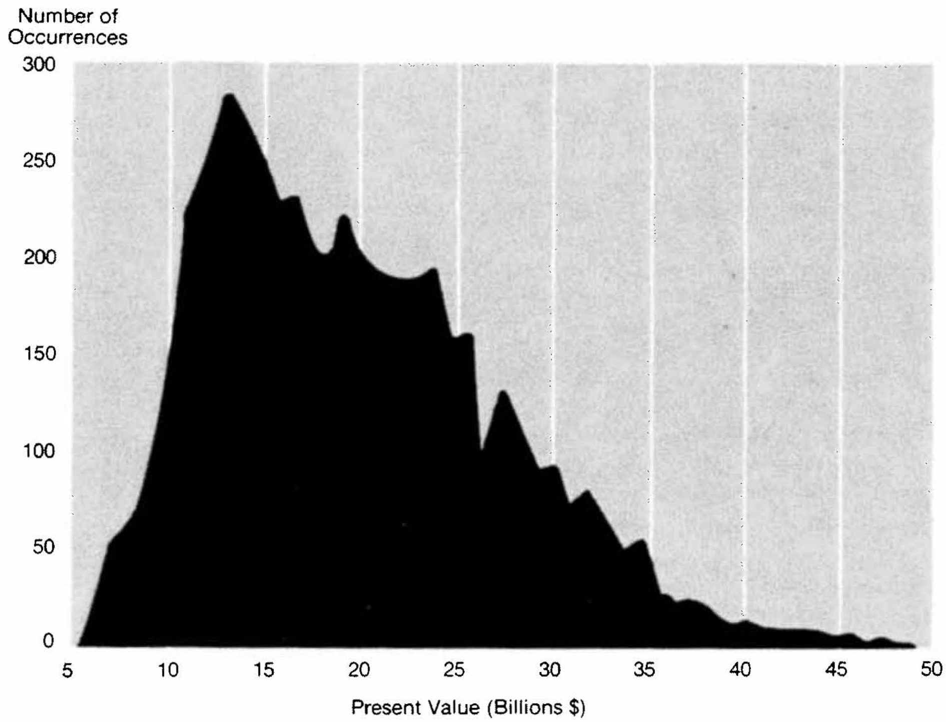


Figure 5-16.
System Cost Probability Plot

Figure 5-16 shows that the Council's analysis produced a range of cost outcomes from a present value of $6 to $48 billion additional system cost. The number that occurs most frequently is about $13 billion while the average is about $20 billion. If we correctly plan for the low electric-demand growth forecast and experience average or better water conditions and thermal plant output, the cost could be as low as $6 billion. If we correctly plan for the high demand growth forecast but experience low-water conditions and thermal plant interruptions, the cost could be as high as $48 billion. If we need to build for the high growth forecast, it will largely be due to a significantly greater number of people and jobs in the region, so there will be more people to pay the $48 billion than the $6 billion. Since the $48 billion investment would produce many more megawatts than the $6 billion, the cost per kilowatt-hour paid by the consumer would not increase as dramatically as it might appear. An estimate of the probable rate increases for all four growth forecasts was discussed in chapter 4.

The Council's analysis throughout the development of this first regional electric power plan has been based on identifying alternatives and evaluating the effects on the total present value of system costs. The concept of present value is a well-established economic procedure to provide consistent evaluations between investment choices that require paying out money at different times. Developing a regional electric power plan involves evaluating energy investments made by the region over the twenty-year period. (An explanation of the economic analysis is provided in Appendix F.)

The Council's approach is to evaluate the total present-value cost of various resource alternatives. The aim is to find the set of electricity-producing facilities which has the lowest possible total system costs over the useful lifetime of the facility. The Council gave due consideration of environmental, fish and wildlife, risk, legal, and political constraints that cannot be specified in dollars or examined in quantitative models. In this respect, the quantitative analysis results provided the basis from which the Council exercised its judgment to select the appropriate combination of resources to meet the region's future electric power needs.

The following chapter of the plan will discuss the conservation, renewable, and conventional resource elements of the Council's portfolio. A two-year action plan for the region fits the twenty-year plan into the framework of the current energy supply and demand situation and the need to begin developing conservation programs so that they can be available in case rapid economic growth resumes in the region.

"the plan shall [include] ... due consideration by the Council for ... compatibility with the existing regional power system"

Chapter 6
Existing Resources and Resources Under Construction

This chapter describes the amount of firm energy and peak capacity available from existing Northwest resources, including the hydropower system, under critical water conditions. These resources are the base to which the Council's portfolio must be added to meet the total load as it develops.

The resources identified in this chapter are assumed to be available to meet loads during the next twenty years. The Council has made no determination of the need for Bonneville to acquire any of these resources beyond WPPSS 1, 2, and 70 percent of WPPSS 3, which are already part of the federal system. The two-year action plan discusses acquisition of existing resources or resources under construction.

Facilities under construction and those assumed to be completed on schedule include three nuclear power plants, WPPSS 1, 2, and 3 in Washington, and three conventional pulverized coal-fired steam-electric units, Colstrip 3 and 4 in Montana, and Valmy 2 near Winnemucca, Nevada (121 megawatts of Valmy's capacity will be available to the region). WPPSS 1 was assumed to be complete in 1988 in the high and medium-high growth forecasts and in 1991 in the medium-low and low growth forecasts.

Figure 6-1 shows the amount of electric power that should be available over the twenty-year planning period from existing resources and resources now under construction. Existing conservation is not shown as a resource in figure 6-1. In forecasting loads, the Council included estimates of existing conservation savings through 1982. After 1982, all additional conservation is treated as a new resource to assure consistent cost-effectiveness comparisons with new generating resources. The data on existing residential conservation is based on a 1979 Bonneville survey of conservation measures in existing houses and buildings in the region. The Council's residential energy forecasting model and data from more recent utility billing were used to estimate conservation that has taken place between the 1979 survey and 1983. The Council's commercial energy forecasting model and a variety of surveys were used to estimate commercial sector

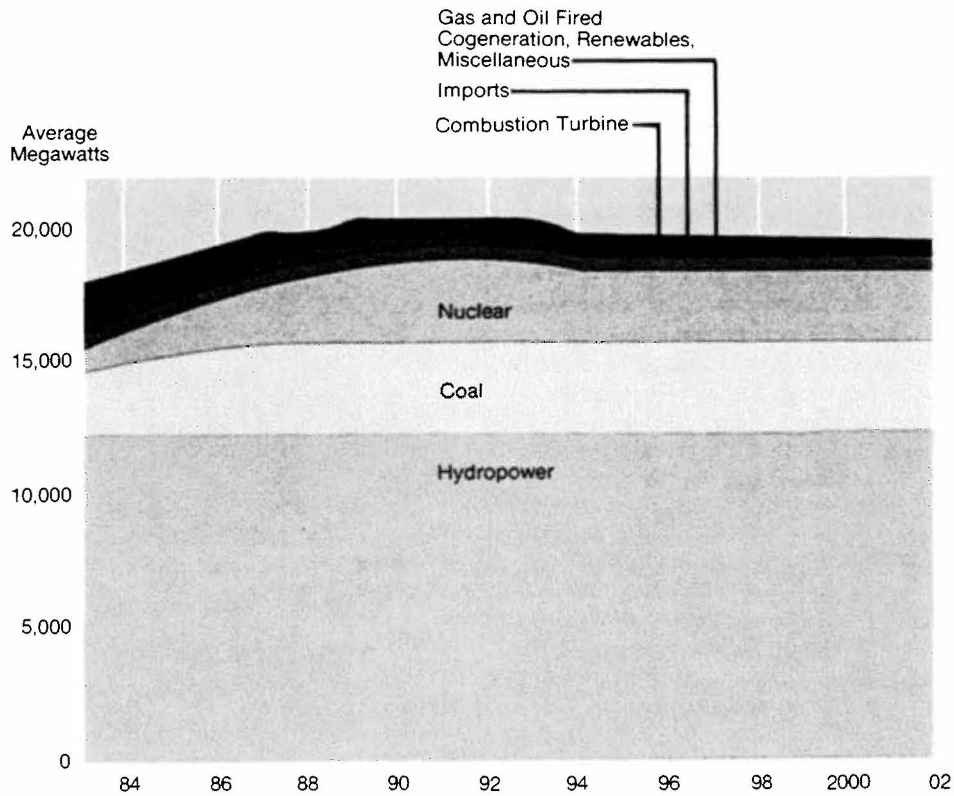
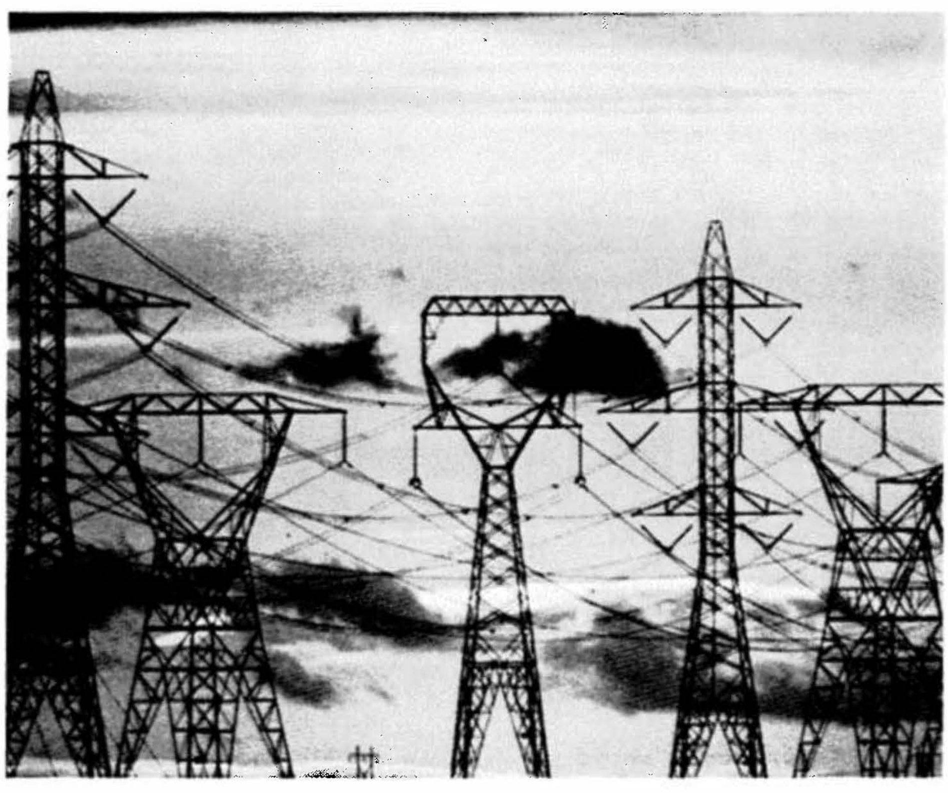


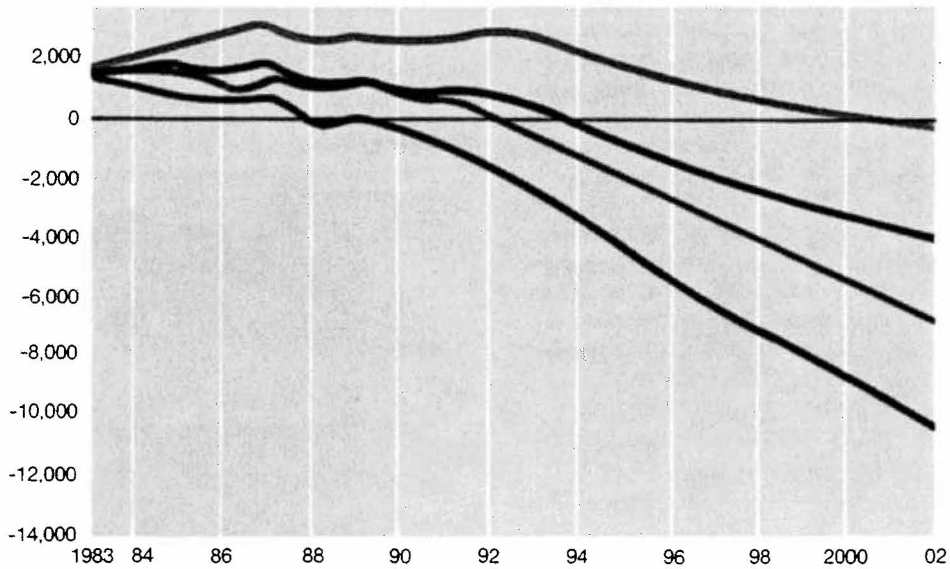
Figure 6-1.
Electric Power Availability, 1982-2002



conservation levels. Industrial and agricultural conservation were based on Council studies and interviews with industrial customers.

Figure 6-2 shows the result of subtracting the Council's four demand forecasts from the energy capability of these resources to obtain projections of the surpluses and deficits that would occur under each forecast. The loads used here have not been adjusted for new program or model conservation standard savings. In 2002, the potential range of new resource requirements is from 250 average megawatts in the low forecast to 10,700 average megawatts in the high forecast. The first deficit occurs in 1988 in the high forecast, but not until 2002 under the low forecast. Figure 6-3 represents figure 6-2 adjusted for the new resource additions (including conservation) in the Council's resource portfolio. It gives an indication of the region's load/resource balance as resource additions are made over the twenty-year period. The numerical data supporting figures 6-1, 6-2, and 6-3 are contained in table 6-1.

The Council has relied on information developed by PNUCC for existing resources and resources under construction as listed in the PNUCC "Blue Book" (see Glossary). However, the Council used different assumptions about equivalent availability of coal and nuclear plants. The Council has assumed that all nuclear plants have an equivalent availability of 65 percent. Coal plants that are smaller than 530 megawatts have an equivalent availability of 72 percent, and coal plants that are larger than 530 megawatts have an equivalent availability of 70 percent.



Note: Assumes no conservation or consumer reaction to price

Figure 6-2.
Surplus and Deficit Before New Additions

High
Medium High
Medium Low
Low

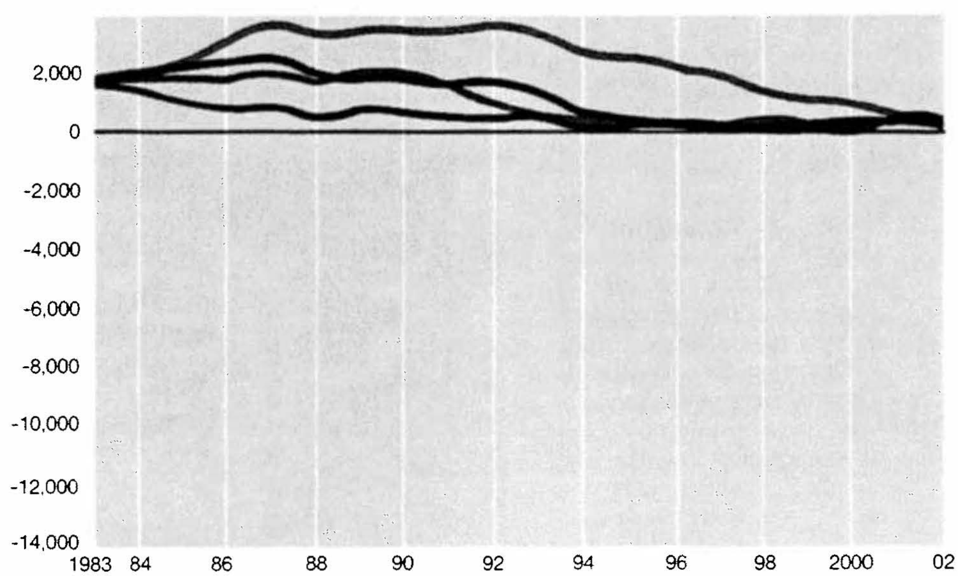


Figure 6-3.
Surplus and Deficit After New Additions

Table 6-1.
Summary of Firm Loads and Resources

						SURPLUS/DEFICIT (+/-) (Average MW)							
	FIRM[2] RESOURCES	FIRM ENERGY LOADS (Average MW)[3]				BEFORE NEW ADDITIONS				AFTER NEW ADDITIONS			
YEAR[1]	(AVG MW)	HIGH	MED HI	MED LOW	LOW	HIGH	MED HI	MED LOW	LOW	HIGH	MED HI	MED LOW	LOW
1983	17887	16685	16430	16245	16055	1202	1457	1642	1832	1206	1461	1646	1836
1984	18337	17395	16832	16498	16016	942	1505	1839	2321	1021	1581	1913	2394
1985	18777	18189	17344	16866	16052	588	1433	1911	2725	761	1598	2072	2881
1986	19013	18855	17817	17223	16122	158	1196	1790	2891	451	1474	2060	3150
1987	19724	19490	18313	17631	16296	234	1411	2093	3428	671	1819	2485	3797
1988	19580	20041	18738	17996	16431	-461	842	1356	2921	120	1379	1869	3386
1989	20356	20514	19108	18324	16544	-158	1248	1269	3049	588	1929	1881	3530
1990	20327	21049	19547	18697	16714	-722	780	928	2911	319	1606	1621	3408
1991	20372	21661	20047	19059	16874	-1289	325	772	2957	189	1311	1547	3471
1992	20350	22342	20589	19417	17021	-1992	-239	883	3279	153	935	1746	3811
1993	20248	23064	21149	19812	17198	-2816	-901	325	2939	162	532	1276	3489
1994	19818	23799	21715	20247	17409	-3981	-1897	-474	2364	-37	51	574	2931
1995	19778	24545	22291	20710	17652	-4767	-2513	-932	2126	106	86	279	2711
1996	19707	25360	22932	21194	17947	-5653	-3225	-1487	1760	110	70	23	2369
1997	19618	26172	23572	21618	18231	-6554	-3954	-2000	1387	-32	86	-18	2027
1998	19555	26975	24216	22023	18533	-7420	-4661	-2468	1022	-62	168	30	1693
1999	19517	27762	24841	22427	18826	-8245	-5324	-2910	691	-13	162	76	1392
2000	19513	28568	25466	22872	19124	-9055	-5953	-3359	389	52	-29	98	1121
2001	19487	29425	26119	23348	19436	-9938	-6632	-3861	51	58	233	62	806
2002	19465	30183	26679	23758	19708	-10718	-7214	-4293	-243	181	111	11	529

1. Years are expressed on a September-August operating year basis (e.g. 1983 represents September 1982-August 1983)
2. Firm resources include existing resources and those currently under construction plus regional imports.
3. These loads have been adjusted for transmission and distribution losses but have not been adjusted for new conservation savings. They do not include the loads of the SDI top quartile but do include firm regional exports. The compound growth rates described in Chapter 4 were based on 1981 loads, and growth rates calculated from the above loads will not be comparable.

Existing Resources

Hydropower

Existing hydropower resources represent 28,083 megawatts of capacity and 12,350 megawatts of energy. This includes power from all the existing hydropower dams in the region (except those of Montana Power Company and Utah Power and Light) including generation in the United States resulting from storage regulation of three Canadian reservoirs—Duncan, Arrow, and Mica—in accordance with the Pacific Northwest Coordination Agreement. Montana Power Company and Utah Power and Light generation are included as imports to the region in figure 6-1. The energy production from existing hydropower facilities has been adjusted to consider irrigation requirements at Grand Coulee Dam.

Hydropower resources have also been adjusted to take into consideration the effects of the Council's fish and wildlife program. The Northwest Power Act required the Council to develop a Columbia River Basin Fish and Wildlife Program to protect, mitigate, and enhance fish and wildlife on the Columbia River and its tributaries. An important element of the fish and wildlife program is a Water Budget to improve streamflows for downstream migration of salmon and steelhead. The Water Budget is expected to reduce the firm electric energy load carrying capability of the region's power system by approximately 450 megawatts. This projected loss is based on recent studies by Bonneville and is less than originally estimated by the Council in the fish and wildlife program as adopted November 15, 1982. The Council will examine this and similar recent studies in more detail in its review of the Water Budget implementation prior to the first amendment of the program.

Renewable and High-Efficiency Resources

Existing cogeneration (where a facility providing heat for industrial use can also be used to generate electricity) totals 130 average megawatts of firm energy and includes Eugene Water and Electric Board's Weyerhaeuser Energy Center, Washington Water Power's Vaagen Brothers Lumber, Puget Sound Power and Light's Boeing Number 1, Seattle City Light's Metro West Point Project, and Bonneville's Weyerhaeuser and Longview Fiber purchase. Firm cogeneration from existing resources is expected to drop to 49 average megawatts in the 1983-84 operating year (see PNUCC "Blue Book").

Existing renewable resources include 3 average megawatts from Bonneville's Goodnoe Hills Wind Turbines research and development project. Washington Water Power's Kettle Falls project and Idaho Power's Tamarck project are expected to increase the contribution of renewables to 38 average megawatts by the 1984-85 operating year.

Large Thermal Resources

Existing thermal resources represent 3,193 megawatts of energy and 4,019 megawatts of peaking capacity in the Pacific Northwest. A detailed listing of plants included in this category can be found in table 6-2. Additional thermal units, or portions of thermal units serving regional loads but owned by companies with both in-region and out-of-region loads, are included in the section, Imports to the Region, in this chapter.

The Council has assumed that generation of electricity from the Hanford N reactor will continue through July of 1993 as specified in a recently negotiated contract between the U.S. Department of Energy and the Washington Public Power Supply System. However, this contract is subject to cancellation with one year's notice, and the Council will continue to monitor the status and performance of this resource.

Gas and Oil-Fired Resources

These resources have a total peak capacity of 1,444 megawatts. These plants, with the exception of Portland General Electric's Beaver Plant, are not designed to serve firm base loads in the region. Combustion turbines include Pacific Power and Light's Libby Unit; Portland General Electric's Bethel Unit; Puget Sound Power and Light's Whidbey Island, Whitehorn, and Frederickson Units; Washington Water Power's Othello and Northeast Units; and Idaho Power's Wood River Unit. Also included in this category are old existing steam plants, small diesel generators, and miscellaneous small purchases. These resources are listed in table 6-3.

Table 6-2.
Existing Resources (Coal and Nuclear)

	PROJECT	UNIT	IN-SERVICE DATE	SUSTAINED CAPACITY[a,b] (MW)	AVERAGE ENERGY[b,g] (Average MW)
Coal Units	Boardman	1	1980	530	382
	Centralia	1	1971	638	447
		2	1972	638	447
	Colstrip[e]	1	1975	166	120
		2	1976	166	120
	Jim Bridger[f]	1	1974	170	122
		2	1975	170	122
		3	1976	170	122
		4	1979	170	122
	Valmy	1	1981	121	87
Nuclear Units	Hanford Generating Project		1966	0	400[c]
	Trojan		1976	1,080	702[d]
	TOTAL			4,019	3,193

[a]Net sustained capacity, available to the region PNUCC (1982a), PNUCC (1982b).

[b]Available to region.

[c]Drops to 400 in the 1983-84 operating year, removed from resource base in 1993. The contract for this resource is subject to cancellation on one-year notice.

[d]Based on Council's assumption of 65% equivalent availability.

[e]The plant consists of two 330 MW units, each of which can produce 247 MW of energy. The amounts not shown in this table meet Montana Power Company loads both inside the region, in Western Montana, and outside, in Eastern Montana.

[f]The plant consists of four 500 MW units, each of which can produce 350 MW of energy. The amounts not shown in this table meet PP&L loads both inside the region and in Wyoming, outside the region.

[g]An equivalent availability of 72% is assumed for all coal units of 530 MW capacity or less. For those larger than 530 MW capacity, an equivalent availability of 70% is assumed.

Imports to the Region

Regional resources include arrangements for importing both firm energy and peaking capacity from systems outside the region. These arrangements largely involve intra-company transfers by utilities that serve both regional loads and loads in portions of Montana, Utah, and Wyoming that are outside the region, and are primarily coal-fired generation in Montana and Wyoming. Included as imports to the region are portions of thermal resources that are outside of the region's boundaries, but are intended by the utilities to serve regional loads. Inclusion of these resources as "imports" should not be interpreted to mean that the Council believes these resources are cost-effective or available for acquisition.

Additional resources include capacity and energy exchanges with California utilities.

Table 6-3.
Existing Reserves (Oil and Natural Gas)

	PROJECT	TECHNOLOGY[a]	IN-SERVICE DATE	SUSTAINED CAPACITY (MW)	AVERAGE ENERGY (Average MW)
OIL FIRED	Beaver	Combined Cycle	1977	534.0	301.0
	Boundary	Combustion Turbine	1976	0.75	Reserve Unit
	Libby	Combustion Turbine	1972	20.0	Reserve Unit
	Othello	Combustion Turbine	1973	32.8	4.0
	Whidbey	Combustion Turbine	1972	29.0	0.7
	Point Whitehorn 1	Combustion Turbine	1974	68.0	7.0
	Bonners Ferry 1 and 2	Diesel	1930	2.2	Reserve Unit
	Crystal Mountain	Diesel	1969	2.8	0.1
	Summit 1 and 2	Diesel	1970	6.0	1.0
	Lake Union	Steam Electric	1921	26.0	Reserve Unit
	Shuffleton	Steam Electric	1930	86.0	0
NATURAL GAS FIRED	Bethel 1	Combustion Turbine	1973	58.0	6.0
	Bethel 2	Combustion Turbine	1973	58.0	6.0
	Frederickson 1	Combustion Turbine	1981	89.0	9.0
	Frederickson 2	Combustion Turbine	1981	89.0	9.0
	Northeast	Combustion Turbine	1978	68.0	7.0
	Whitehorn 2	Combustion Turbine	1981	89.0	9.0
	Whitehorn 3	Combustion Turbine	1981	89.0	9.0
	Wood River	Combustion Turbine	1974	50.0	1.0
	TOTAL			1,406.0	369.8

[a]CC — Combined Cycle; CT — Combustion Turbine, D — Diesel; S — Steam Electric.

Table 6-4.
Thermal Resources Which Are Under Construction and Assumed to be Completed

	PROJECT	SCHEDULED IN-SERVICE DATE	SUSTAINED[a] CAPACITY (MW)	AVERAGE[a] ENERGY (Average MW)
COAL	Coalstrip #3b	Jan. 1984	490	343
	#4b	Jul. 1985	490	343
	Valmy #2	Sep. 1985	121	87
NUCLEAR	WPPSS #1	1988/1991[c]	1,250	813
	#2	Feb. 1984	1,100	715
	#3	Dec. 1986	1,240	806
NATURAL GAS	Fredonia #1	1983	104	10
	#2	1983	104	10
	TOTAL		4,899	3,127

[a]Available to serve regional loads.

[b]The total plant consists of two 700-megawatt units capable of producing 980 megawatts of energy. The 30% share not shown on this table is owned by Montana Power Company and is assumed to serve loads both in the region, in Western Montana, and outside, in Eastern Montana.

[c]In the high and medium-high growth forecasts, WPPSS 1 comes on-line in 1988. In the low and medium-low growth forecasts, WPPSS 1 comes on-line in 1991.

Resources Under Construction

New Hydropower Resources

Figure 6-1 includes new hydropower projects in cases where construction is assured (PNUCC "Blue Book"). All federal projects included are authorized projects which are under construction or have been funded for construction or preconstruction planning. Non-federal hydropower projects include expansion at Seattle City Light's High Ross Dam, or its equivalent. Other new projects that are not included in figure 6-1 are included in the hydropower assessment of chapter 8.

Thermal Resources Under Construction

Thermal resources under construction represent 3,127 average megawatts to serve regional loads. This category includes Washington Public Power Supply System Plants 1, 2, and 3; Idaho Power Company's Valmy 2; Colstrip 3 and 4 operated by Montana Power Company; and Fredonia Units 1 and 2 owned by Puget Sound Power and Light. Characteristics of these plants are listed in table 6-4. Resources not included in this category and therefore not represented in figure 6-1 include WPPSS 4 and 5 and Skagit/Hanford Plants 1 and 2.

Chapter 7
Conservation

"the plan shall include ... an energy conservation program"

The key element in the Council's resource portfolio for meeting future energy needs is conservation. This chapter first describes present electric consumption for the region's residential, commercial, industrial, and irrigated agricultural sectors. It then assesses potential conservation savings for each sector and identifies how much conservation from that sector is included in the Council's resource portfolio.

Conservation involves more efficient use of electricity. This means (a) ensuring that new houses and commercial and industrial facilities are more energy-efficient; (b) installing more efficient water heaters and appliances; and (c) finding more efficient ways to manufacture products, to perform industrial processes, or to move irrigation water into the fields.

Conservation also involves steps to make existing houses and buildings more energy-efficient by adding insulation in walls and ceilings, installing water heater blankets, and adding other cost-effective conservation measures.

If we could ignore cost, there is technology available to reduce our needs for electricity dramatically. The Council considered any conservation measure as technically achievable if it could improve the efficiency of electric use at a cost of 10 cents (or less) per kilowatt-hour. The Council's assessment of the portion of this technically achievable conservation that can be developed cost-effectively took into account four important factors.

First, the Act grants conservation a 10 percent cost advantage over other resources. This means that a conservation measure can cost 10 percent more than the next lowest-cost resource and still be cost-effective under the Act.

Second, conservation measures also reduce the need for additional transmission lines and other distribution facilities. From the regional perspective, when a conservation action reduces the need for these facilities, it reduces the associated facilities' costs by approximately 2.5 percent.

Third, conservation avoids the "line losses" that occur when electricity is transmitted over long distances. About 7.5 percent of the electricity generated at a power plant is "lost" in transmission to its ultimate point of use. Subsequently, any comparison between a generating resource and conservation must adjust for this fact. Therefore, for purposes of its cost-effectiveness analysis, the Council reduced conservation's cost by 7.5 percent. The combined effect of adjustments for the cost advantage provided by the Act, and transmission cost and line loss savings, is to reduce conservation's cost by 20 percent.

Finally, to assess accurately the amount of cost-effective conservation available, the administrative cost of programs needed to secure conservation must be included. The Council reviewed current utility conservation programs and those operated by other agencies. This review indicated that conservation program administrative costs are in the range of 15 to 25 percent of the direct cost of measures for fully operational programs. The Council, in its cost-effectiveness evaluations of conservation, has assumed a 20 percent administrative cost.

The Council has established its cost-effectiveness limit at a levelized cost of 4 cents per kilowatt-hour in 1980 dollars. Conservation measures which have an installed cost in excess of this amount are less economically attractive than other new resources the region could acquire. This limit was established by comparing the levelized cost of conservation measures with the levelized cost of other, similarly available and reliable resources.

In the Council's high growth forecast, it currently appears that the last resource to be acquired will be a coal plant with a levelized cost slightly above 4 cents per kilowatt-hour. Conservation measures which could displace this coal plant would be considered cost-effective if they were compatible with the existing power system. To assess this, the Council used its strategic planning model and the systems analysis model. Finally, in judging whether conservation was cost-effective, the Council considered its ability to limit the region's exposure to higher risk thermal resources which have long lead times and require large capital investments.

Although the amount of conservation available at 4.0 cents per kilowatt-hour is economically achievable, not all of these savings can be realized. Changes in consumer behavior and consumer resistance, quality control, and unforeseen technical problems will prevent the region from developing 100 percent of this potential. However, the Council has decided that, using the wide assortment of incentives and regulatory measures the Act makes available, the region's electric consumers could be persuaded to install a large percentage of the economically achievable conservation. The amount of conservation included in the plan and referred to in the following discussions is the net savings the Council anticipates after taking into account all of these factors. The proportion considered realizable under the plan varies from 36 percent for residential appliances to nearly 100 percent for the industrial and irrigation sectors. In aggregate, the Council's plan, under the high growth forecast, calls for the development of approximately 75 percent of the conservation that can be achievable at a cost equal to or less than 4.0 cents per kilowatt-hour.

The amount of technically and economically achievable conservation is directly related to the amount of energy used. This section describes the amount of electricity presently used in each sector, the amount that would be used if there were no conservation programs, and the savings made possible by the plan. A technical discussion of the Council's conservation assessment appears in Appendix K (Volume II, available on request).

The conservation savings identified in this chapter are higher than other projections made in the region. A major reason is that the analysis assumes the Council's high growth forecast which is based on record economic growth in the region. If one of the Council's lower growth forecasts should occur, fewer new buildings and new factories would be built. Less total energy would be needed, and consequently less conservation could be saved.

Any direct comparison of the Council's conservation assessment with those made by other organizations should take two other factors into account. The supply data used in the plan include all conservation without distinguishing between conservation put into place as a result of specific programs and conservation measures motivated by rising prices of electricity. These estimates are also based on the high penetration rates the Council's plan assumes for each conservation program.

The figures shown do not include any adjustment for line losses. All costs shown are for the direct cost of the measures and do not include program cost, transmission cost savings, or quantifiable environmental costs and benefits.

Residential Sector

Current Use of Electricity

In 1981, the region's residential sector consumed an estimated 5,323 average megawatts of electricity. This represented approximately 34 percent of the region's total consumption. The two largest residential uses of electricity are space and water heating. Space heat consumption in 1981 was 1,650 average megawatts or 31 percent of the residential use. Electricity used for water heating represented an estimated 26 percent of the residential use, or 1,380 average megawatts. The remaining 2,300 average megawatts (43 percent) were consumed by lights and other appliances.

Potential and Planned Conservation

Council studies indicate significant cost-effective conservation potential in the residential sector. Under the Council's low and medium-low growth forecasts, residential needs in the year 2002 could be accommodated without using more electricity than in 1981. Even the record population and economic growth rates envisioned by the Council's high growth forecast could double the number of residential customers yet require only one-third more electricity than in 1981.

Three-quarters of the currently identified residential conservation potential is available through more efficient space heating and water heating. The remainder would come from improvements in efficiency of major household appliances, such as refrigerators and freezers, and in lighting. The conservation potential for each of these uses of electricity is discussed in the following paragraphs.

Figure 7-1 shows estimated space heating savings available in existing residences at a cost between 1 and 10 cents per kilowatt-hour. These savings can be achieved through improving the insulation levels, adding storm windows, and reducing the air leakage in existing houses. Of the 770 megawatts of technically achievable space heating conservation shown in figure 7-1, the Council's plan calls for developing 520 megawatts at an average cost of 1.5 cents per kilowatt-hour by the year 2002. This assumes a 33 percent reduction in energy used for space heating.

The Act directs the Council to establish model conservation standards for new buildings. These standards must secure all the power savings that are cost-effective for the region. In addition, they must be economically feasible for consumers. Subsequently, in the development of its model standards for new residential buildings, the Council took into consideration such factors as mortgage rates, increases in the initial cost of a house to pay for conservation measures, the present and future cost of electricity, and other consumer investment opportunities. To ensure that its assessment of economic feasibility was conservative, the Council deliberately excluded from its analysis the tax deductions a homeowner is permitted for interest paid on home mortgages. The Council also did not include in its calculations the fact that houses built to its model standard will require much smaller and, less expensive heating systems. If both of these factors were included, they would significantly reduce the cost of attaining the Council's standard.

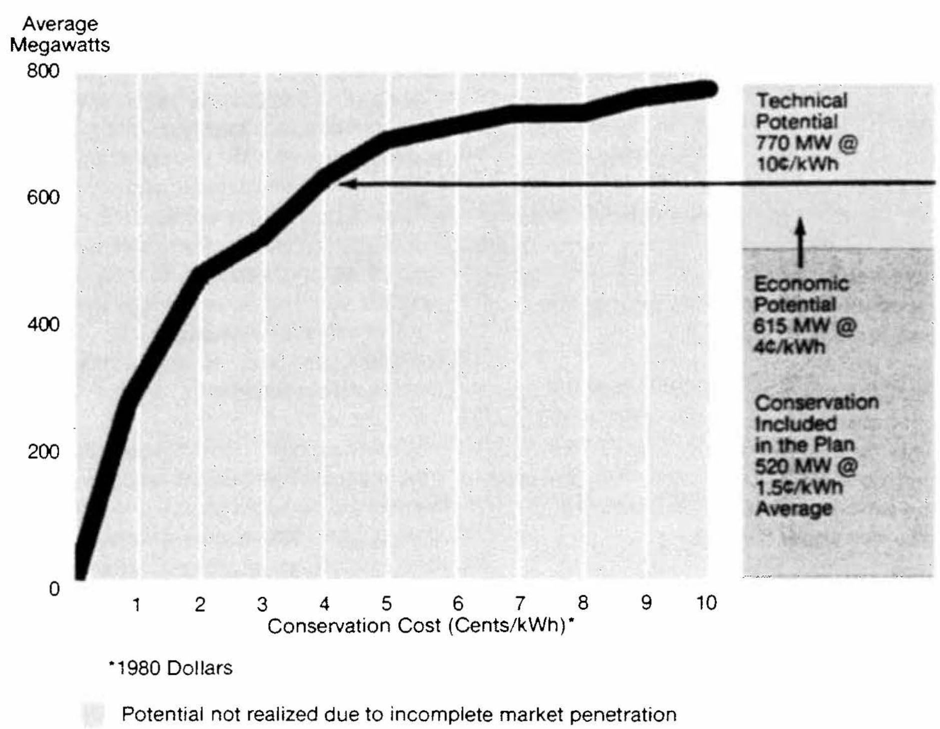


Figure 7-1.
Residential Space Heating (Existing Houses)

As is shown in figure 7-2, a consumer living in a house built to the Council's model standard would use 60 percent less electricity for space heating than in a house built to current codes. Although a house built to the Council's model standard will have a slightly higher initial cost, over the life of the house the consumer will be economically better off than if living in a house built to current codes. If tax deductions for interest on the added cost of the mortgages and cost savings from smaller heating systems are considered, a consumer's first year combined payment for space heating and mortgage payments will be less than if they purchased a house built to current codes. Figure 7-3 depicts the effects of interest deductions and heating system cost savings for a house built in Seattle or Portland.

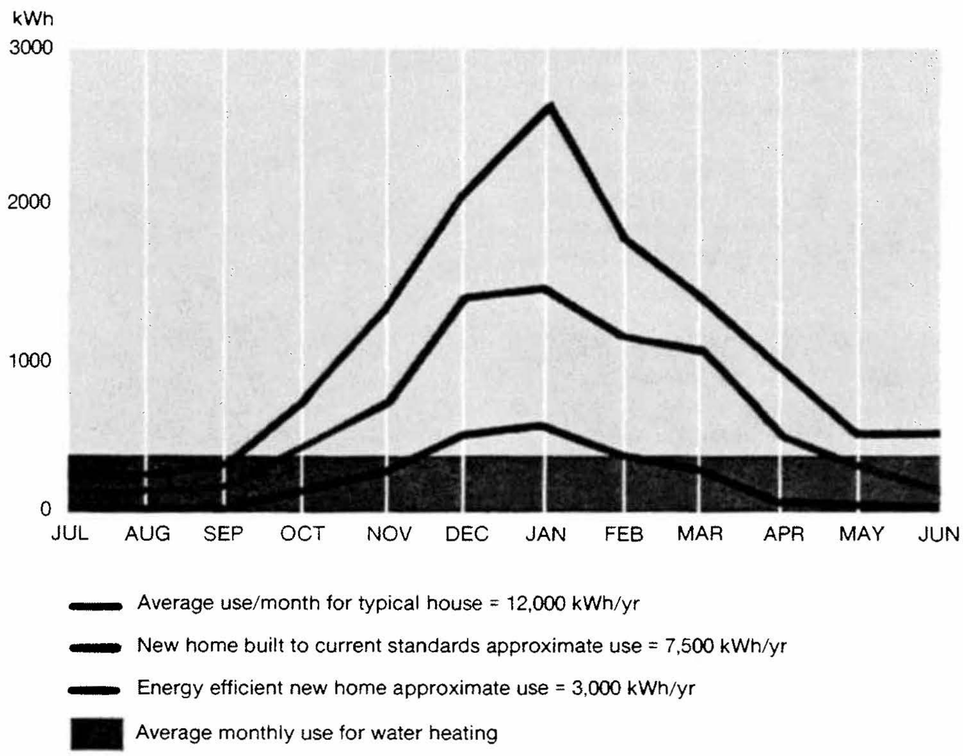
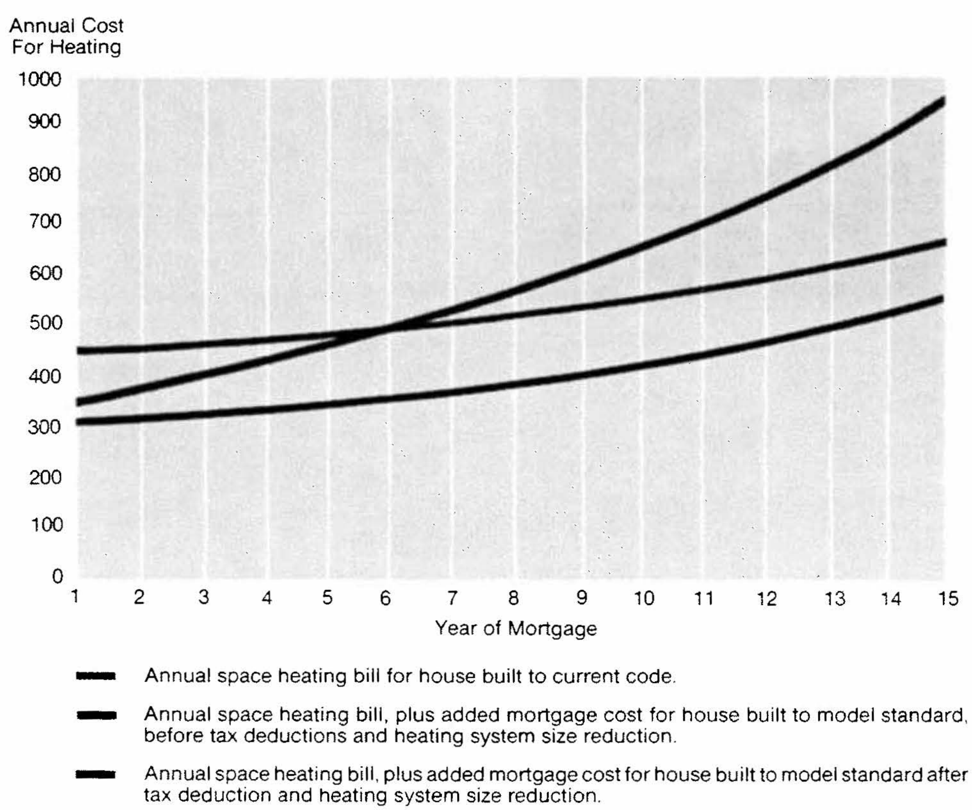


Figure 7-2.
Average Monthly Space Heating Use



NOTE: For houses built to current code, the annual cost shown is the consumer's electric bill for space heating. For houses built to the Council's standard, the annual cost shown is the consumer's electric bill for space heating, *plus* the increased mortgage payment needed to pay for the additional conservation measures installed in the house. In climate zones 2 and 3 a homeowner's combined payment (electricity plus mortgage) is less than his energy cost even before taxes and heating system cost savings are considered.

Figure 7-3.
Annual Space Heating Cost for Houses Built to Current Code and Model Standard, Climate Zone 1 (example: Portland/Seattle)

The Council's plan calls for implementing these model conservation standards by January 1, 1986. Figure 7-4 shows the space heating conservation potential in new residences under the Council's high growth forecast. As is shown in this figure, these model standards could save 880 megawatts by the year 2002. The average cost of these savings is less than 2.0 cents per kilowatt-hour.

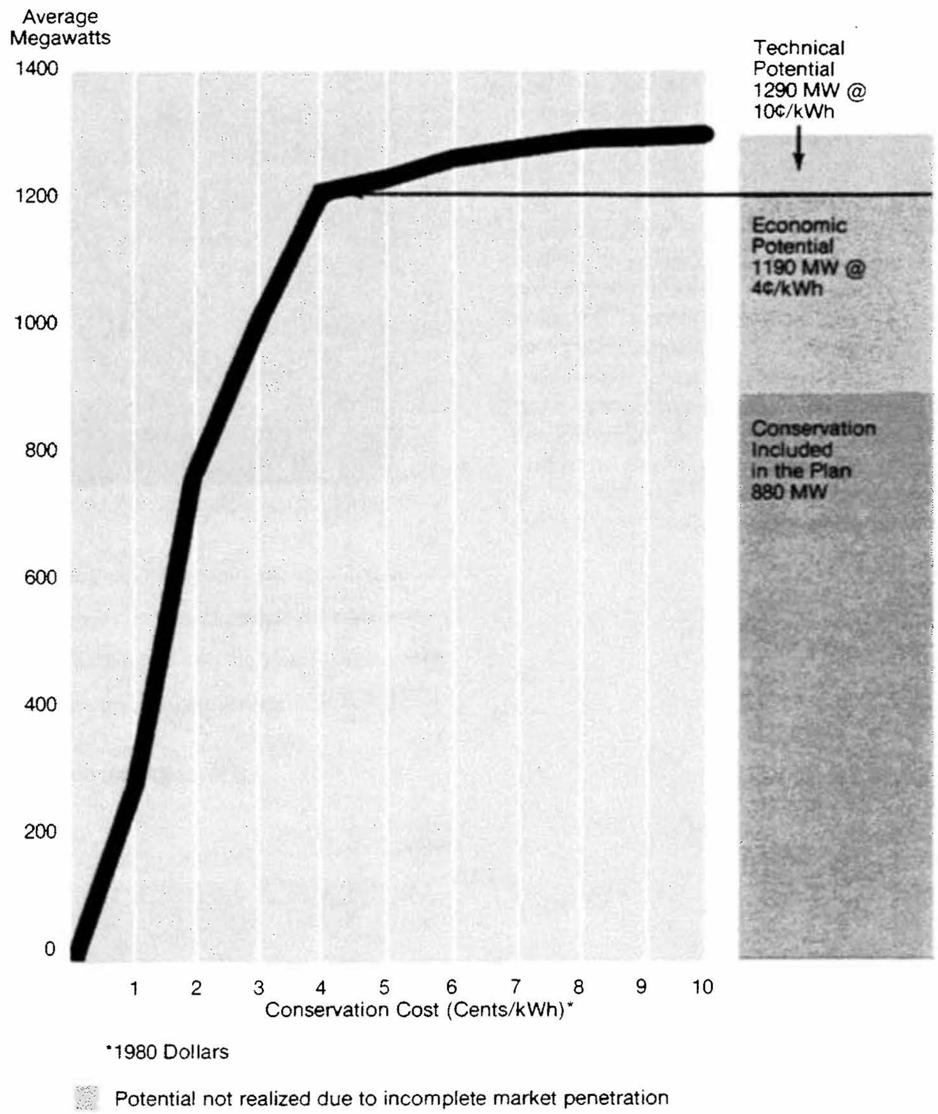


Figure 7-4.
Residential Space Heating (New Houses)

Water heating represents the second largest single residential use. Figure 7-5 shows the potential for improving the efficiency of residential water heating at a cost between 1 and 10 cents per kilowatt-hour. These savings represent better-insulated water heaters, pipe wraps, and lower water temperature. Also included in the savings estimates are water heaters that use a heat pump or solar energy to heat water rather than electric resistance elements. These devices are commercially available from major distributors throughout the region. However, because they are relatively expensive, heat pump and solar water heaters are most economical for households with above-average water use. Therefore, the cost-effectiveness of the savings from heat pumps and solar water heaters depends on the number of people in a household.

In addition, the economic attractiveness of solar water heaters for consumers is dependent upon the amount of sunshine in a particular area, and state and federal tax credits.

The Council's high growth resource portfolio includes 510 megawatts of water heating conservation. The average cost of improving the efficiency of tanks, pipe wraps, etc., is less than 2 cents per kilowatt-hour. Heat pump water heater savings are expected to cost 3 cents per kilowatt-hour. Solar water heater savings are expected to be acquired at prices equivalent to the cost of heat pump water heater savings.

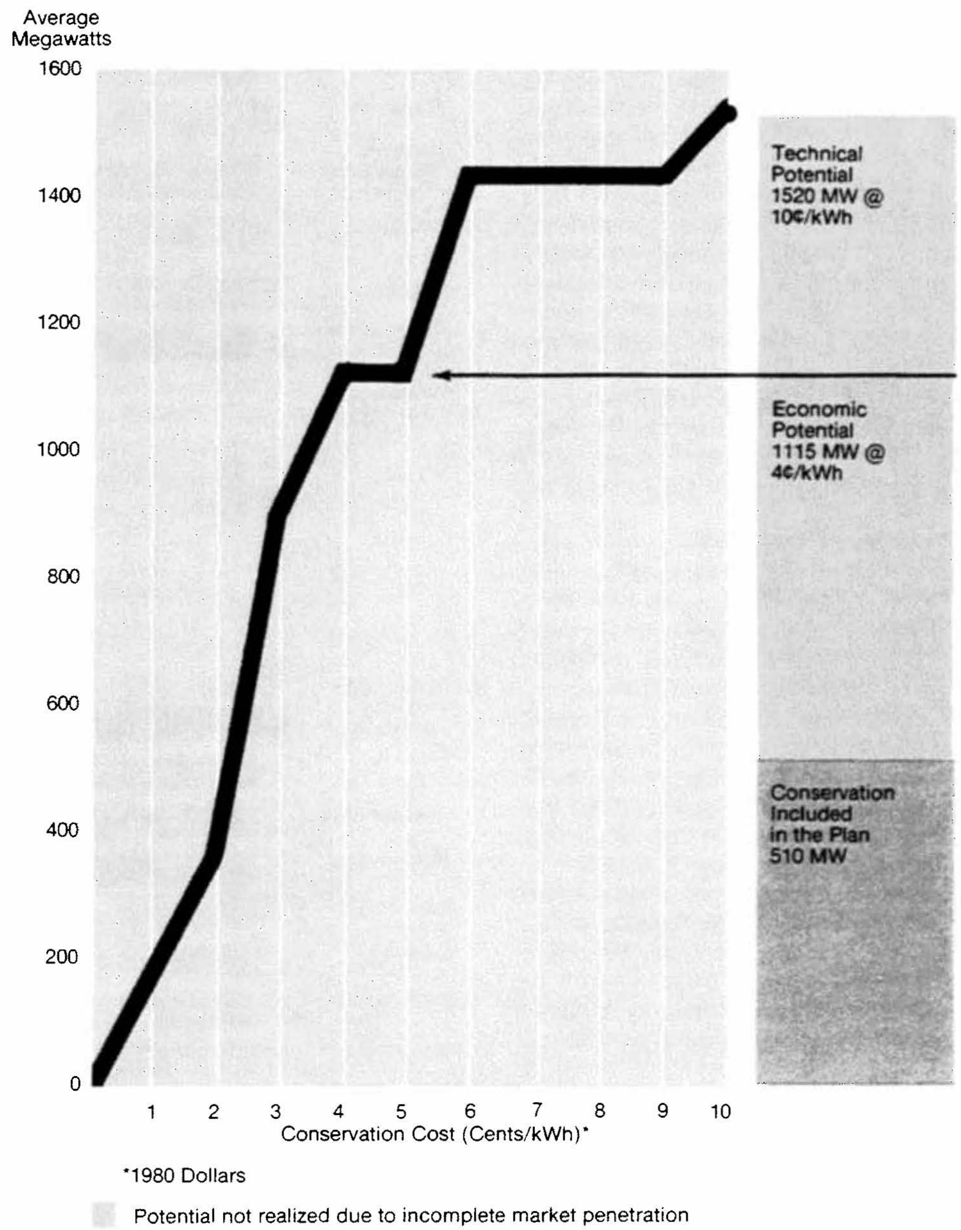


Figure 7-5.
Residential Water Heating

Nearly one-half of residential electricity is consumed by an assortment of appliances. Refrigerators and freezers, cooking, and lighting make up approximately one-half of the electricity used by these appliances. Figure 7-6 compares the average amount of electricity used per household in the region by these appliances with the annual use of electricity of the most efficient models currently on the market. Under the Council's high growth forecast, the conservation potential from these more efficient appliances is 995 megawatts, or about 10 percent of the total electricity used by appliances. The Council's plan calls for developing approximately 36 percent of this potential (355 megawatts) by the year 2002.

The Council assessed the potential impact that adoption of the State of California's Appliance Standards would have on improving residential appliance efficiency. The California standards were compared to estimated average efficiencies of appliances now sold in the region. It appears that the current California Standards, adopted in 1979, are being met by the vast majority of appliances now marketed in the Pacific Northwest. The Council plan calls for the implementation of incentive programs which promote consumer purchases of highly energy-efficient appliances. During the next two years, the Council will assess the impact of these incentive programs as well as the desirability of adopting more stringent appliance standards.

Figure 7-7 summarizes the savings anticipated under the plan for different residential uses of electricity under the Council's high growth forecast. Space heating use in existing houses would be one-third more efficient than at present. New houses would use nearly 60 percent less for space heating than houses built to current standards. Water heating demands would be reduced by over 21 percent. Refrigerators, freezers, and other appliances would consume 7 percent less than projected at their current efficiencies. Together, these savings are projected to bring about a 21 percent reduction in residential electric needs compared to residential requirements in the year 2002 without further efficiency improvements. The average cost of these savings is less than 2 cents per kilowatt-hour.

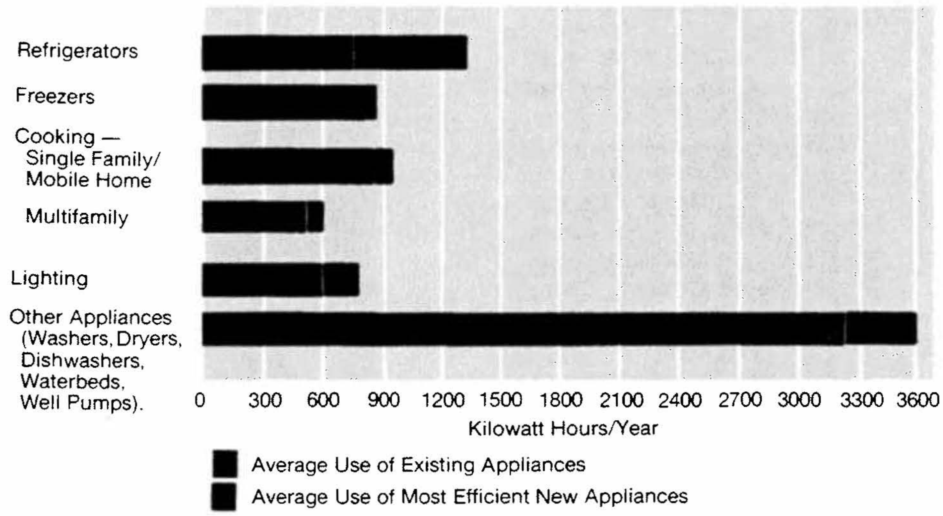


Figure 7-6.
Appliance Energy Use and Savings

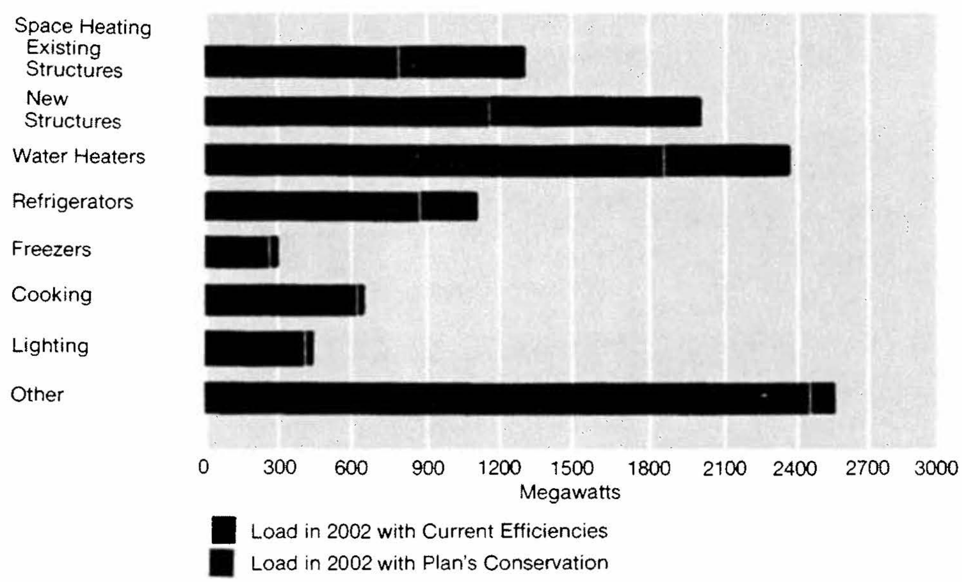


Figure 7-7.
Residential Sector - Planned Conservation

Commercial Sector

Current Use of Electricity

The commercial sector consumed approximately 18 percent of the region's total firm energy sales in 1981, or an estimated 2,713 average megawatts. The commercial sector's energy consumption is split between space heating (13 percent), cooling (23 percent), lighting (43 percent), and other (21 percent).

Potential and Planned Conservation

The commercial sector is composed of diverse customers, ranging from individual phone booth lights to entire office towers. This diversity, along with the absence of data, prohibits a detailed analysis of commercial conservation potential by type of use of electricity that was presented for the residential sector. Consequently, the Council's studies of the conservation potential in commercial buildings focused on engineering assessments and available survey data regarding commercial energy savings. This review indicated that a 30 to 40 percent reduction in electric energy use can be achieved. Moreover, 90 to 95 percent of this conservation can be obtained at a cost below 3 cents per kilowatt-hour.

Figure 7-8 shows the technical and economic conservation potential in existing commercial buildings available for between 1 and 10 cents per kilowatt-hour. Under the Council's high growth forecast this represents a total conservation potential of 800 megawatts for 4 cents or less per kilowatt-hour.

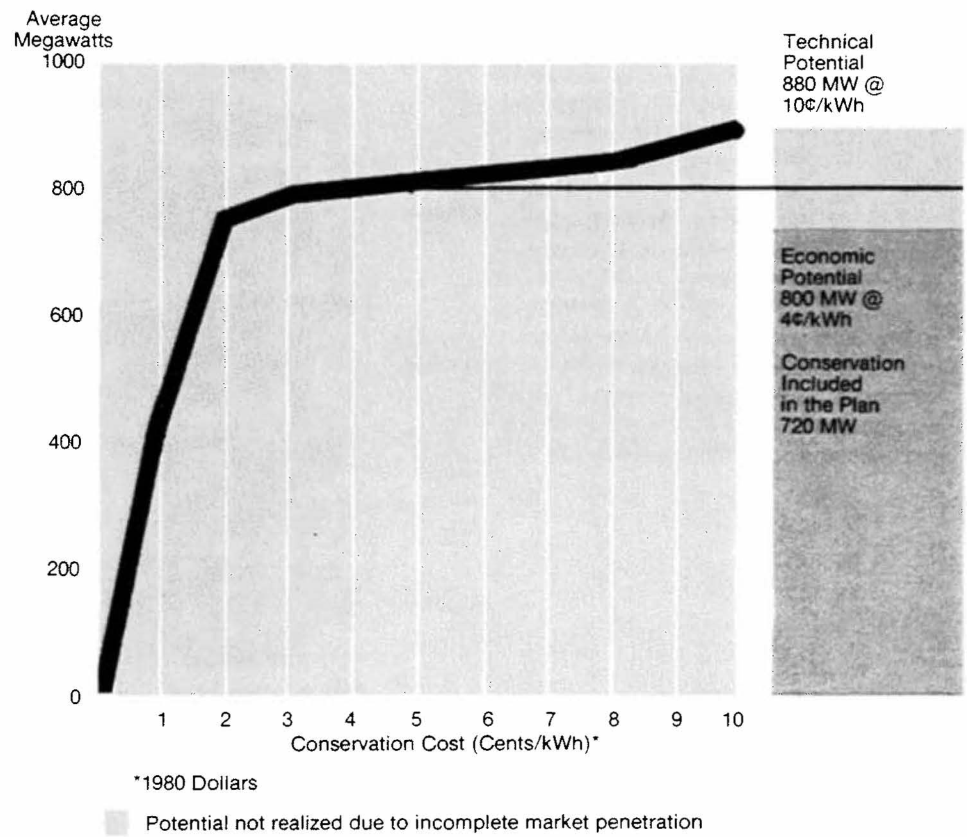


Figure 7-8.
Commercial Sector Conservation Potential (Existing Buildings)

New commercial buildings are being constructed to use energy more efficiently. Figure 7-9 compares the regional average annual energy use by building category for existing and new all-electric commercial buildings. For new buildings, this figure shows energy use for existing standard practice as well as under the most energy-conserving commercial building code currently in effect in the region. Figure 7-10 shows that regionwide adoption of this energy code could produce 685 megawatts of savings under the Council's high growth forecast at a cost below 4 cents per kilowatt-hour, assuming that all new commercial buildings complied with the code.

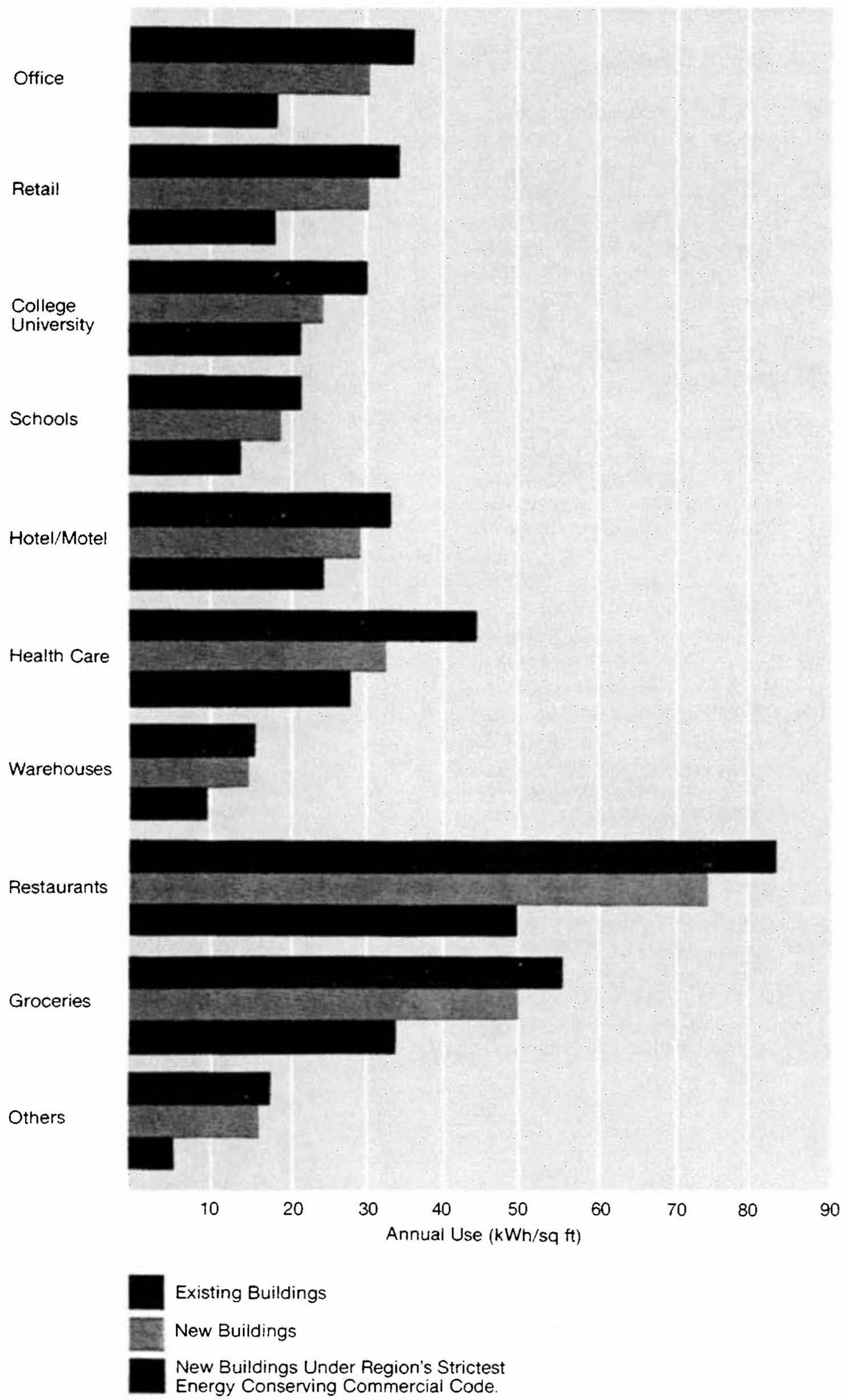


Figure 7-9.
Average Annual Energy Use by All-Electric Commercial Buildings

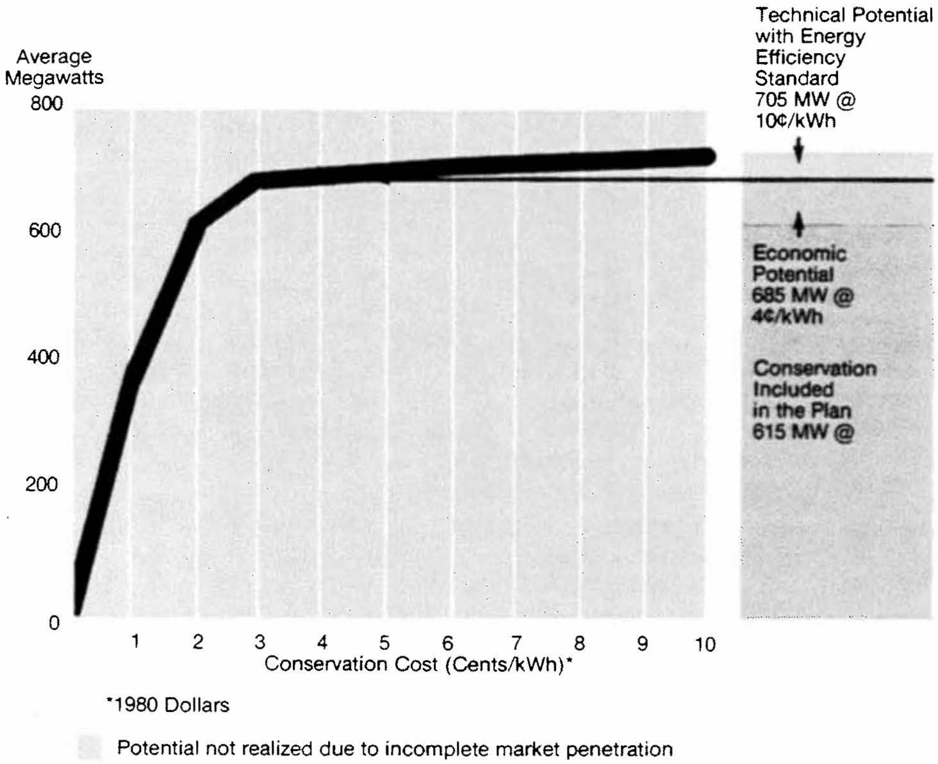


Figure 7-10.
Commercial Sector Conservation Potential (New Buildings)

The Council's plan calls for developing 1,135 megawatts of the conservation potential in new and existing commercial buildings by the year 2002. An aggressive program to upgrade existing commercial buildings is projected to produce 720 megawatts of these savings for 1.6 cents or less per kilowatt-hour. The Council's proposed model standard for new non-residential buildings requires that 90 percent of the new commercial buildings in the region achieve efficiency levels equivalent to those now required by the region's strictest energy code. Under the Council's high growth forecast, this standard would save 615 megawatts.

The projected annual energy use for a sample of energy-efficient commercial buildings which represent the most efficient design practices now commercially available is shown in table 7-1. The projected average annual energy use of these buildings is 45 percent below buildings constructed to the strictest energy code

Table 7-1.
Energy-Efficient Commercial Buildings

BUILDING	SIZE	ANNUAL ENERGY USE Btu/sq ft	kWh/sq ft
NOAA Administrative Building* Seattle, Washington	84,000	28,000	8.2
Willow Creek Building Idaho Falls, Idaho	284,000	38,234	11.2
Western Life Insurance/ Massachusetts Woodbury, Minnesota	350,000	46,585	13.7
Gulf Oil Square Ontario, Canada	1.3 million	34,130	10.0
Shell Wood Creek Harris County, Texas	828,000	32,000	9.4
Hooker Chemical Company Niagara Falls, New York	2,000,000	33,000	9.7
	Average Use	33,993	9.97

*Annual energy use for the NOAA building is based on the building's projected operating schedule and use. Actual use has been significantly higher due to substantially longer hours of operation and the installation of a major computer center in the building. The energy use shown for all other buildings is based on actual consumption records.

now in effect in the region as shown in table 7-2. The Council anticipates that an incentive program to encourage widespread use of these more efficient commercial building design practices could achieve another 515 megawatts of savings for less than 4 cents per kilowatt-hour. However, the Council has not counted on any savings above the amount available from the proposed model standard in its resource portfolio. The Council has called for a demonstration program to investigate the potential for additional savings and will modify future plans based on the cost, commercial availability, and energy savings of new techniques. As a result, the 515 megawatts do not appear in the Council's resource portfolio.

Table 7-3 summarizes commercial conservation potential for the Council's high growth forecast. Planned conservation would reduce projected commercial use of electricity in the year 2002 by approximately 20 percent. The average cost of these savings is less than 2 cents per kilowatt-hour.

Table 7-2.
*Projected Annual Energy Consumption of Major Commercial Buildings**
Constructed in Downtown Seattle between 1979 - 1983

BUILDING	TOTAL FLOOR AREA	PROJECTED ANNUAL CONSUMPTION** kWh/sq ft/hr	kWh/yr
Daon Building	261,636	24.0	6,286,010
1111 Third Avenue	560,250	16.1	9,028,348
One Union Square	795,629	16.1	12,821,446
PEMCO	166,600	39.6	6,589,804
Blanchard Plaza	259,000	14.9	3,881,575
Metropolitan Park	329,000	26.6	8,757,974
Seattle First Plaza	986,000	17.6	17,333,724
Columbia Center	1,500,000	17.9	26,809,259
Holiday Inn	338,000	49.8	16,835,628
Madison Hotel	457,750	18.1	8,288,588
	5,653,865		116,632,360

Average Consumption $= \frac{116{,}632{,}360 \text{ kWh/yr}}{5{,}653{,}865 \text{ sq ft}}$

=20.63 kWh/sq ft/yr
(70,410 Btu/sq ft/yr)

Median Consumption =18 kWh/sq ft/yr
(61,434 Btu/sq ft/yr)

*These buildings conform to the Seattle Building Code which is the strictest in the region.

**Annual consumption estimates are based on final environmental impact statements and/or contacts with the building architect/engineer.

Table 7-3.
Commercial Sector — Summary of Projected Loads and Conservation Potential
Year 2002

ELECTRICITY USE	LOAD: WITH CURRENT EFFICIENCIES (MW)	LOAD: WITH PLAN'S CONSERVATION (MW)	CONSERVATION: SAVINGS (%)	CONSERVATION: CONSERVATION INCLUDED IN THE PLAN (MW)
Existing Buildings	2,520	1,800		720
New Buildings	4,140	3,525		615
TOTAL	6,660	5,325	20%	1,335

*Savings potentially available through use of best commercially available, energy-efficient commercial building design are not included.

Industrial Sector

Current Use of Electricity

Bonneville's current industrial loads consist of the Direct Service Industries (DSIs) and the industrial customers of Bonneville's retail utilities. In 1981, sales to the region's non-DSIs were 4,020 average megawatts. Sales to the DSIs (mainly the aluminum industry and some chemical producers) in 1981 were 3,131 average megawatts of which 2,405 megawatts were firm sales. The largest consumers among the non-DSIs are pulp and paper (19 percent), chemical (13 percent), lumber (7 percent), non-DSI primary metals (7 percent), and food products (4 percent). In 1981, industrial sector sales accounted for 41 percent of firm electric sales in the region.

Potential and Planned Conservation

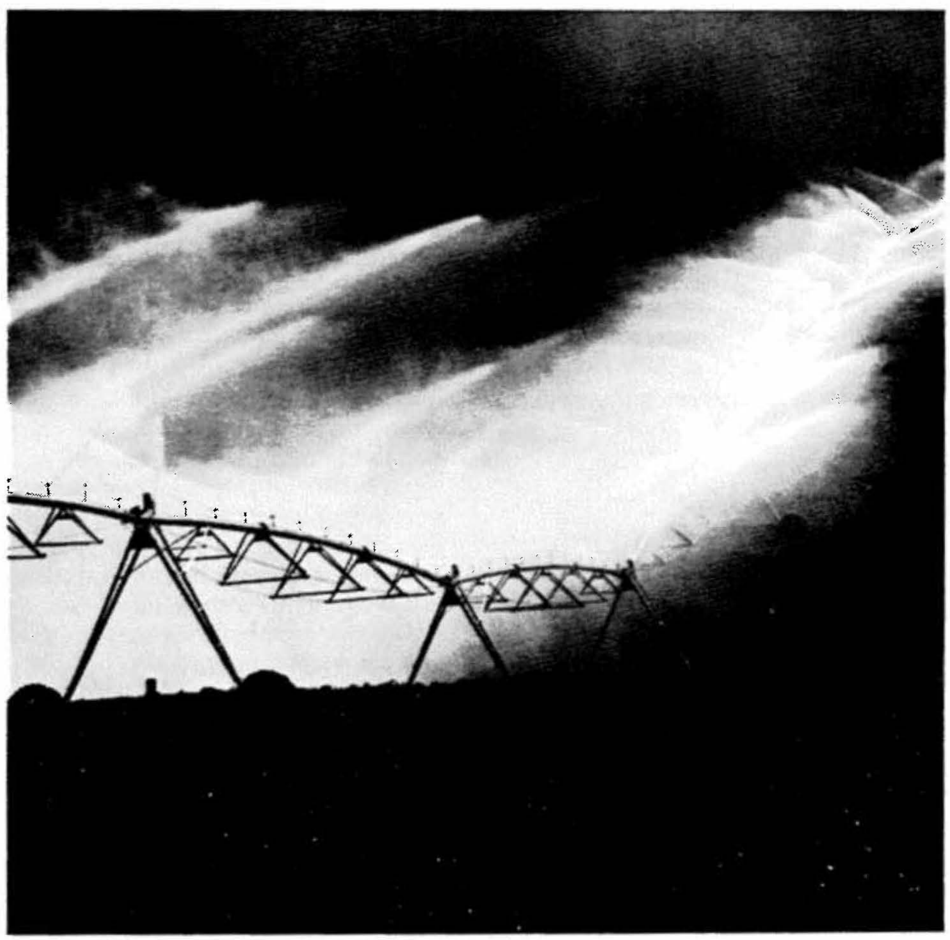
Assessing the technical and economic potential for industrial conservation presents a more difficult problem than any other sector. Not only are industrial uses of electricity more diverse than the commercial sector, but the conservation potential is also more site-specific. Moreover, because energy use frequently plays a major role in industrial processes, many industries consider energy-use data proprietary. As a result of these problems, past attempts to assess the industrial sector's conservation potential have not been particularly successful.

The Council's assessment of industrial sector conservation, summarized in table 7-4, is based on surveys conducted by the region's major industrial electric customers, including Bonneville's Direct Service Industries. Each industry was asked to estimate the amount of electric efficiency improvements it would make if it were paid a specific amount of money for the savings. While all respondents indicated that their assessments were preliminary, these survey results do signify that industrial conservation could provide the region with significant savings.

Table 7-4.
Industrial Sector — Technical and Economic Conservation Potential

COST (Cents/kWh) in 1980 $)	CUMULATIVE POTENTIAL (Average MW)
1.0	105
1.5	200
2.0	545

The Council's plan includes developing 545 megawatts of the currently identified conservation potential in the industrial sector at an average cost of 1.5 cents per kilowatt-hour. Under the Council's high growth forecast these savings would reduce projected industrial demand for electricity in the year 2002 by approximately 6 percent.



Irrigated Agriculture Sector

Current Use of Electricity

Electricity used in irrigated agriculture accounted for approximately 5 percent of the region's firm electric sales in 1981. Just over 770 average megawatts were used for well and irrigation pumping in that year.

Potential and Planned Conservation

The costs of energy-conserving water application systems are highly variable depending upon specific situations. In general, the cost per kilowatt-hour saved for new energy-conserving systems is less than or equal to the cost of electricity that farmers are currently paying. The costs are generally higher for conservation efforts on existing systems than for installation of more efficient technologies and new systems.

Water application scheduling improvements and more efficient water application systems could provide the largest energy savings potential of any of the irrigation energy conservation options studied. Because such improvements reduce the amount of water used for irrigation, more water could be available for hydropower production. Council studies indicate that 440 megawatts can be saved in irrigated agriculture at a cost between 1 and 10 cents per kilowatt-hour. Figure 7-11 depicts this potential.

The Council concluded that conservation programs in irrigated agriculture would be implemented rapidly if adequate financing can be secured. Farmers, particularly those with high-pumping lifts and high-pressure systems, are experiencing significant cost increases for electricity. Consequently, they are actively seeking ways to reduce their electric consumption.

The Council's plan anticipates that 385 megawatts of conservation potential in irrigated agriculture can be realized by the year 2002. The development of this conservation would reduce anticipated agricultural demand for electricity in the year 2002 by 30 percent.

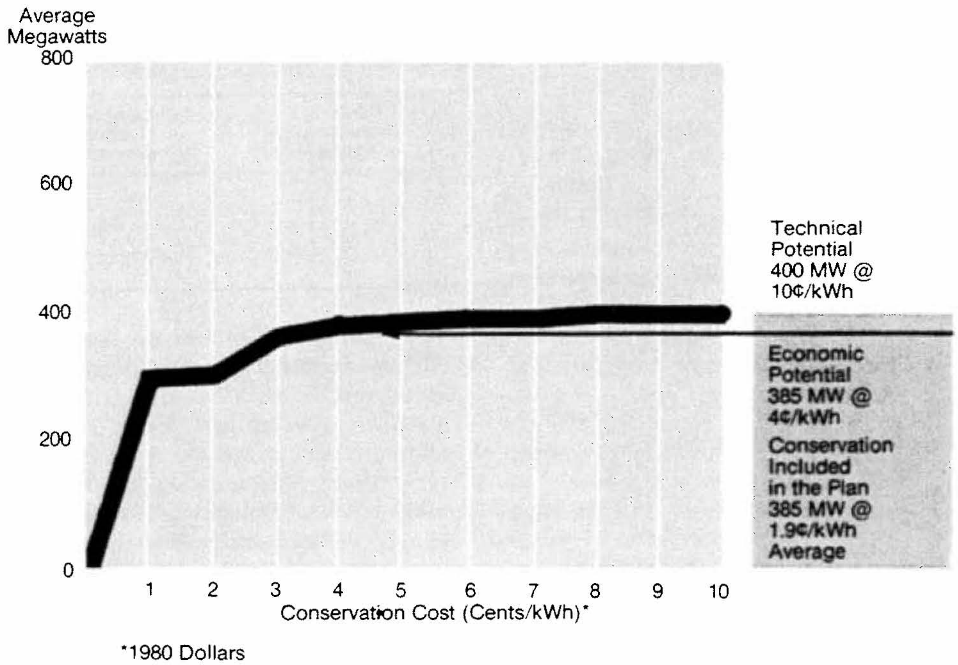


Figure 7-11.
Irrigated Agriculture Conservation Potential

Conservation on the Existing Power System

Efficiency improvements to existing generating units as well as the region's transmission and distribution system represent a source of conservation savings.

The Council has not prepared a detailed analysis of the potential for conservation in those areas, but has been informed over the last year and in testimony received during the public hearings that there is considerable potential. Both Bonneville and the Corps of Engineers have programs underway to improve efficiency of the existing system.

Bonneville has estimated the loss on their customers' distribution systems to be as high as 900 average megawatts and on their own transmission systems to be as high as 300 average megawatts. Measures such as changing system configuration, adding more efficient capacitors, changing conductors to reduce resistance, and replacing transformers could be cost-effective in the near future. Bonneville is also considering raising the voltage levels and installing parallel feeders. The potential for saving electricity is significant. Additionally, Bonneville has estimated that efficiency improvements to existing Kaplan turbines at dam sites in the region could result in up to 200 average megawatts of savings.

The Corps of Engineers has estimated that efficiency improvements at their dams could result in savings of 100 to 150 average megawatts in addition to Bonneville's turbine efficiency improvements.

The Council believes that there may be other opportunities to improve system efficiency and will work toward identifying those opportunities in the next two years and beyond. The Council feels that it is conservative planning to assume that with existing and yet to be identified programs, 270 average megawatts can be achieved through efficiency improvements over the twenty-year plan.

Direct Application Renewables

In addition to improving the efficiency of electric energy use, other technologies are available which substitute renewable energy forms for electricity to perform the same task. These include such things as wood, solar, and geothermal space and water heating, and wind machines used for mechanical drive (such as pumping). These technologies are called direct application renewables. Their cost-effectiveness is highly site-specific. For example, the economics of geothermal district heating depends upon the distance between the geothermal resource and its ultimate point of use. The economics of solar space and water heating depend upon (among other things) whether a house has clear access to the sun. Wood heating may be cost-effective if consumers have close access to an adequate wood supply and take measures to reduce air pollutants emitted from their stoves. The site-specific nature of the economics of these direct application technologies prohibits a general statement regarding their cost-effectiveness to the region. Subsequently, with the exception of solar water heating, the Council has not included them in its resource mix. However, it anticipates that some of these technologies will make significant contributions toward offsetting the need for new generating resources during the next twenty years.

Planned Conservation—All Sectors

Table 7-5 presents a summary by sector of projected loads and planned conservation for the Council's high and low growth forecasts. Figure 7-12 illustrates this information. Conservation in the Council's plan could reduce the projected overall demand for electricity by 17 percent in the year 2002 under the high forecast. This would require developing just over three-quarters of the technical and economic conservation potential available for less than 4 cents per kilowatt-hour by the turn of the century. Under the Council's low growth forecast only a 5 percent reduction in the projected demand for electricity is required to maintain the region's load/resource balance.

The actual rate of conservation development between 1983 and 2002 depends on the level of population and economic activity that occurs during that period. Thus, as described previously, the Council's resource portfolio for its high growth forecast contains significantly more conservation than that required under its low growth forecast. This is because fewer resources are required and less potential savings can be obtained from new customers. The Council's long-term conservation goals and near-term actions are described in the two-year action plan, chapter 10.

Table 7-5.
Summary of Projected Loads and Conservation in the Year 2002 (Average Megawatts)*

	LOAD IN 2002				CONSERVATION			
	WITH CURRENT EFFICIENCIES		WITH PLANS CONSERVATION		SAVINGS (%)		CONSERVATION INCLUDED IN COUNCIL'S PLAN	
SECTOR	HIGH	LOW	HIGH	LOW	HIGH	LOW	HIGH	LOW
Residential	10,850	6,380	8,610	6,085	21	5	2,240	295
Commercial**	6,655	3,475	5,305	3,230	20	7	1,350	245
Industrial	8,850	7,360	8,305	7,315	6	1	545	45
Agriculture	1,280	975	895	940	30	5	385	35
Power System Efficiency Improvements	NA	NA	<270>	<40>	NA	NA	270	40
TOTAL	27,635	18,190	22,845	17,530	17	5	4,790	660

NA — not applicable

*Does not include line losses

**Includes 15 MW of governmental sector conservation

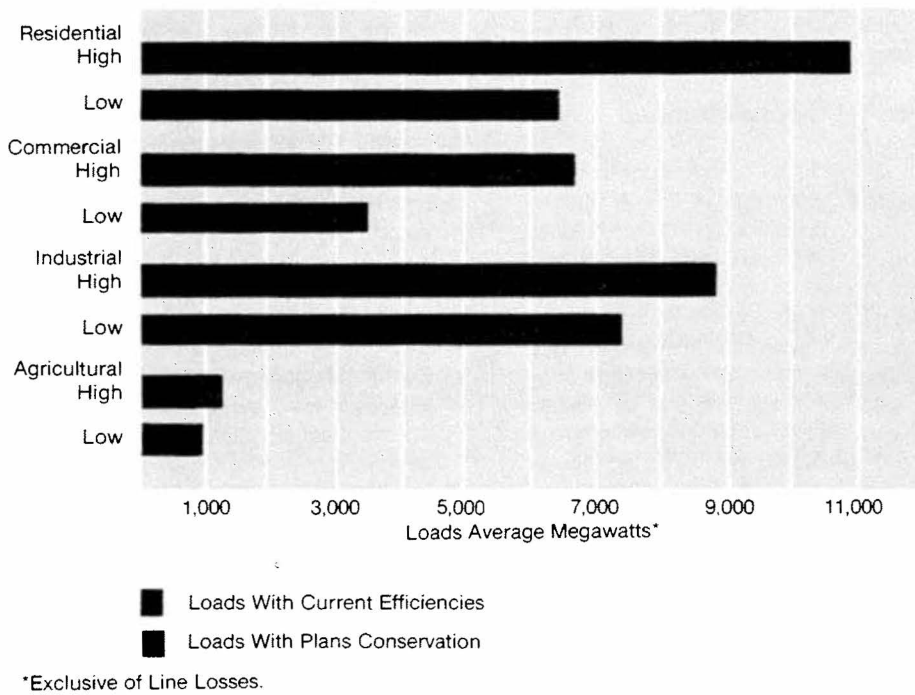


Figure 7-12.
Summary of Projected Loads and Conservation in 2002 for High and Low Forecasts

Rate Design

The Council has identified two points at which rate design affects conservation: (1) initial incentive to act (achievement of desired penetration), and (2) maintenance of conservation investment (minimizing takeback or "thermostat creep"). For example, conservation investments that lower the cost of heating a house may encourage the homeowner to increase the thermostat setting, thereby reducing the net energy saving to the region for its conservation investment.

The Council encourages the use of various rate designs to bring about conservation without proposing specific rate design recommendations as model conservation standards. Depending on utility progress toward the Council's conservation program goals, the Council may choose in the future to include more specific rate design recommendations in the model conservation standards.

Section 9(j)(1) of the Act states:

> The Council, as soon as practicable after the enactment of this Act, shall prepare, in consultation with the Administrator, the customers, appropriate State regulatory bodies, and the public, a report and shall make recommendations with respect to the various retail rate designs which will encourage conservation and efficient use of electric energy and the installation of consumer-owned renewable resources on a cost-effective basis, as well as areas for research and development for possible application to retail utility rates within the region.

The Council therefore recommends that the following principles be used in establishing rate designs:

- An appropriate rate design is one that is based on regional marginal cost. Only regional marginal cost gives a true test of the cost-effectiveness of "conservation and efficient use of electric energy and the installation of consumer-owned renewable resources;"

- Marginal prices are a significant determinant of consumer behavior. The Council recommends that the appropriateness of proposed or existing rate designs be judged by examining the effect of marginal prices on consumer behavior rather than that of average price or the total bill faced by consumers;

- Rate designs should place heavier emphasis on energy charges and less emphasis on demand and customer charges. Because of the operating characteristics of the regional hydropower system, the binding constraint on the system is expected to be meeting energy loads rather than meeting peak demands;

- Customer bills should contain the applicable utility rate structure; and

- Customer bills should display the potential dollar savings a consumer could attain by reducing consumption through conservation by a significant amount (such as 10 to 15 percent).

Reduced customer charges and demand charges, increased energy rates, and particularly increased marginal energy rates (inverted rates) are appropriate rate designs given the above recommendations, but the exact form these rate design changes take should reflect the diversity among local utilities. The aggressiveness with which these rate designs should be implemented will depend on the duration and saleability of the current firm surplus and the revenue problems attendant on the surplus.

One appropriate method for calculating the conservation impacts of different rate designs is included in the ICF study, Module IV Final Report (with Technical Appendix), included in the Technical Exhibits to this plan.

In reference to wholesale rates, the Council recommends that Bonneville make its rate designs at the wholesale level consistent with the goal of giving individual wholesale customers the most appropriate price signals about future costs of electricity. In particular, given the nature of the hydropower system, further shift toward increased energy charges and reduced demand charges would be appropriate in the future.

"the plan may include ... an estimate of the types of resources from which such power should be acquired"

Chapter 8
Generating Resources

Renewable and non-renewable generating resources are included in the Council's resource portfolio. Renewable resources, such as hydropower, wind, biomass, geothermal, etc., use a self-sustaining source of energy. Non-renewables are those resources that consume fossil fuels and, therefore, face a limited fuel supply. This chapter provides background information that was used by the Council in deciding how much of each resource to include in the plan. Expected costs and levels of power generated from both renewable and non-renewable resources are discussed. Although hydropower, biomass cogeneration, and geothermal are the only renewable resources in the Council's plan, summaries of the Council's findings on wind and solar-electrical generation also are included.

The direct application of solar and geothermal for space and hot water heating interacts with the conservation actions discussed in chapter 7. For this reason direct application of renewable resources which compete with individual conservation actions, such as increased insulation levels and the use of heat pumps, was discussed in chapter 7 to assure consistency.

Renewable Resources

Council studies indicate that 2,100 megawatts of renewable resources are available in the region during the twenty-year planning period, using currently available technology, at a cost ranging between 2 and 7 cents per kilowatt-hour in 1980 dollars. This estimate includes no firm power contribution from geothermal, wind, or solar energy because the Council's analysis shows that these resources are not presently cost-effective at producing electricity. Direct applications of the renewable resources considered in chapter 7 can be cost-effective and are included as potential resources in the Council's conservation program.

The Council expects that future technological advancements will increase the availability of renewable electric generation and at the same time decrease costs in real terms. The Council has included a number of measures in the two-year action plan (chapter 10) to promote the development of renewable resources during the next two years.

This plan includes measures to encourage the development of renewable resources which are grouped into five categories: hydropower, geothermal, wind, solar-electric, and biomass. Cost estimates include all equipment necessary to meet federal and state air and water quality and siting requirements. Other environmental costs and benefits were considered in the Council's determination of which resources to include in the plan (see chapter 9).

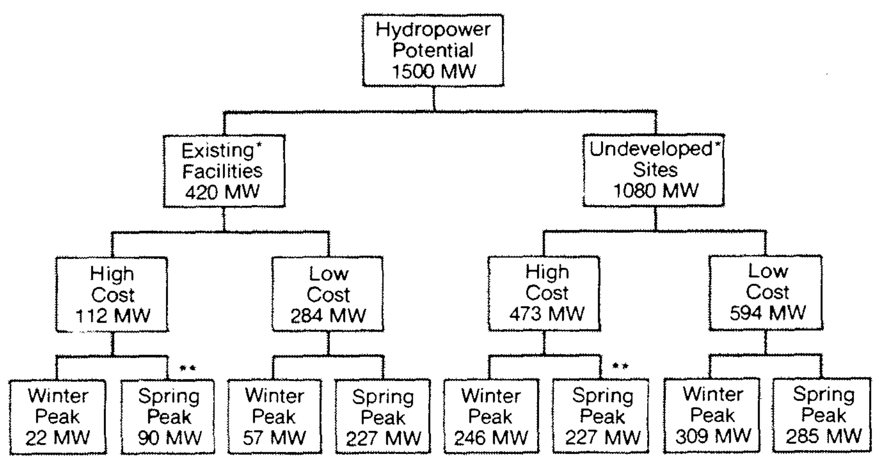
Hydropower

For planning purposes, the Council has identified 1,500 average megawatts of new hydropower potential at costs ranging from 1 to 5 cents per kilowatt-hour. Of this potential the Council has included 1,150 megawatts of cost-effective new hydropower in the twenty-year plan. In low-water years, this hydropower is expected to provide 920 megawatts of firm energy. The selection of this level of new hydropower development represents less than 10 percent of estimates of the region's undeveloped hydropower resource. If the region were facing deficits and suitable arrangements could be made to protect the environment and fish and wildlife, then the potential could be closer to the 4,078 megawatts identified by the PNUCC Hydropower Subcommittee in the addendum to the draft report, *Northwest Regional Hydroelectric Power Development Projections, (November 16, 1982).*

The estimates included in this chapter do not include hydropower energy or capacity that has been identified as "scheduled" by PNUCC in the "Blue Book." Scheduled hydropower is already included in the existing resources and is assumed to be operated by the sponsors of these projects to meet regional loads.

Hydropower availability and costs are difficult to assess because of the large number of potential sites and because costs and operating characteristics depend on the site chosen. Without conducting a specific review of the hundreds of hydropower sites that exist within the Northwest, the Council was still able to make reasonable estimates of the total hydropower potential available. The 1,500 average megawatts was divided into 420 megawatts at existing facilities and 1,080 megawatts at undeveloped sites as shown in figure 8-1.

Within each of these two categories, a further breakdown divided the energy potential into high-cost and low-cost categories. Since these cost groupings include two groups of hydropower that are very high cost, not all of the 1,500 megawatts was selected for further cost-effectiveness study. One final breakdown split each of



*24 MW of the existing and 13 MW of the undeveloped were screened out at this point due to very high cost.

**Found to be not cost effective.

Figure 8-1.
Hydropower Potential

the cost categories of hydropower available into two different seasonal generation shapes. These two categories contained hydropower sites likely to have a winter peak in generation and hydropower sites that will have a spring peak in generation.

This information on seasonal flows, costs, and the total number of megawatts in each category was used to determine how much hydropower out of the 1,500 megawatt planning target to include in the plan. In total 350 megawatts were determined to be incompatible with the regional power system leaving the 1,150 megawatts referred to above. Council judgment and the Strategic Planning Model were used in making this determination.

Most of this hydropower would not be developed until the latter half of the 1990's, and then only if demand develops. Given this fact and the uncertainties in the hydropower resource assessment described below, the Council has determined that additional work is needed over the next two years to further refine the hydropower estimates.

In developing these estimates, the Council analyzed four independent studies to develop the estimates of achievable hydropower included in this plan. These studies are summarized in table 8-1 and are discussed in further detail in the following paragraphs.

Estimates of achievable new hydropower in the region from the four studies range from as little as 450 average megawatts (CH_2M Hill for PNUCC) at or below 5.0 cents per kilowatt-hour to as much as 2,377 average megawatts (PNUCC Hydropower Subcommittee) at or below 4.0 cents per kilowatt-hour. These estimates should be compared to the total undeveloped potential in the region which has been estimated by the U.S. Army Corps of Engineers to be more than 55,000 average megawatts. Each of these studies derated the undeveloped potential to account for fish and wildlife, land use, and technical constraints in arriving at their estimates. The Corps, in commenting on the draft plan, estimated that 3,350 average megawatts could be developed. The Corps comments were based on their assessment of 226 sites in the region.

Table 8-1.
Comparison of Realistically Achievable Hydropower Stated in Average Megawatts Under Average Water Conditions

STUDY NAME	CENTS/kWh 1	2	3	4	5
Council Study	415	875	1,286	1,485	1,530
PNUCC Hydropower[a] Subcommittee	NA	NA	NA	2,377	—
CH_2M Hill[b,c]	—	80[d]	330[d]	430[d]	450[d]
Bonneville	—	1,050[d]	1,400[d]	1,600[d]	1,600[d]

[a] PNUCC's hydropower subcommittee in their modified draft hydropower assessment report started with the total theoretical energy potential of all undeveloped hydropower within the region. This theoretical potential was separated into four categories of potential projects, (1) proposed sites, (2) irrigation sites, (3) existing non-power sites, and (4) existing power dams. These categories were reduced to 11 percent, 72 percent, 48 percent, and 64 percent of the theoretical totals, respectively, to account for efficiency losses, land use, fish and wildlife constraints and minimum flow requirements. The PNUCC study used 1982 constant dollars. (Source: PNUCC's testimony to Council on Draft Plan.)

[b] The CH_2M Hill study, "Pacific Northwest Regional Hydropower Assesment," October 1982, was based on a hydropower project list compiled by PNUCC and its hydropower subcommittee. This list contains over 700 hydropower sites with current FERC licensing activity. The study begins by removing from the PNUCC list those projects representing approximately 500 average megawatts, which include recently completed hydropower projects (71 megawatts), projects with licenses granted (99 megawatts), projects outside of the region (69 megawatts), projects sponsored by the Corps of Engineers (114 megawatts), projects that have been granted exemption (22 megawatts), and projects under construction (114 megawatts). An estimate of new hydropower was then developed from the remaining sites identified on the PNUCC project listing. The supply function was developed by BPA, the Council and PNUCC based on the results of a CH_2M Hill telephone survey of potential developers.

[c] For comparison with other studies in the table approximately 350 MW should be added to the total to account for projects that were removed from the data base prior to constructing a supply curve.

[d] Approximate translations to 1980 levelized dollars.

[e] Bonneville, in their Draft "Generating Resources Supply Curve", September 15, 1982, developed estimates of costs and quantites for the region for the years 1985-2000.

The Council study assessed the hydropower potential that reasonably could be developed between now and 2002, concentrating on sites where adequate cost estimates existed. The study also screened sites to eliminate those with environmental constraints which might preclude development, such as proximity to wilderness areas, scenic and wild rivers, etc. The Council analyzed information regarding cost and power production from 130 new hydropower sites currently in the Federal Energy Regulatory Commission's (FERC) licensing process. These sites represent a total of 1,585 megawatts of energy and 4,244 megawatts of peak capacity at a cost ranging from 0.6 of a cent to 12 cents per kilowatt-hour. Ninety-four percent of the hydropower energy available fell below 4 cents per kilowatt-hour.

The Council, PNUCC, and Bonneville formed a working group to reconcile differences in the studies and to generate a hydropower estimate that could be used for planning purposes. This group focused only on those sites that have already been included in the FERC licensing process, excluding all other hydropower potential. These projects indicate a serious attempt by potential hydropower sponsors to develop the resource. Projects with active FERC applications reflect a commitment of resources by potential developers that can be significant, ranging from as little as $1,000 for preliminary permits to as much as $200,000 to prepare for a license application. Based on results of the analysis by this working group, the Council decided that 1,500 average megawatts of new hydropower was the appropriate planning target.

Bonneville concurred with this estimate. Specific sites that comprise the 1,500 megawatts have not been identified by the Council. Both the Council and Bonneville think that 1,500 average megawatts may be a conservative estimate given the fact that all potential hydropower outside of the FERC licensing process has been ignored. The

1,500 megawatts includes approximately 450 megawatts currently beyond the license applications stage of the FERC licensing process and 59 megawatts now under construction.

As a further check on the appropriateness of 1,500 average megawatts as a planning target, the Council performed a parallel assessment to the one done by CH_2M Hill for PNUCC, again concentrating only on those sites where FERC permit activity has occurred. That study concluded that over 1,500 average megawatts of new hydropower could be developed from projects with active FERC applications as of June 28, 1982.

The weight of evidence from the four studies and subsequent efforts pointed to the consideration of at least 1,500 average megawatts of hydropower in the Council's planning process.

Geothermal

Geothermal energy has the potential for a large contribution to the region's electric energy supply. However, opinions are divided as to how much electric energy and at what price. A Council study estimated more than 2,000 average megawatts of electric generation were available from high-temperature (greater than 150 degrees centigrade) resources at costs ranging from 3.2 to 8.8 cents per kilowatt-hour. In addition, intermediate-temperature (90 to 150 degrees centigrade) hydrothermal resources could provide direct heating for groups of houses and businesses, replacing 716 average megawatts of electricity at costs ranging from 3.0 to 6.5 cents per kilowatt-hour.

These estimates represent only part of the geothermal potential in the region. The Council has not examined geothermal resources at temperatures below 90 degrees centigrade for non-electric uses or temperatures between 90 and 150 degrees centigrade for electric generation. Some communities in the region, including Boise, Idaho, have developed low-temperature resources for space heating, and estimates show that other communities could exploit geothermal resources to provide cost-effective space heating. Efforts are underway in the region and in California to generate electricity from geothermal fluid in the 100 to 115 degrees Centigrade range using well-head generators. The Council will monitor progress in these areas.

The geothermal resource is large, and effective technology to develop these sites exists. However, more precise information would be needed on temperature and chemical makeup of the geothermal fluid, size of promising geothermal reservoirs, and all related costs before the Council could forecast geothermal energy to be a cost-effective resource in the plan. Considerable information about the region's geothermal resource has already been documented by the U.S. Geological Survey in their Geological Survey Circular 790, published in 1979. Since that time, the U.S. Department of Energy and the four states of the region have extended that information. The Council does not see additional expensive resource exploration as the responsibility of Bonneville, and expects that traditional funding sources for those activities will continue.

The Council has identified actions to encourage cost-effective geothermal resource development. The Council expects to include power from geothermal energy as a firm resource in subsequent revisions to the plan. Detailed actions to achieve this goal are described in the two-year action plan, chapter 10.

Wind

Wind resources are presently in a research, development, and demonstration stage. The region could have as much as 2,200 megawatts of wind turbines installed by the year 2002. However, estimating costs of future wind turbines is highly speculative. Cost will decrease only if more wind turbines are built, and this will happen only if they become cost-effective. The Council has not included any wind energy in this plan because of this uncertainty about costs and performance, but the Council will amend its resource portfolio if and when those uncertainties are resolved in favor of wind resources. Moreover, the Council has identified actions the region can take when technology and production improvements reduce the cost of wind turbines to a cost-effective level. These actions are described in the two-year action plan, chapter 10.

Solar

Solar-electric generation is an emerging technology with medium- to long-term potential in the region. The direct application of solar energy for space or water heating was considered in the Council's conservation assessment (see chapters 7 and 10).

The Council has not included solar-electric generation in the twenty-year plan because of the expected high cost of electricity generated from either central station solar receivers or photovoltaics. Council studies estimate the cost at 11 to 19 cents per kilowatt-hour for central station receivers and from 65 to 75 cents per kilowatt-hour for photovoltaic stations. The Council recognizes that significant cost reductions could occur in this technology and that solar-thermal electricity from central generating stations has the *potential* to become competitive with other resources depending on a reasonable production rate and large-scale demonstration of performance and reliability. Because of the potential for significant cost reductions and the number of acceptable sites in the region, the Council recommends continuing and expanding Bonneville's current data collection activities as described in the two-year action plan, chapter 10.

Biomass

Biomass includes wood residue, agricultural waste, and municipal solid waste. Biomass is used as a fuel to generate electricity alone as well as to generate electricity and process steam simultaneously. The biomass assessment was divided into two parts: (1) the potential for biomass industrial cogeneration, and (2) non-industrial biomass potential whether as a cogenerator or to produce only electricity.

Industrial Cogeneration (Biomass)

Industrial cogeneration occurs when an industrial plant sequentially produces both electric energy and useful thermal energy from the same fuel source. The Council has included 400 megawatts of biomass-fueled industrial cogeneration in its twenty-year plan under the high and medium-high growth forecasts. Industrial cogeneration acquisition schedules are outlined in chapter 5.

The 400 megawatts of industrial cogeneration fueled with biomass represents 80 percent of a total of 500 megawatts of industrial cogeneration which the Council estimated could be developed for between 3.5 and 6.5 cents per kilowatt-hour. The other 20 percent is fueled with gas, oil, or coal and is a priority three resource [see Cogeneration (Non-Biomass) below] under the Act. Achieving this level of industrial cogeneration requires the development of a regional policy recognizing cogeneration's positive aspects and addressing the difficulties potential cogenerators face when they try to market electricity. These difficulties arise because of limited access to markets, both inside and outside the region, and the fact that cogenerators generally are not part of the utility community. Regional actions to encourage cogeneration are described in the two-year action plan, chapter 10.

The Council also identified 541 megawatts of existing cogeneration capacity in the region. In the past, these resources have produced 320 average megawatts of electricity in good business years. (Less than 100 megawatts of these resources were included in chapter 6 because most do not belong to utilities and therefore have not been offered to the region as firm resources. The effect of these resources on demand for electricity is unknown.) Since the last two years have been poor for business and the region has had surplus hydropower, many of these existing facilities have not been operated. This situation points out one of the primary benefits of cogenerated electricity. It tends to follow changes in demand caused by business-cycle fluctuations. When business is down, so generally is the demand for electricity, and the cogenerating units can be shut down. If business improves, so does the demand for electricity, and the cogenerating units can be brought on-line.

Non-Industrial Uses of Biomass

The Council has not counted on any non-industrial biomass resources in the plan. The Council has estimated the biomass potential, other than biomass used in *industrial* cogeneration processes, to be 380 average megawatts by the year 2002. About 45 average megawatts of biomass are planned to be in service between now and 1985. This includes the 32 average megawatts from Washington Water Power's Kettle Falls project (chapter 6). A municipal solid waste project at Oregon City, sponsored by the Metropolitan Service District and scheduled for service in 1986, has recently been suspended indefinitely. Perceived environmental concerns were chiefly responsible for the suspension of the plant. Citizens in the area of the planned facility passed an initiative to stop development.

However, other projects recovering energy from municipal solid waste are being pursued in the region. Advances in experience and technology may make this resource available to solve the disposal problems of the major urban areas where there is a demand for power. Plants totalling 48 megawatts have proceeded to the planning stage, but are not authorized yet for construction by the sponsor, and 290 average megawatts have been identified as potential. All of these identified sites must clear many obstacles before development.

Cost estimates range from 0 to 21.9 cents per kilowatt-hour depending on negotiated price of fuel, in the case of wood residue-fired biomass generation, and how much credit is given for avoided dumping costs when municipal solid waste is used as fuel. The Council's initial resource assessment indicated that the 100 average megawatts could be acquired for 6.5 cents per kilowatt-hour or less. Considering the lower costs and abundance of competing resources, the Council has not included biomass resources in the plan. Present assessments of the quantity, quality, and cost of the biomass generating resource in the region are inadequate and additional study is needed. Although not included in this plan, biomass is a high-priority resource in the Act, and the Council encourages development, when needed, of cost-effective and environmentally sound projects that can be included in future plans and acquired by the Administrator to benefit the region.

Non-Renewable Resources

The Council has assessed the cost and availability of non-renewable generating units that could meet regional demand for electricity over the twenty-year planning period. This assessment included plants that have been identified by name in various planning documents, as well as unnamed resources.

Council decisions regarding cogeneration that uses fossil fuels, conventional and advanced coal-burning power plants, and nuclear power plants are summarized in this section and background information supporting these decisions is also presented. Natural gas combustion turbines have been analyzed separately and are included in chapter 5.

The Council also conducted a detailed assessment of the desirability of coal plants relative to nuclear plants. During the public comment period, a number of consultations were held on this assessment and the Council received many comments on this issue. A detailed summary of the Council's analysis can be found in chapter 5 and Appendix G (Volume II, available on request).

Cogeneration (Non-Biomass)

About 400 of the 500 average megawatts of industrial cogeneration that could be developed in the region over the twenty-year planning period are fueled with biomass, a priority two resource in the Act. The other 100 average megawatts are fueled with oil, gas, or coal. Assuming that cogenerated electricity could be acquired at just below the price of coal-generated electricity, the Council's analysis has included all 100 megawatts in the plan under both the high and medium-high growth forecasts.

Comments received during the public hearings on the draft plan suggested that the estimate could be raised to as high as 800 megawatts of cogenerated electricity fueled with natural gas. The Council will study these comments further. But since acquisition of cogeneration is not anticipated until 1994, the more conservative figure of 100 megawatts will be retained for planning purposes. The higher estimate will be considered in future revisions of the plan.

Coal

The Council has analyzed cost-effectiveness to the system of using either coal plants or nuclear plants (see Appendix G, Volume II, available on request). The results of the analysis lead to the conclusion that for planning purposes coal plants are preferred to nuclear plants. The Council has considered this analysis and has included approximately 3,294 average megawatts of coal-generated electricity in its high growth forecast. Approximately 1,098 average megawatts are included in the medium-high growth forecast and no coal plants are needed in the medium-low and low forecasts. Council decisions on acquisition schedules for coal plants were described in chapter 5.

Appendix G (Volume II, available on request) also contains background information and decisions made regarding expected equivalent availability factors for coal and nuclear plants, fuel escalation rates, construction lead times, and other assumptions that influence the relative costs of electricity from coal plants versus electricity from nuclear plants.

The generation of electricity at a coal-fired power plant is a well-established technology. However, operators of coal plants are still gaining experience with new pollution abatement equipment required to comply with environmental standards. These requirements have made new and proposed coal plants more costly and somewhat less reliable than earlier plants. However, the Council has determined that coal could meet energy needs through the Council's twenty-year planning period at a cost between 4.0 and 4.7 cents per kilowatt-hour. For the plan, the Council relies on conventional coal-fired plants only. Advanced concepts are discussed later in this chapter.

Currently, the region relies on coal-fired generation for 2,091 average megawatts with a total peaking capacity of 2,939 megawatts. Additionally, most of what is classified as "imports" to the region is energy from coal-fired plants in Montana and Wyoming. (See figure 6-1 in the Existing Thermal Resources section of chapter 6.) Coal plants in the Pacific Northwest that are either under construction or being considered represent 2,864 average megawatts with a sustained peaking capability of 4,040 megawatts. These plants include Colstrip Units 3 and 4 and Valmy 2 which are under construction, the four Creston units being planned by Washington Water Power, Portland General Electric's Boardman 2, and Pacific Power and Light's Wyodak II. (The Colstrip and Valmy plants are assumed to be built on schedule and have been included in the Resources Under Construction section of chapter 6.)

Council studies have also developed cost estimates for five generic coal plants that can be used to meet load in the region over the planning period. These generic plants are shown in table 8-2 along with the planned and prospective plants. Table 8-2 contains capacity and energy rating for the plants along with estimates of capital costs. The generic plants include advanced-technology coal plants using atmospheric fluidized-bed combustion, pressurized fluidized-bed combustion, coal-gasification combined cycle, and coal-gasification fuel-cell combined cycle. Although cost estimates appear promising for these advanced technologies, they are not certain enough to be included in the current plan. The Council will continue to study development of these technologies.

Table 8-2.
Planned, Prospective and Generic Coal Plants

PROJECT	UNIT	EARLIEST IN-SERVICE DATE	SUSTAINED[a] CAPACITY (MW)	AVERAGE[a] ENERGY (Average MW)	COST TO[b] COMPLETE (1980 $/kW)	SUNK[b] COSTS ($/kW)
Colstrip[c]	3	Jan 1984	490	343	40	1,346[d]
	4	Jul 1985	490	343	148	939[d]
Valmy	2	Sept 1985	121	87	301	1,071[d]
Creston	1	1988	560	392	1,321	0
	2	1990	560	392	900	0
	3	1992	560	392	945	0
	4	1993	560	392	840	0
Boardman	2	1991	500	360	1,036	0
Wyodak	2	1988	252	181	NA	0
Conventional		1993	1,000	700	1,127	0
Atmospheric Fluidized Bed Combustion	—	1996	1,000	700	750[d]	0
Pressurized Fluidized Bed Combustion	—	1997	1,300	910	806[d]	0
Coal Gasification	—	1994	1,000	700	935[d]	0
Coal Gasification Fuel-Cell Combined Cycle	—	1998	1,500	1,050	924[d]	0

[a]Available as firm resources to the region.

[b]Costs expected to be expended as of January 1984 and costs to complete from January 1984. Sunk costs for Colstrip #3 and #4 and Valmy #2 are shown here in nominal dollars.

[c]Assumed to be built and included as an existing resource. The total plant consists of two 700 megawatt units capable of producing 980 megawatts of energy. The 30% share not shown on this table is owned by Montana Power Company and serves loads both in the region in Western Montana, and outside the region, in Eastern Montana.

[d]Costs and performance of those advanced technologies are highly uncertain. The Council intends to monitor the progress of these technologies as their preliminary costs appear promising.

Nuclear

The Council has focused on the nuclear plants where construction has begun or where significant planning has occurred. Plants included in the Council's assessment are WPPSS 4 and 5 and Skagit/Hanford 1 and 2. The WPPSS 1, 2, and 3 plants are assumed to be completed and have been included as existing resources in chapter 6. WPPSS 1 is assumed to be completed in 1988 in the high and medium-high growth forecasts and in 1991 in the low and medium-low growth forecasts.

The Council has put together technical and cost data for nuclear plants. The data was derived from published sources and was used in the comparison of nuclear and coal plants. Cost data for the seven proposed plants are shown in table 8-3 along with capacity and energy ratings for each of the plants. The Council's load forecasts show the need for base-loaded plants only in the event that the medium-high or the high forecasts occur. Even then, base-loaded plants are not needed until 2001 in the medium-high forecast and 1998 in the high forecast. At this time, it appears that either coal plants or nuclear plants are the most likely resources to meet those loads, although by 1994, the earliest time when construction would have to begin, it is possible that geothermal or some other resource may be more desirable to serve base loads in the region.

Of the nuclear plants not already assumed to be complete, the Council's analysis has shown that if base-loaded nuclear plants were needed, completing WPPSS 4 and 5 would be cheaper than terminating those plants and building Skagit/Hanford 1 and 2. This decision was based on the fact that WPPSS 4 and 5 are 24 and 16 percent complete respectively, and their expected completion costs have undergone considerable review both in the Washington State Legislature's *Independent Review of WPPSS Plants 4 and 5* and in the analysis done by the Council. Moreover, construction has not started on Skagit/Hanford 1 and 2. Thus, the cost estimates of WPPSS 4 and 5 should be less uncertain than for Skagit/Hanford 1 and 2. Additionally, Council analysis of levelized costs of energy, under assumptions of current ownership, showed the costs of WPPSS 4 and 5 to be lower than Skagit/Hanford 1 and 2.

For these reasons, the Council compared WPPSS 4 and 5 with generic coal plants to determine whether coal plants or nuclear plants would be included in the twenty-year plan. (See the explanation and summary of this analysis in Appendix G, Volume II, available on request.)

Based on current analysis, no additional nuclear plants beyond WPPSS 1, 2, and 3, which are assumed to be completed, are included in this plan.

Table 8-3.
Technical and Cost Data for Potential Nuclear Plants

PROJECT	ASSUMED IN-SERVICE	SUSTAINED CAPACITY (MW)	AVERAGE ENERGY (MW)	COST TO[a] COMPLETE (1980 $/kW)	SUNK COSTS (NOMINAL DOLLARS) ($/kW)
WPPSS 1[c]	1991	1,259	818	1,182	1,689
WPPSS 2[c]	1984	1,093	697	0	2,981
WPPSS 3[c]	1987	1,240	806	629	1,876
WPPSS 4	1995	1,259	818	1,475	1,240
WPPSS 5	1995	1,240	806	1,573	1,020
Skagit/Hanford 1	1995	1,275	829	1,517	311
Skagit/Hanford 2	1995	1,275	829	1,274	3

[a]Costs include construction costs to complete, allowance for funds used during construction, working capital and where appropriate preservation and remobilization expenses.

[b]Costs shown for Skagit/Hanford plants 1 and 2 are architect and engineering estimates, whereas, the coss shown for the WPPSS plants are from construction budgets for these plants. Thus, they are not comparable. (See text.)

[c]Costs to complete and sunk costs for WPPSS 1, 2 and 3 are those expected as of January, 1984.

"The plan shall [include] *... due consideration for environmental quality* [*and the*] *protection, mitigation, and enhancement of fish and wildlife"*

Chapter 9 Consideration of Environmental Quality and Fish and Wildlife

In compliance with the Northwest Power Act, the Council has considered environmental quality and fish and wildlife concerns throughout development of this energy plan. Although these considerations were important, the Act also required the Council to consider the compatibility of the plan with the existing regional power system, to choose the most cost-effective resources, and to follow certain priorities in selecting those resources. For this reason, selection of the resource portfolio involved not only choosing those resources which were most environmentally sound or most protective of fish and wildlife, but also balancing these concerns with the other requirements.

In addition, the Act requires that all resource cost-effectiveness evaluations must include quantifiable environmental costs and benefits. Costs for pollution abatement equipment and fish and wildlife mitigation required under state and federal regulations have been included in estimates of generic resource costs. The Act further specifies that the Council must develop a method to quantify other environmental costs and benefits to be used by Bonneville in measuring the cost-effectiveness of specific resource acquisition decisions. This method, developed by the Council, is presented in Appendix C. The Council expects Bonneville to use this method in evaluating each resource and resource site prior to acquisition.

This chapter describes the process the Council used in giving due consideration to environmental quality and fish and wildlife in its selection of resources.

Environmental Quality

Due Consideration Process

The Council began its consideration process by performing studies to identify the potential environmental and fish and wildlife effects on resources. These studies and important issues arising from them were subjected to public review and comment and guided the Council as it drafted its resource portfolio.

During the public comment period on the draft plan, many comments and considerable data were received regarding the environmental effects of the various resources discussed in the plan. In particular, many public commenters offered data documenting the environmental effects of hydropower dams, coal-fired power plants, and high-voltage transmission lines. All this information was carefully considered by the Council.

During review of the draft plan, the Council held a public consultation meeting on March 21, 1983 to discuss the Council's consideration of environmental quality and fish and wildlife concerns. This consultation was attended by representatives of environmental groups, Indian tribes, utilities, and an agricultural organization. Views and data presented at this meeting assisted the Council in furthering its consideration of environmental quality and fish and wildlife concerns.

Analysis of Resources and Alternatives

While selecting the individual components of its resource portfolio, the Council assessed all available energy technologies, including their environmental benefits as well as impacts. The Council also considered the amounts of power to be expected from each resource type, how effects on environmental quality and fish and wildlife could be mitigated, and how mitigation measures may affect energy production. Although not included as major components of the Council's plan at this time, the environmental costs and benefits of alternative resources such as geothermal, solar-electric generation, and wind were considered. These alternative resources will be closely monitored and assessed in the future for their environmental effects as well as for their increased cost-effectiveness and feasibility. As they become eligible for inclusion in the Council's resource portfolio, these resources again will be subject to the same environmental considerations.

This section discusses some of the mitigation measures that the Council expects Bonneville to consider in any resource acquisitions or other actions which are required by the Act to be consistent with the plan. While the Council has now adopted specific standards only for hydropower development (for the protection of fish and wildlife, in Appendix E), it is expected that the implementing agencies will be guided by the considerations set forth in this appendix. Over the next two years, the Council will study the feasibility of establishing a general set of resource acquisition criteria. The analysis that follows first discusses the resources that are included in the two-year action plan and then the resources identified for acquisition in later years and then only if higher growth is realized.

Conservation

The Council expects that conservation will contribute by far the largest share of energy under any of the resource mixes for the four growth forecasts. To that end, the two-year action plan includes measures in the residential sector to weatherize existing houses and to set weatherization standards for both new houses and houses converting to electric space heating. In the commercial sector, the Council expects two-year actions to include weatherizing new buildings and setting conversion standards. The action plan also calls for acquiring industrial and agricultural conservation savings. These conservation actions were developed by the Council with full consideration of their potential environmental costs and benefits.

As identified by the Council, the environmental benefits of conservation are substantial. First, reduction of electric demand due to conservation measures can help the region avoid construction of new conventional energy resources with their accompanying environmental impacts. Conservation "generates" electricity without transmission lines, significant air or water pollution, noise, solid waste, or land use impacts. Though the production of conservation devices (insulation, storm windows, etc.,) may include some environmental impacts, the Council recognizes that the amount of electricity "produced" by conservation is much more environmentally acceptable than, for example, the equivalent amount of energy generated by a coal-fired power plant or hydropower dam. The 5,100 megawatts expected to be contributed by conservation under the Council's high growth forecast is equivalent to the output of fourteen 366-megawatt coal-fired power plants (the size of plants assumed by the Council if increments of coal-fired generation are required), and is accompanied by only minor environmental impacts.

Conservation is not likely to harm fish and wildlife. In fact, by reducing the use of fossil fuels, conservation will benefit fish and wildlife by avoiding unnecessary air and water pollution, transmission lines, mining, habitat interference or destruction, and water use. However, the Council is concerned about the potential indoor air quality impacts of weatherization unless mitigation measures are employed. The Council study noted that residential weatherization could reduce ventilation and cause harmful concentrations of various pollutants from space heating equipment, insulation, and building materials. These pollutants included formaldehyde from particle board and some insulation, and radioactive emissions from masonry and concrete buildings. The report noted, however, that health levels for these pollutants have not yet been established.

The Council decided that heat exchangers could adequately mitigate these air quality impacts in that they provide adequate ventilation without sacrificing much heat. The Council's model conservation standards include an air-to-air heat exchanger if the house does not meet Bonneville's exemption criteria for air-tightening measures. With this mitigation, the Council believes that conservation is attractive from an environmental perspective.

Hydropower Development

The Council's two-year action plan also calls on Bonneville to acquire options on hydropower projects at six sites. The development process for the Council's Columbia River Basin Fish and Wildlife Program, adopted November 15, 1982, provided a wealth of information on the fish and wildlife and environmental effects of hydropower development as well as measures for mitigating those effects. Those considerations have also been taken into account in this plan to the extent they are appropriate outside the Columbia Basin. The Council's fish and wildlife program should be examined for a more complete description of the impacts and mitigation measures applicable to the Columbia River Basin.

The Council identified several potential environmental effects of hydropower development. For one, the transformation of a river to a deep, still reservoir can alter the temperature of the water. However, the use of special structures and reservoir draft techniques can mitigate this effect. Another impact is nitrogen supersaturation caused by spilling water over the dam. Though lethal to fish, it can be avoided with the use of devices that deflect spilled water. These impacts are generally limited to large hydropower projects involving reservoirs, while the Council expects many new hydropower projects to be small, run-of-the-river projects without reservoirs.

Construction of a hydropower project may include erosion and sedimentation near the stream, causing increased water turbidity. The Council's data note that these effects can reduce the aesthetic quality of the stream as well as harm its value for fish, wildlife, or recreational uses. Sometimes, these effects are limited to the period of construction and are not considered significant enough to warrant foregoing otherwise feasible hydropower sites.

Federal law prohibits licensing hydropower projects on or directly affecting wild and scenic rivers, and special consideration is required when historic or archeologic sites, national wildlife refuges, national monuments, national recreation areas, endangered species habitat, or lands adjacent to wilderness are involved. In estimating the amount of hydropower potential, the Council accordingly eliminated such areas from consideration.

Installation of hydropower projects on a previously free-flowing stream can reduce or eliminate the stream's value for kayaking, rafting, and some types of fishing, as well as reduce the forest land base and eliminate Indian religious sites through inundation. Also, although the effects of particular projects may be relatively minor, the cumulative effects of several hydropower dams on a single stream can be serious. However, this plan includes measures described below to support future hydropower development at the least sensitive locations and with minimum environmental impact. The fish and wildlife program portion of this energy plan is applicable only to the Columbia River Basin, while the energy plan itself is applicable to the entire region. Measures adopted by the Council for the Columbia Basin and the rest of the region are more fully described in the discussion of fish and wildlife impacts in a later section of this chapter.

Because of these safeguards, the Council believes needed additional hydropower development can occur in an environmentally sound manner. The first hydropower included in the plan would not be needed until the early 1990's. This allows sufficient time to study the impacts of hydropower and to refine methods for alleviating them. The effects of hydropower generation are limited generally to the stream affected by the dam. No serious air pollution or solid waste problems are raised by hydropower projects, and they do not rely on a finite fossil fuel. It should be recognized, however, that the Council's environmental assessment of hydropower so far has addressed only generic hydropower projects. The site-ranking study (see chapter 10) will focus on the potential environmental impacts of siting projects on particular stream reaches.

Development of Additional Markets for Interruptible Energy

To utilize the present surplus economically, the two-year action plan expects Bonneville to develop additional markets for interruptible energy in the region's industrial sector. Potentially, this could require the siting and construction of additional high-voltage transmission lines. Such lines can have adverse impacts on environmental quality and on fish and wildlife, which are discussed below in connection with coal and nuclear facilities. Because the location of new markets and their relation to existing power lines is uncertain at this time, the Council was unable to consider the impacts of specific power line routes or even the approximate amount of new lines that may be needed. The Council did, however, consider the potential impacts of additional power lines in general. As with all resources in the plan, the Council expects that any new lines will be sited in conformance with all state standards.

Geothermal

Under the two-year action plan, Bonneville is expected to develop a demonstration project to purchase 10 average megawatts from geothermal sources. Council studies indicate that electric generation from geothermal sources can cause emissions of a variety of gases, including hydrogen sulfide. At low concentrations, this pollutant causes an offensive odor, and can be harmful to the human respiratory system and to local wildlife. Although no federal air quality criteria exist for control of hydrogen sulfide, the Council's analysis suggests that current pollution control technology can achieve 90 percent hydrogen sulfide removal.

Nevertheless, uncontrolled emissions during preliminary drilling could harm wildlife, especially birds. Clearing of land and construction of roads and pipelines required to tie in numerous geothermal wells to central generators could destroy wildlife habitat and create barriers to wildlife migration. Once geothermal water or steam is used to generate electricity, it is usually reinjected into the earth. Studies suggest that the impacts of fluid disposal are site-specific, depending largely upon the chemical nature of the fluids. Though reinjection is normally preferred, the Council's data notes that other disposal techniques deserve study.

Venting of excess steam or water vapor can create noise, but this is estimated by the Council to be a minor impact because most geothermal sites are far removed from population centers. Again, there may be some impact from this noise on wildlife populations. Some geothermal projects may require large quantities of water for cooling. This may pose serious problems because geothermal sites are frequently located in dry regions. Public comments suggest that extraction of geothermal steam or water may cause the earth to settle. Also, geothermal development may disrupt scenic areas and expose workers to risk of injury while working near steam or hot water.

Any impacts that result from the demonstration project may be minor considering the small size of the project. The Council also realizes that one function of the demonstration project would be to further assess environmental effects of geothermal power and refine methods for dealing with them.

Industrial Cogeneration

The Council expects about 80 percent of the available cogeneration to be fueled with biomass (wood waste, for instance). Particulates would be emitted from combustion of wood chips or other biomass fuel, but could be controlled by pollution control technology as required by law. The Council's analysis and comments from the wood products industry suggest that "cyclones" (pollution control devices) can remove larger particles while wet scrubbers, electrostatic precipitators, and baghouses can remove smaller ones. However, some have questioned whether control technology for cogeneration is as sophisticated as it is for thermal plants. Also, cogeneration units are more likely to be located near population centers. Use of coal as a backup fuel would entail the air quality impacts discussed later regarding coal.

Timber harvesting raises concerns regarding erosion, sedimentation, aesthetic impacts, and destruction of wildlife habitat. Because biomass fuels are usually byproducts of lumber processing, the Council believes most of these effects may be attributable to the production of wood products and not to biomass electric generation. Nonetheless, when biomass harvesting involves picking up fallen wood in forests, it may independently cause the effects described above.

Any impacts associated with cogeneration would occur only in the medium-high and high growth forecasts. Key to the Council's decision was that use of cogeneration to generate electricity would reduce the need to construct coal-fired or nuclear plants, which, for the reasons stated below, are less environmentally sound than resources such as cogeneration. Cogeneration, because of its overall efficiency, entails fewer environmental risks than the separate production of electricity and process steam. Because cogeneration depends largely upon existing facilities, it normally does not include the "boom town" impacts or major transmission lines associated with larger thermal plants. The Council also recognizes that, unlike fossil fuel-fired generators, cogeneration has the advantage of utilizing a renewable resource.

Combustion Turbines

Because of their flexibility, combustion turbines have been included as a "planning hedge" in the medium-high and high growth forecasts. Fueled by natural gas or oil, combustion turbines are expected to emit certain air pollutants. The Council's data shows that emissions of natural gas-fired turbines are minimal compared to those of oil-fired turbines or coal plants. Combustion of natural gas releases small amounts of nitrogen oxides and about half the amount of carbon dioxide emitted by coal plants. The Council's data suggests that nitrogen oxides from gas-fired turbines can be reduced to comply with air quality regulations by reducing the temperature of combustion air, recirculating flue gas, or injecting demineralized water.

Oil-fired turbines release larger amounts of these pollutants, plus sulfur dioxide. According to the Council's studies, sulfur dioxide emissions from oil-fired turbines can be minimized by using distillate oil or by limiting the sulfur content of fuel oil used. Finally, though public comments suggest that operation of these turbines may be noisy, this impact may be mitigated by siting the plants away from population centers and developing buffer zones.

Use of combustion turbines fueled with natural gas or oil also raises certain environmental concerns in connection with exploration, development, and transportation of the fuel. The Council notes that off-shore exploration and development of fossil fuels can interfere with commercial and recreational fishing, and could cause aesthetic impacts on shoreline areas. On-shore exploration and development can intrude on roadless areas and wildlife habitat, and affect the aesthetics of natural areas. If reliance is placed on foreign imports, there also may be increased risk of oil spills from tanker accidents. Transportation by pipeline can disrupt existing land uses and cause some aesthetic impacts.

As previously noted, the role of combustion turbines in the plan is limited. Combustion turbines are included only as insurance to meet unexpected load growth. Merely preserving the potential for using these turbines can postpone or avoid construction and operation of large-scale coal or nuclear facilities. The Council chose combustion turbines in the higher growth forecasts because they can be brought on-line quickly and operated in harmony with the hydropower system. This flexibility and avoidance of other impacts, in the Council's judgment, outweighs the effects of combustion turbines on environmental quality and fish and wildlife.

Coal-Fired Power Plants

Coal-fired generation was clearly the most controversial resource included in the Council's resource portfolio. As considered by the Council, the environmental effects of coal-fired generation span the entire fuel cycle. Coal to fuel regional generators will most likely come from strip-mines in eastern Montana or Wyoming. Exploration for coal can include drilling and blasting that risk contamination of groundwater. Strip-mining coal involves removing large amounts of soil and other materials overlying the coalbeds. Federal law requires reclamation of strip-mined lands and includes procedures for refilling and regrading, water protection, and revegetation, as well as prohibitions against mining sensitive lands, such as alluvial valley floors and prime farm land. However, there is some question whether these reclaimed lands can sustain long-term productivity or establish a diversity of species characteristic of native range. Because coalbeds often serve as aquifers, their removal by mining often disrupts groundwater and can dry up neighboring wells used for domestic or stock watering uses. According to public comments, the resaturation of soils when mined pits are refilled can degrade water quality. The Council's data indicates that acid mine runoff can contaminate local surface and groundwater, and toxic materials exposed by mining can both contaminate nearby water sources and hamper later efforts to reclaim the land.

Extraction of coal releases large quantities of dust into the air, hindering nearby livestock operations and decreasing local visibility. Opening mines in rural communities can disrupt the stable agricultural economy and culture as construction workers arrive for short-term employment, and rapid growth due to mining can overload local social services such as schools and hospitals and cause tension with earlier residents. Though some states and energy developers provide local impact assistance (often pursuant to state law), local residents often feel they are forced to subsidize new development. According to public commenters from coal regions, the severity of "boom town" impacts are lessened somewhat when additional mines are sited in areas that already have other energy development and social structures.

The Council's studies show that transportation of coal to the generating plant includes various environmental effects, depending upon the location of the generators. Minemouth plants, those located where the coal is mined, include fewer transportation effects. However, they concentrate all the effects of both mining and generation in one community, and increase the amount of transmission lines required. Load-center generation, where the coal is transported long distances for generation where the electricity is needed, somewhat eases the effects on the community where the coal is mined, but increases transportation-related effects. Most coal is transported via railroad, and in some areas new mines require additional rail spurs. According to public comments from Montana, these lines can disrupt local farms and ranches by consuming valuable bottom land, hindering drainage, increasing noise, and bisecting fields and pastures. Use of unit trains (trains consisting of up to one hundred coal cars) can increase noise, coal dust pollution, and railroad crossing problems in the rural towns they pass through.

Coal slurry pipelines have been proposed to carry crushed coal suspended in water from the Great Plains coal fields to generating plants in Washington and Oregon. Council reports indicate that such pipelines would require large quantities of water and could pose serious water pollution problems at the terminus where the water must be removed from the coal. Also, the pumping systems required for such pipelines would require large amounts of energy to transport the coal several hundred miles. Such pipelines would require rights-of-way which could disrupt local land uses and affect aesthetics.

According to Council reports and public comments, coal generation can have serious air quality impacts. Though federal and state laws require elaborate pollution control devices, all coal plants emit sulfur dioxide, nitrogen oxide, particulates (small particles), carbon dioxide, and trace elements. Sulfur dioxide has demonstrated detrimental effects on some crops, and is suspected to be harmful to human health. Along with nitrogen oxide, sulfur dioxide can react in the atmosphere to form sulfates and nitrates which in turn cause acid rain downwind from coal-fired generators. Many commenters stated that the effects of acid rain are controversial. Some suggest that acid rain is responsible for harming fish, vegetation, soil, and surface water. Particulates can cause respiratory ailments in humans and reduce the traditionally excellent visibility in rural areas of the Great Plains. Sulfates also reduce visibility.

Although sulfur dioxide emissions can be reduced through the use of "scrubbers", these devices in turn produce large amounts of sludge as a byproduct. This sulfur-laden sludge poses a solid waste disposal problem because it must be prevented from leaching into local water supplies. Also, fly ash left over from combustion of coal contains various trace metals, and also must be disposed of in a safe manner. Public comments from Montana also suggested that water demands for power plant cooling could conflict with water needs for irrigation, and that ponds used to store cooling water can alter local water tables.

As with coal strip-mining, construction and operation of coal-fired generators in rural communities can cause 'boom and bust' impacts. When the plan moves out of construction, it can cause rapid out-migration, unemployment, and declining tax base.

As with any central station power generation, electricity generated at most coal-fired power plants must be transported long distances to load centers using high-voltage transmission lines. The Council's reports indicate that siting these lines can change local land use patterns, disrupt agricultural operations, and cause aesthetic impacts. Construction of lines through mountainous areas can cause erosion as well as interrupt wildlife habitat and recreational pursuits, and clearing rights-of-way often involves use of controversial herbicides detrimental to fish and wildlife. Transmission line corridors may interfere with migratory patterns of birds or big game. The amount of electricity passing through high-voltage transmission lines raises concerns about noise, interference with local television and radio reception, and risk of electrical shock.

It is in part because of its concern for these effects of coal-fired generation that the Council has included coal in the energy plan only to meet loads under the unlikely high or medium-high growth scenarios in the late 1990's. Because coal and nuclear generation include serious environmental effects, neither was considered preferable from an environmental standpoint. The Council's decision to choose coal over nuclear is based largely upon its judgment that the lead times and sizes of coal plants posed less risk than nuclear.

Nuclear Power Plants

The environmental effects of nuclear power, described in data analyzed by the Council, also span the entire fuel cycle. Uranium, the fuel source for nuclear generators, is extracted by surface or open pit mining. Exploration can involve drilling, blasting, and road building that may contaminate groundwater and disrupt wildlife habitat. The Council's data indicates that many of the same water pollution, air pollution, and reclamation problems are encountered in uranium mining as in coal mining. Also, the radioactive nature of uranium ore poses potential health risks to miners and persons living near uranium mines. Milling operations which process uranium ore result in large amounts of tailings, which are radioactive waste materials that raise human health concerns. These tailings must be disposed of properly to avoid contamination of water sources or transportation by the wind.

According to the Council's data, construction of a nuclear power plant is a major undertaking, and because of large plant sizes can create more severe boom and bust social and environmental effects than coal.

As mentioned above, the Council recognizes that all central station power development (including nuclear plants) includes high-voltage transmission lines and their associated effects. Operation of nuclear power plants may also require large amounts of water for cooling. Council studies indicate that water intake structures may harm fish, and any thermal water discharges can also be detrimental to fish. Cooling systems can also discharge chemical blowdown which may contaminate air and water. Concerns regarding possible nuclear accidents and meltdowns have increased since the Three Mile Island incident in 1979.

The Council's studies show that spent fuel and other radioactive wastes from plant operations require safe disposal. Spent fuel must be either reprocessed to recover uranium and plutonium or treated as waste. Transport to and from reprocessing plants again raises concerns regarding highway accidents, accidental spillage, and theft.

Long-lived radioactive wastes must be isolated for thousands of years. Pursuant to federal statute, research is now underway to identify suitable disposal sites. One method of decommissioning or dismantling a nuclear plant requires the removal of all fuel. Next, the plant is sealed and cooled for ten years, during which time the site must be monitored and isolated. The reactor building is then covered to withstand natural forces for two hundred years.

Based on the foregoing analysis, the Council cannot discern in nuclear power plants any environmental advantages sufficient to outweigh the planning considerations favoring coal-fired power plants in the high or medium-high growth cases.

Other Resources

Other resource technologies, although not included in the Council's resource portfolio because of their high-cost or technical infeasibility at this time, were duly considered by the Council for their potential impacts. The two-year action plan calls for a study of cost-effectiveness and operating experiences of existing wind demonstration projects. The Council expects this study to determine the feasibility and cost-effectiveness of including 50 average megawatts in the next revision of its energy plan. The Council estimates that wind generators will cause only minor environmental effects. Though operation of some wind turbines may create low-frequency noise, this effect may be minor because generators will likely be located far from population centers. Future wind power studies should examine these potential effects further and mitigation techniques should be developed if necessary. Siting wind turbines in areas of high wind may alter the aesthetics of mountain passes and gorge areas. Also, the need to avoid obstructions around wind generators may require restrictions upon certain types of land use. The Council recognizes that wind generators do not pollute the air or water, use water, create solid waste, and may not cause severe boom town effects. They do not affect free-flowing rivers and can probably be sited with minimal impact on wildlife habitat. When costs are reduced and the technology matures, the Council expects wind power to be a desired energy resource for the region.

Solar electric generation is another resource not yet included in the Council's portfolio because of present high costs and immature technology. The Council's data indicates that this technology also would have relatively minor environmental impacts. Solar systems using fluids to exchange heat raise a possibility of contamination of water and land, albeit minor. A typical solar-electric generation plant will require installation of solar reflectors or cells on large land areas and could affect land use, wildlife habitat, and aesthetics. How ever, because such plants would not include major water or air pollution or solid waste disposal problems, the Council expects that the impacts of solar-electric generation would be minor compared to the wide range of serious effects associated with large-scale thermal electric generation. As this and other emerging technologies mature, the Council will gather additional, more detailed data concerning their environmental effects, which will receive careful consideration in all future Council decisions regarding these resources.

Additional Fish and Wildlife Concerns

Due Consideration Process

The requirement of due consideration for fish and wildlife is in addition to the Act's mandate that the Council adopt a Columbia River Basin Fish and Wildlife Program. That program was adopted by the Council on November 15, 1982, and is contained in Volume III of the energy plan.

The fish and wildlife program is, however, limited to the Columbia River Basin. The energy plan, on the other hand, must cover the entire region. Also, the plan covers all types of generating resources, while the fish and wildlife program was limited to dealing with the effects of the hydropower system. Under the Council's energy plan, resource acquisitions by Bonneville generally must comply with the plan's environmental and fish and wildlife provisions. Those acquisitions proposed within the Columbia River Basin must also comply with the provisions of the Council's fish and wildlife program.

The Council's consideration of the relationship between energy supply and development and the protection of fish and wildlife began with its development of the Columbia River Basin Fish and Wildlife Program. Federal hydropower project operators and regulators must take that program into account at each relevant stage of decisionmaking to the fullest extent practicable. Also, Bonneville must use its legal and financial powers consistently with the program. On December 16, 1982, the Council also released an "Environmental Document for the Columbia River Basin Fish and Wildlife Program." That document described consideration of the fish and wildlife and environmental impacts of the Council's Columbia River Basin Fish and Wildlife Program. It noted that, while some minor environmental impacts might result from implementation of the Council's program, its overall effect was to remedy effects that had gone largely unmitigated for decades. The document noted numerous ways in which the Council's program would benefit fish and wildlife in the Columbia River Basin.

The effects of the Council's fish and wildlife program were considered as the Council developed its energy plan. For instance, annually 450 average megawatts of energy capability are estimated to be lost due to use of the Council's Water Budget to provide adequate flows for migrating anadromous fish. This was taken into account in the Council's estimate of the amount of hydropower available to meet future demand.

The costs of fish and wildlife mitigation and protection measures required in the fish and wildlife program were included as the Council estimated costs of various resources. As previously noted, also included in the Council's resource cost calculations were the costs of pollution control technology required by existing law. By reducing or preventing air and water pollution, these measures will benefit fish and wildlife.

Analysis of the Fish and Wildlife Impacts of Hydropower Development

Hydropower development can have serious effects on fish and wildlife. Construction of dams may create reservoirs that inundate important wildlife habitat. However, as previously noted, the Council expects many of the new hydropower projects to be run-of-the-river projects without reservoirs. As noted in the fish and wildlife program, dams hinder migration of fish. Juvenile anadromous fish passing downstream may be slowed by the size of the reservoirs or killed while passing through the dam's turbines. Successive dams and reservoirs on a single river can eliminate the natural flushing of migrating juvenile fish to the ocean during the spring months. Without adequate passage facilities, dams present barriers to upstream migration as well. Water level fluctuations above or below hydropower dams can disrupt fish spawning and strand wildlife populations. Water impoundments caused by hydropower dams can alter water temperatures to the detriment of fish. Many comments from fish and wildlife agencies, Indian tribes, and environmental groups have expressed concern over the role hydropower is expected to play in the Council's resource portfolio. Some suggested that the cumulative effects of many small hydropower projects on certain stream-reaches could be catastrophic to both anadromous and resident fish.

Within the Columbia Basin, the Council's fish and wildlife program includes a Water Budget on the Columbia and Snake rivers designed to provide adequate flows for downstream migration. The Council's program also includes specific measures across the Columbia Basin to assist fish in upstream migration. These measures incorporate provisions for flows and spill as well as fishways. The Council's program includes measures applicable to the Columbia Basin to minimize the harmful effects of water level fluctuations, and temperature control measures for specific Columbia Basin dams.

Thus, all future hydropower projects within the Columbia Basin will be subject to specific provisions in the Council's program to avoid or mitigate the above effects. The program calls for consolidated review of all applications or proposals for hydropower development in a single river drainage within the Basin. The Council intends such review will assess cumulative effects of existing and proposed hydropower development on fish and wildlife. The program also expects Bonneville to fund a study to develop criteria and methods for assessing potential cumulative effects of hydropower development. The program calls on Bonneville to study alternative methods for classifying and designating certain streams and wildlife habitat in the Basin for protection from future hydropower development, based upon their value for fish and wildlife and their hydropower potential. Based upon this study, the Council will designate stream-reaches and wildlife habitat within the Columbia Basin to be protected from further hydropower development. Finally, the program calls on the Federal Energy Regulatory Commission to require all license applicants within the Basin to demonstrate how their proposed projects would take the Council's program into account to the fullest extent practicable.

The conditions for Bonneville's support of hydropower within the entire region (included in Appendix E) are designed to avoid or mitigate these kinds of effects described above when they occur outside the Columbia Basin. The plan also calls for a study to identify and rank potential hydropower development sites within the entire region. This ranking system will be based upon many factors, including the projects' risk to fish and wildlife populations and habitat.

Although hydropower development includes serious risks to fish and wildlife, the Council believes that the provisions of this plan will minimize the effects of any future hydropower development. Subject to these comprehensive measures, hydropower development should cause relatively minor environmental and fish and wildlife effects compared to large-scale thermal generation. Dependent upon a renewable fuel, hydropower avoids the air pollution, solid waste, and mining effects of thermal power. In fact, comments from the Corps of Engineers and some utilities suggest that some hydropower projects may benefit fish by providing controlled flows and water temperatures.

"all actions of the Administrator pursuant to section 6 of this Act shall be consistent with the plan ..."

Chapter 10
Two-Year Action Plan

This chapter describes the actions that Bonneville, the Council, and others will take over the next two years. These actions will enable Bonneville to be in a position to acquire the most cost-effective resources throughout the twenty years of this plan.

The Council has concluded that this two-year plan should focus on enhancing the region's capability to (a) implement conservation, (b) develop smaller, more dispersed renewable resources, and (c) shorten the lead time for the siting, licensing, and construction of generating plants. To accomplish those goals, Bonneville must support programs to acquire cost-effective conservation from all major consumer groups (residential, commercial, governmental, industrial, and agricultural). While the rate of conservation acquisitions must reflect the need for power in the region, the development of the capability to acquire conservation cannot wait. Bonneville must be ready to respond on short notice with conservation programs and resources if power demands increase. Currently, Bonneville and the region's utilities have limited capability to implement conservation programs outside the residential sector. Bonneville must also begin developing resource options. This includes completing the planning and regulatory activities on certain resources and providing services to facilitate the early development of resources that might otherwise be lost to the region, such as cogeneration. Finally, Bonneville must conduct research, development, and demonstration projects to improve the information on which future resource decisions will be made.

It is not possible to forecast the precise resources that will be most cost-effective over the next twenty years. Resources currently projected to serve an unlikely, high demand growth may ultimately be displaced by new technologies and other resources that become more cost-effective, or may not be needed because high demand growth does not materialize. To respond to changes in demand growth, in available resources, and in resource costs, the Council will review this plan every two years. This two-year process allows the Council to provide much more detail in its conservation program and resource acquisition plan for the beginning of the twenty-year planning period. General guidelines for resource acquisitions appropriate to the later years are inadequate during the early years when Bonneville must start implementing specific conservation programs and acquiring resources.

As described in previous chapters, this plan forecasts regional electric power demands for the twenty-year period over four separate demand growth conditions: low, medium-low, medium-high, and high. The actions in this chapter will develop conservation programs and resource options that are capable of meeting all demand growth conditions.

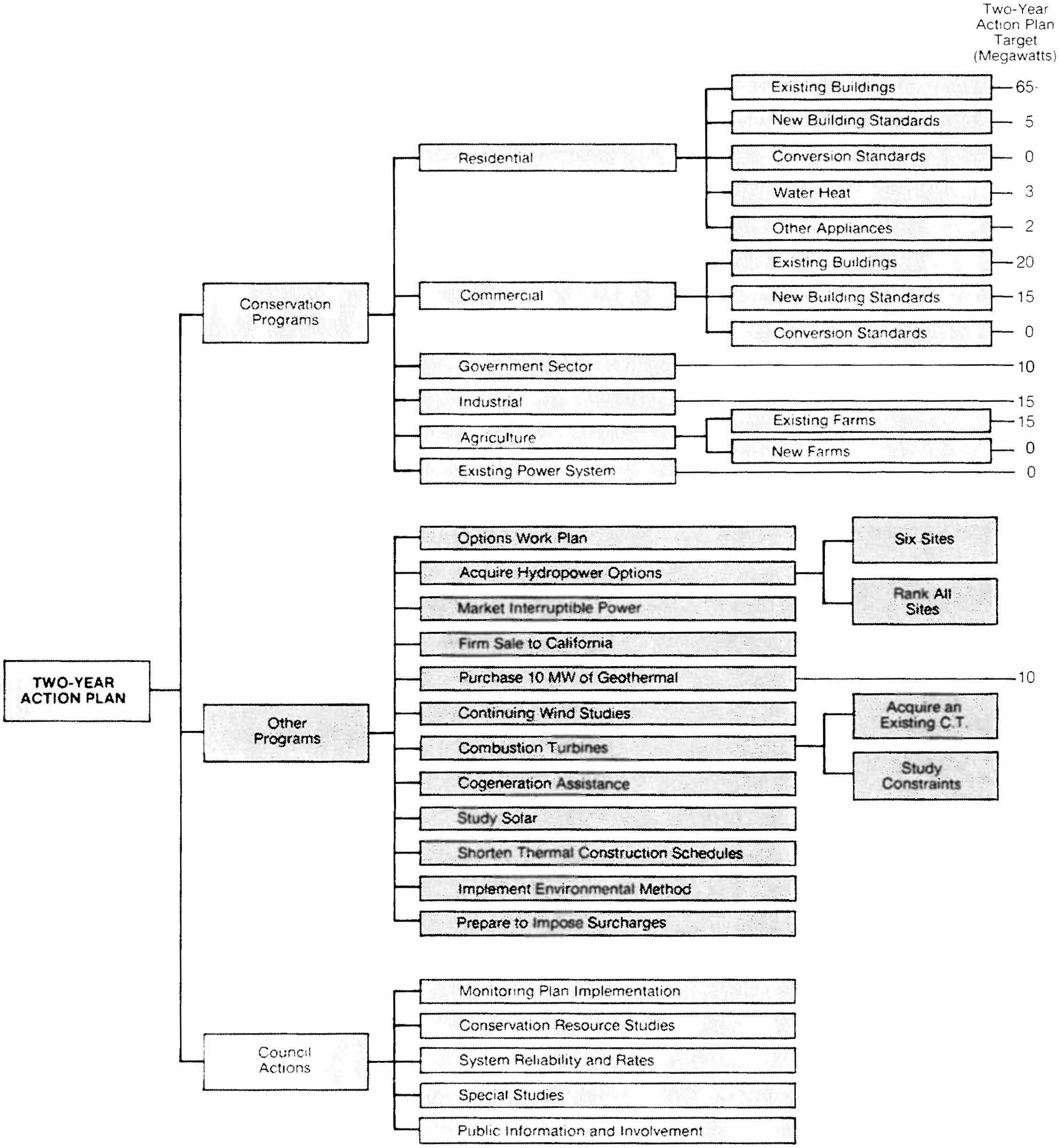


Figure 10-1.
Summary of Two-Year Actions

Figure 10-1 contains a summary of the actions in this two-year plan.

These actions are designed to maintain or improve Bonneville's ability to acquire conservation and other resources when they are needed. Because of the current surplus of power, this two-year plan does not include the acquisition of any conservation or other resource solely for the purpose of acquiring power.

The Council has considered the financial effect these conservation programs may have on Bonneville and the region's ratepayers. The conservation programs are expected to add only 3/100 of a cent per kilowatt-hour (1980 dollars) to the electric rates of consumers over the two-year period. Figure 10-2 illustrates the approximate relationship of the costs of these conservation programs to the other costs that make up Bonneville's budget.

The Council anticipates that this two-year plan will have only minimal environmental impacts. The major actions over the next two years involve conservation, the most environmentally benign energy resource. To deal with the potential indoor air quality effects associated with weatherization, the Council's model conservation standards include an infiltration package designed to increase ventilation in houses with potential air quality problems. Moveover, conservation measures will create a significant environmental benefit by helping to reduce the need for additional generation of electricity from less environmentally desirable resources. This two-year plan also calls for acquiring options on several hydropower sites in order to test the feasibility of options. The actual development of these sites could result in some environmental and fish and wildlife impacts. The provisions of the Council's fish and wildlife program covering the Columbia River Basin and this plan's conditions for future hydropower development, along with the site-ranking study of this two-year plan, are expected to minimize those impacts. Other actions in this plan are of a demonstration nature and, as such, are undertaken in part to develop a better understanding of environmental effects.

The Council has determined that the actions in this two-year plan are cost-effective,

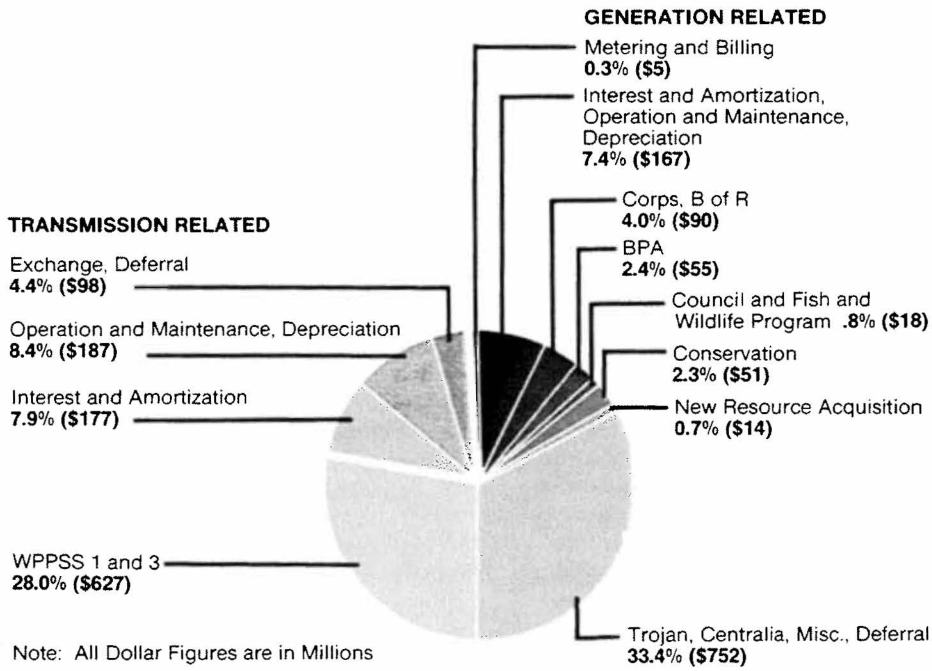


Figure 10-2.
Use of Bonneville Power Administration Revenues (FY 1983)

prudent, and necessary for Bonneville to acquire the lowest cost resources consistent with the priorities, considerations, and other requirements of the Northwest Power Act.

Section 4(d)(2) of the Act provides that all conservation and resource acquisitions by Bonneville "shall' be consistent with this plan, except as otherwise specifically provided in the Act. Section 6 of the Act, dealing with Bonneville resource acquisitions, states:

> "(b)(1) Except as specifically provided in this section, acquisition of resources under this Act shall be consistent with the plan, as determined by the Administrator.
>
> (2) The Administrator may acquire resources (other than major resources) under this Act which are not consistent with the plan, but which are determined by the Administrator to be consistent with the criteria of section 4(e)(1) and the considerations of section 4(e)(2) of this Act."

Any major resource acquisition is subject to review by the Council and a Council determination of consistency or inconsistency with this plan. A major resource is a resource with a planned capability greater than 50 average megawatts that is acquired for a period of more than five years.

The Council has used the word "shall' in this two-year action plan, when referring to actions to be carried out by Bonneville, to express the Council's expectation tha these actions can and should be implemented. It is the sense of the Council that these actions must be taken now for Bonneville to be able to acquire the lowest cost mix of resources over the next twenty years. The Council will consider Bonneville's record in implementing these actions as a part of any Council proceedings under section 6(c)(2) of the Act, regarding the consistency of major resource proposals with this plan. If significant changes in circumstances occur, this two-year plan can be revised at any time by Council action.

To ensure proper coordination in the implementation of these actions, the Council intends that all Bonneville actions in this two-year plan shall be taken in consultation with the Council. In addition, the Council requests that by August 1, 1983 Bonneville provide the Council with a schedule and work plan for Bonneville's responsibilities under this chapter.

Cost-Effectiveness

In ranking conservation and other resources for this two-year plan, the Council gave priority to resources it determined to be cost-effective. Cost-effectiveness was determined by employing the strategic planning model to identify resources that will meet demands at the lowest cost. The resources selected by use of the strategic planning model were further evaluated by use of the system analysis model. This model simulates the actual operation of the Northwest power system to determine the compatibility of resources with the existing regional power system, including the sale of electricity outside the region. The seasonal characteristics of the resources, their compatibility with the existing power system, their capital commitments and construction periods, and their effects on the environment and fish and wildlife were considered in determining cost-effectiveness. Other considerations affecting the decisions in this two-year plan included the value of maintaining existing programs, the need to acquire certain resources when the opportunities become available, and the need to provide programs to ensure conservation as an available, short-lead-time resource.

Cost-effectiveness is in part a function of the pace and level of new resource development. For instance, when a house is weatherized, a decision must be made as to what measures should be installed. Should a measure that costs 3.8 cents per kilowatt-hour be installed? If so, should the next most expensive measure, at 4.2 cents per kilowatt-hour, also be installed? If the Council had perfect knowledge of the future, the solution would be relatively simple; all measures would be installed that do not exceed a levelized life cycle cost of the most expensive resource planned for acquisition. Because the Council cannot determine what resources might be needed, the Council must set this cost-effectiveness limit with imperfect knowledge.

The Council has determined that for purposes of these conservation programs, all measures that have an installed cost at or below 4.0 cents per kilowatt-hour are cost-effective to the region and should be installed. This 4.0 cents per kilowatt-hour limit was selected based upon the cost-effectiveness studies described above, which included comparative costs of other resources. It represents a level of conservation investment that, in the Council's analysis, is cheaper than any thermal power plant that may be needed during the twenty-year planning period. The Council estimates that the average cost of the conservation programs will be 1.8 cents per kilowatt-hour.

If a cost-effectiveness figure lower than 4.0 cents per kilowatt-hour had been selected and less conservation were acquired, the region would be foregoing cost-effective opportunities for conservation; if demand was to grow fast enough, the region would later have to acquire a more expensive thermal plant in place of the lost conservation. On the other hand, if the Council had selected a higher cost-effectiveness figure, the region would be purchasing conservation that would be more expensive than thermal resources in this plan. The Council will be re-evaluating this cost-effectiveness limit as the extent of future demand growth becomes more clear.

All costs in this two-year action plan, including the regional cost-effectiveness level of 4.0 cents per kilowatt-hour, are levelized life-cycle costs expressed in 1980 dollars. Levelized life-cycle costs were determined using a 3 percent real discount rate and conventional levelizing methods. (See Appendix K, Volume II, available on request, for specific procedures and assumptions.) For the purpose of determining the cost-effectiveness of conservation, the costs of administering conservation programs were included. Conservation also receives benefits from not having transmission and distribution costs and line losses and from the 10 percent cost advantage included in the Act.

Transition Resources

Chapter 5 explains that the cost-effectiveness of resources was determined based upon all costs borne by the region's ratepayers, rather than only those costs borne by Bonneville. Viewing resource costs from a regional ratepayer perspective requires special consideration of so-called "transition plants," those resources now built or under construction that were not used to meet regional demand in the year prior to the enactment of the Act. Transition plants (such as Boardman, Valmy 1 and 2, Colstrip 3 and 4, and the privately owned share of WPPSS 3) were assumed in this plan to be completed and to be available to meet regional demand. They present a problem because their incremental costs, the costs to complete and operate them, are lower from the viewpoint of the regional ratepayers as a whole than their likely costs to Bonneville if they were to be acquired. A transition plant might be ranked as very cost-effective from the regional ratepayers' perspective but not cost-effective at all from Bonneville's perspective. Use of the regional ratepayers perspective might cause the apparent anomaly of Bonneville's having to acquire a relatively expensive transition plant when conservation or other resources that would cost Bonneville less might be available. (The Council has found that even on a "cost to complete" basis WPPSS 4 and 5 would not be the preferred thermal resources for meeting high regional demand growth, if a decision had to be made now. Otherwise, the Council has assumed that all other resources under active construction in the year prior to the passage of the Northwest Power Act will be completed.)

Acquisition of a major resource by Bonneville requires that the acquisition be consistent with this plan, with the Council reviewing Bonneville's decision and determining consistency. Necessarily, the decision on acquisition of a specific resource involves more than the decision to include generic resources in the plan. For instance, while the Council gave due consideration to environmental and fish and wildlife concerns to the extent practicable when including resources in the plan, the acquisition decision will require such consideration on a site-specific basis. Clearly, site-specific information is not available at the time of planning. The Council expects to take a detailed look at all the consequences of any proposed acquisition when determining consistency.

Since Bonneville will not be needing any additional resources in the immediate future, and there is little danger that the major transition plants which are complete or near completion will be lost to the region after the surplus is over, the Council believes there currently is no need to resolve the treatment of transition plants.

When additional demands are placed on Bonneville and one or several of the transition plants are offered for acquisition, the Council anticipates that acquisition by Bonneville of a transition plant would be appropriate under the following conditions:

- The plant is included in this plan as being necessary to meet regional loads;
- The acquisition price does not exceed the fully allocated cost of the plant;
- The region does not experience significant additional environmental costs from the acquisition; and
- The acquisition would result in net benefits to the region through greater reliability, lower total regional financing costs, reduced environmental costs, or other factors.

These conditions should be evaluated at the time of acquisition.

Conservation Program

As explained under *Cost-Effectiveness*, the Council has determined that conservation investments are cost-effective to the region if the installed cost of any measure does not exceed 4.0 cents per kilowatt-hour saved. The Council also has determined that it is cost-effective for Bonneville to continue its existing conservation programs (modified as provided in this plan), despite the current surplus. The region must not lose the benefits of investments made to date or lose the ability to accelerate conservation programs when demand begins to grow. The effectiveness of conservation programs depends upon the involvement of all 8 million consumers of electricity in the Northwest. A program involving so many people must not be subjected to repeated starts and stops in response to short-term power resource conditions. Conservation is unique in the ability it offers to adjust to the pace of resource acquisition that is needed. Conservation can serve that function, however, only if programs are developed, tested, and maintained throughout the planning period.

Table 10-1 provides the two-year (1985), five-year (1988), and twenty-year (2002)

Table 10-1.
Summary of Conservation Acquisition Plan by Forecast
(Average Megawatts, Exclusive of Line Losses)

SECTOR/END USE	HIGH			MEDIUM HIGH			MEDIUM LOW			LOW		
	1985	1988	2002	1985	1988	2002	1985	1988	2002	1985	1988	2002
Residential												
Existing Space Heating	65	160	520	65	160	440	65	160	475	65	160	160
New Space Heating	5	75	855	5	35	505	5	25	305	5	10	125
Water Heating	3	5	510	3	5	420	3	5	200	3	5	5
Other Appliance	2	5	355	2	5	260	2	5	200	2	5	5
Sector Total	75	245	2,240	75	205	1,625	75	195	1,180	75	180	295
Commercial												
Existing Structures	20	90	720	20	90	630	20	90	605	20	90	90
New Structures	15	50	615	15	45	370	15	35	230	15	20	140
Sector Total	35	140	1,335	35	135	1,000	35	125	835	35	110	230
Governmental												
Sector Total	10	15	15*	10	15	15*	10	15	15*	10	15	15*
Industrial												
Sector Total	15	45	545	15	45	545	15	45	545	15	45	45
Agricultural												
Existing	15	35	300	15	35	300	15	35	300	15	35	35
New	0	0	85	0	0	85	0	0	85	0	0	0
Sector Total	15	35	385	15	35	385	15	35	385	15	35	35
Existing Power System												
Efficiency Improvements	**	**	270	**	**	270	**	**	270	**	**	40
TOTAL	150	480	4,790	150	435	3,840	150	415	3,230	150	385	660

*Twenty-year target will be revised based on Council assessments of conservation potential in this sector scheduled for completion during the next two years.

**Two- and five-year targets have not been established for power system efficiency improvements.

conservation targets for each of the Council's four growth forecasts.

This table reveals that depending upon the rate of economic growth, the Council forecasts that the region should acquire between 660 and 4,790 megawatts of conservation by the year 2002 (in the low growth forecast, conservation programs and model conservation standards would add approximately 400 megawatts more than the estimate of regional needs over the twenty-year period). During the next two years the residential sector conservation provides approximately 50 percent of these savings, the commercial sector 25 percent, the governmental sector 5 percent, the industrial sector 10 percent and the agricultural sector 10 percent (see figure 10-3). Bonneville should diversify its conservation efforts to develop capability in all sectors. The pace of these programs has been designed to enhance the region's ability to finance, develop, test, and implement new programs that serve all sectors, while taking the current surplus into account.

The conservation programs described in this chapter address problems that have hindered conservation efforts during the past decade. The Council believes the plan's conservation programs must be ambitious if conservation is to fulfill the role assigned to it by Congress. The Council will monitor these programs closely to ensure that the lessons learned can be translated into revisions to the plan and can result in improved confidence regarding the reliability of the region's "conservation resource."

The general aim of the Council's conservation programs is to build the capability of the region's conservation system to ensure that, as the current power surplus diminishes, Bonneville, utilities, state and local governments, and the private sector will be able to acquire cost-effective conservation at a pace sufficient to meet the Council's long-run conservation targets. This will require the development and implementation of new conservation programs as well as the modification of existing programs. In addition to bolstering the region's conservation system, the programs are designed to promote efficiency, diversity, competition, and equitable distribution in the provision of conservation services.

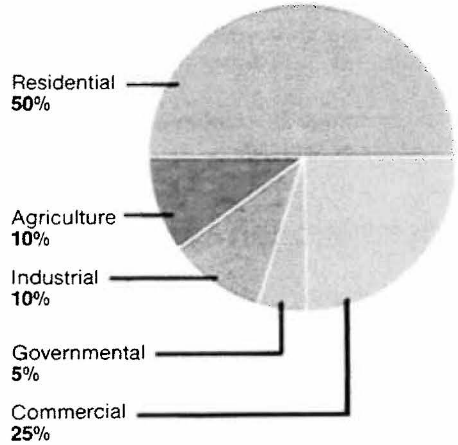


Figure 10-3.
Conservation Savings—High Forecast

Bonneville's basic role in this overall scheme is to provide financial assistance for conservation improvements that are cost-effective for the region. To guarantee that such regionally financed improvements are accomplished efficiently and effectively, the Council's program includes requirements designed to avoid repeated retrofits of the same building, to ensure quality in workmanship, and to improve the skill and accuracy of those individuals who determine which conservation measures are cost-effective for a specific building. In addition, the programs define a number of actions to improve the operation of the market for conservation services and include research and demonstration projects to improve information about indoor air quality, solar space and water heating, heat pump water heaters, and other matters of interest to the region's consumers.

References are made in this two-year action plan to the implementation of certain programs "throughout the region.' Specifically, these programs relate to (a) reimbursing code enforcement agencies for certain incremental costs associated with the model conservation standards, (b) providing educational programs regarding the model conservation standards, and (c) providing consistent procedures for certifying compliance with the model conservation standards. The Council intends that funding for these programs be provided regardless of the status of local utility contracts with Bonneville and the specifics of local government and utility boundaries. The Council made this decision because (a) utilities that are not currently placing their demands on Bonneville could do so during the twenty-year planning period, and (b) enforcement of the model conservation standards and education and certification programs must be implemented regionwide to be effective.

Finally, the Council's programs envision the development of a decentralized market for the delivery of conservation services in the region. There are provisions designed to encourage a more active role for qualified private contractors in the marketing of conservation services. The programs aim to encourage local utilities, state and local governments, and private firms to contract directly with Bonneville to provide conservation savings. This decentralization will help serve the diverse needs of the region as well as increase the overall capabilities of the region's conservation system.

The conservation programs focus on the attainment of six long-term goals:

- Make existing and new residential and non-residential buildings as cost-efficient as current technology and life-cycle economics allow;
- Operate buildings that use electricity in an energy-efficient manner;
- Use renewable resources, in particular passive solar applications, in new and existing residential and non-residential buildings where their use is economically justified;
- Cause industrial electric processes, commercial equipment, and household appliances to be as energy-efficient as current technology and life-cycle economics allow;
- Cause energy-management considerations to be an integral part of the planning and administrative processes of local and state governments and the private sector; and

- Make arrangements to allow government, utilities, and the private sector to share energy-management resources, information, technical expertise, and experience;

These conservation programs are discussed by sector: residential, commercial, industrial, irrigation, and state and local governments. Where appropriate the sectors are separated into programs for new and existing buildings, and specific acquisition targets are provided. A separate discussion of power system conservation also is provided.

1. Residential Sector—Existing Buildings

Bonneville currently offers a residential conservation program for existing buildings. Because of the present surplus of power, the program is being operated at what Bonneville regards as the minimum level of activity necessary to maintain the region's conservation delivery system for the sector. The Council has decided upon a number of changes that are to be incorporated into Bonneville's program at this time.

A fair and effective residential conservation program must be able to achieve cost-effective energy savings in dwellings occupied by all kinds of households. Current studies demonstrate that utility conservation programs in the Northwest have not been successful in reaching low-income and rental households. The reasons are clear. Conservation programs that do not pay the full cost of the measures exact an entrance fee from the homeowner. Access to the program is dependent upon the homeowner's ability to bear the unreimbursed costs. This situation is aggravated if the program requires, as the Council's program does, the installation of all structurally feasible and regionally cost-effective measures as a condition of receiving Bonneville financial assistance. The homeowner cannot trim costs by rejecting cost-effective measures. For households with a low income, cost becomes a barrier to participation. For tenants, it makes little sense to pay for weatherizing the landlord's property. For landlords, cost and competitive market conditions can often make weatherization a poor investment. Moreover, in the case of both low-income households and tenants, there is reason to believe that improved marketing of conservation programs could improve participation rates.

Section 6(k) of the Northwest Power Act requires that Bonneville distribute the benefits of its resource programs "equitably throughout the region." The Council has concluded that this requires reasonable access to residential conservation benefits by both low-income consumers and tenants.

To bolster the conservation system serving low-income households and tenants, this plan includes (a) a low-income program that pays 100 percent of the actual cost of all cost-effective conservation measures, and (b) penetration rates for low-income households and tenants which are at least proportionate to their respective shares of all electrically heated households in some reasonably defined geographic area (such as a city, county, or utility service area). For example, if 30 percent of the electric heat customers in a utility's service area are tenant-occupied units, then at least 30 percent of the electric heat units weatherized each year must be renter-occupied.

Bonneville's conservation program for existing residential buildings shall:

1A. Include all regionally cost-effective measures (including direct application renewable resources) that conserve electricity in existing residential buildings which use electricity for space heating or water heating. The program shall include both owner-occupied and rental buildings.

1B. Require an audit of the building as a condition of receiving Bonneville financial assistance. The audit shall identify all structurally feasible and regionally cost-effective conservation measures.

1C. Require, as a condition of receiving Bonneville financial assistance, the installation of all structurally feasible and regionally cost-effective conservation measures.

1D. Provide financial assistance at levels not lower than Bonneville's current program, which will achieve the Council's energy savings target in the residential sector, and which will achieve penetration rates for low-income and tenant-occupied electrically heated households at least proportionate to their respective shares of all electrically heated households in a reasonably defined geographic area (e.g., city, county, or utility service area). In no event shall the amount of financial assistance for any measure exceed 4.0 cents per kilowatt-hour.

1E. Provide a program that pays 100% of the actual cost of all structurally feasible and regionally cost-effective conservation measures for low-income households, at a cost not to exceed 4.0 cents per kilowatt-hour saved. This program shall be made available to households with an annual income below that specified in the formula below.

Household Size	Percentage of Median City or County Household Income	Example Based on Regional Median Income*
1	54%	$12,455
2	62%	14,300
3	70%	16,146
4	78%	17,911
5	83%	19,144
6	88%	20,297
7	93%	21,450
8+	98%	22,604

*Shown for illustrative purposes only. Actual income will vary by city or county median income level.

1F. Provide only for hot water efficiency improvements resulting from the installation of hot water heat pumps and solar water heaters. Because the expected lifetime of water heater wraps and thermal improvements to existing tanks is less than the length of the current surplus, these measures are not included at this time.

1G. Provide for local utility or other qualified inspection of the conservation measures before the payment of any financial assistance to the contractor or homeowner and release of the contractor's bond.

1H. Permit and encourage bonded, qualified private contractors to solicit a consumer's business directly, without first going through the local utility. This can be done, for example, through the use of general contractors who audit the building for savings of electricity and provide a bid for all structurally feasible and regionally cost-effective conservation measures. Following approval by Bonneville or the local utility, the measures could then be installed by the general contractor or by subcontractors.

1I. Permit and encourage individual entities other than utilities (such as state and local governments and private firms) to contract directly with Bonneville to provide savings in electric space heating.

1J. Provide certification of energy-efficient electrically heated rental property units.

Bonneville Actions

Bonneville shall:

1.1 Modify its existing residential conservation program to incorporate the features previously described and to achieve the following rate of acquisition:

- By September 30, 1985, acquire 65 megawatts.
- By September 30, 1988, acquire a total of 165 megawatts of which 5 megawatts shall be acquired through the installation of heat pump water heaters or solar water heaters.

1.2 Continue and expand programs such as the Energy Extension Service, which provide technical assistance to residential consumers of electricity.

1.3 Undertake demonstration programs to test the feasibility, effect on market penetration, and cost-effectiveness of a variety of conservation delivery systems including contracting directly with private energy services firms and local governments to secure residential conservation. Demonstration programs should be selected to reflect adequately the diverse circumstances in the region.

1.4 Develop criteria for the acceptance of programs designed by individual entities (utilities, local and state governments, private firms, etc.) to market residential space and water heating savings directly to Bonneville.

1.5 Establish a certification system and training program for auditors which ensures that they will correctly apply the plan's cost-effectiveness criteria in determining the measures to be installed in each building. As a part of that process, Bonneville should evaluate methods for calculating energy consumption and savings. These methods should be suitable for use by auditors, and the most accurate method for use in the field should be chosen.

1.6 Develop and implement a demonstration program to monitor the performance and cost of solar and heat pump water heaters and passive solar space heating designs in each climate zone. This program shall include at least 600 solar water heaters. This program shall be carried out in cooperation with utilities, state and local governments, trade and professional associations, and other interested parties.

1.7 Design and implement a field research program to identify mechanisms that will ensure quality control for all measures, specifically including wall insulation and infiltration control measures.

1.8 Design and implement a research program to assess (a) the effect of reduced air infiltration in weatherized homes on the presence of indoor air pollutants, and (b) the effectiveness of mitigation techniques.

1.9 Provide technical and financial assistance to the shelter industry (builders, lenders, appraisers, etc.) for the implementation of a uniform, region-wide energy-efficiency rating system for existing residential buildings. This system should be similar to that used by the Environmental Protection Agency to provide consumers with information about automobile fuel efficiency. The rating system should be usable by the homebuilding and lending industry and by potential home buyers to estimate future use of electricity and to assess qualification for home loans. This rating system should be consistent with that developed for new residential buildings (see Bonneville action 2.7). This system shall be fully implemented on or before January 1, 1986.

Council Actions

The Council will:

1.10 Conduct a review of conservation programs in the region to determine whether the penetration rates among low-income and tenant households meet the criteria set forth above.

1.11 Conduct a review of the effect that various financial assistance levels and education programs have had on participation rates in programs currently offered in the region and elsewhere. The anaysis will include an examination of participation by income group and by ownership status.

1.12 Conduct research to assess the effectiveness of alternative conservation delivery systems and financing approaches, including full-cost reimbursement for all residential consumers regardless of income or ownership status. These projects will assess the effect of each alternative on:

- Desired penetration rates.
- Program costs.
- Potential versus actual savings.

1.13 To the extent practicable, these research objectives will be coordinated with Bonneville programs currently in place or those soon to be implemented, such as the Hood River and Elmhurst projects.

In addition to these changes, the Council intends to examine the approach described below as a potential change to Bonneville's residential conservation program for existing buildings.

Bonneville's current practice requires that each residential structure undergo a comprehensive audit before participating in the conservation "buy-back" program. Bonneville then pays up to 29.2 cents for each kilowatt-hour estimated to be saved in a retrofit house during the first year. This method for calculating the payment for conservation savings has an apparent problem in that the payment varies substantially based on the condition of the house and its location. For example, conservation measures applied to a house in a cold climate zone will save substantially more electricity than if applied to a house in a moderate climate zone, and therefore will be eligible for a higher payment. However, the cost of installing the conservation masures does not vary significantly between climate zones.

The Council will consider an alternative method for calculating the payment for savings of electricity that adjusts for the climate zone and existing condition of each house. To reduce the administration costs associated with each audit, this alternative would offer financing for those conservation measures which on average have been identified as being cost-effective to the region. (Those utilities desiring to provide comprehensive audits, or which are required by federal law to do so, may continue that practice.) If it is determined that certain measures are on average cost-effective to the region and these measures are not present in the house, then the measures would be eligible for Bonneville financing. One advantage of this alternative is that it may reduce the number and length of visits to the house.

This alternative involves five steps. First, the Council would identify all conservation measures which on average are cost-effective to the region. Second, the Council would determine the average cost of those measures on a cost per square foot basis, assuming that the measures must be structurally feasible. Third, Bonneville, in consultation with the Council, the region's utilities, and others, would establish a financing rate which would cover a percentage (up to 100 percent) of the average cost of regionally cost-effective measures. More than one financing rate may be necessary to achieve the penetration rates for low-income and renter households and tenants as required in this plan. The average cost multiplied by the financing rate would yield the acquisition price. Fourth, the consumer would be required to secure at least three contractor bids (one of which the consumer may provide) and to have all structurally feasible, regionally cost-effective measures installed. Fifth, upon inspection and approval of completed work, the consumer would receive a payment equal to the lower of (a) the low bid, or (b) the acquisition price (i.e., the regional average cost of the work multiplied by the "financing rate").

The Council will seek public comment on this and other alternatives before including any change in the plan. The Council will soon begin a process to consider this matter. In the meantime, Bonneville should ensure that the alternative described above is considered in its conservation programs and contracts and that no action is taken which would prevent its implementation.

Expected Cost and Savings of Electricity

Through this program, Bonneville shall acquire 165 megawatts of savings during the next five years. The Council estimates that the average cost of these savings will not exceed 1.9 cents per kilowatt-hour. The marginal cost of individual conservation measures shall not exceed 4.0 cents per kilowatt-hour. These measures are expected to result in an average savings per building of at least 3,200 kilowatt-hours per year for space heating (a reduction of approximately 35 percent).

2. Residential Sector— New Building Standards

New buildings present one of the most significant opportunities for achieving cost-effective conservation. The installation of measures is far less expensive at the time of construction, and many conservation measures can be incorporated into construction but cannot be installed later without making structural changes to the building. With residential buildings lasting 50 years or more, it is vital to ensure that any building using electric space heat is built to efficient standards—even during periods of surplus.

These model conservation standards have been developed to ensure that new residential buildings using electric space heat are built to produce all the savings of electricity that are economically feasible for the consumer. To allow adequate time for local review, adoption, and implementation of these standards, the Council has decided that the standards will become effective for all residential buildings that receive building permits on or after January 1, 1986.

The Council's model standard for new residential buildings specifies only the maximum electric energy use permitted for space heating in a new building. It allows designers and builders to select any means to achieve the specified energy-use budget. For example, a house could attain the Council's standard by increasing the amount of insulation, by using a passive solar design, by heating with geothermal energy, or by combining all three approaches.

The performance standards for the space heating requirements of single-family and multi-family dwellings are shown below:

	Climate Zone*		
Building Type	1 (kWh/sq ft/yr)	2 (kWh/sq ft/yr)	3 (kWh/sq ft/yr
Single-Family	2.0	2.6	3.1
Multi-Family	1.2	2.3	2.8

*Climate zones are based on the number of heating degree days experienced in a particular location (Zone 1: less than 6,000; Zone 2: 6,000 to 8,000; Zone 3: in excess of 8,000).

These standards are based upon the cost of electricity, using the Council's method of estimating space heating needs. Other methods may produce different results for the same measures. However, the Council's estimates of the electricity used by energy-efficient homes in the Pacific Northwest are accurate to within less than 7 percent of their actual use. Also, the Council has not analyzed the economic feasibility of these standards for consumers of other space heating fuels.

These model conservation standards may be adopted and enforced by a state or local government or by utilities where utilities are legally authorized to do so. Those entities which choose not to adopt and enforce the applicable standards should prepare an alternative plan for achieving savings that are comparable to those achievable through the use of the standards. The alternative plan may employ electric service requirements, rate designs, or any other technique for achieving conservation. Failure to implement the standards or achieve comparable savings will subject utilities to the surcharge provisions of this plan (see Method for Calculating Surcharges, Appendix D).

Actions

State governments, local governments, or utilities should:

2.1 By January 1, 1986, adopt and enforce the applicable model conservation standards for new electrically heated residential buildings; or

2.2 By January 1, 1986, adopt and enforce an alternative plan for achieving savings comparable to those that would be achieved through implementation of the applicable model conservation standards. This plan should be developed by or in cooperation with the electric utility or utilities serving the jurisdiction.

Suggested approaches to achieving these residential performance standards are provided in Appendix J (Volume II, available on request).

Bonneville Actions

Bonneville shall:

2.3 Develop a consistent procedure for certifying compliance with these model standards. This procedure shall be available on or before January 1, 1985 and shall be offered throughout the region.

2.4 Develop a procedure to review and evaluate alternative plans to achieve comparable savings. This procedure shall be available on or before January 1, 1985.

2.5 Develop and implement an education program regarding the provisions of these model standards for builders, architects, designers, real estate appraisers, code officials, and lending institutions. This program shall be in place and operating by January 1, 1985 and shall be offered throughout the region.

2.6 Assist the U.S. Department of Housing and Urban Development to develop and adopt electric energy-efficiency standards for manufactured housing in the Pacific Northwest. The standards should be cost-effective for the region and economically feasible for owners of manufactured housing. To the extent practicable, these standards should be consistent with the standards in this section for other types of construction.

2.7 Provide technical and financial assistance to the housing industry (including builders, lenders, appraisers, etc.) for the implementation of a uniform regionwide energy-efficiency rating system for new residential buildings. This rating system should be similar to that used by the Environmental Protection Agency to provide consumers with information about automobile fuel efficiency. The rating system should be usable by the homebuilding and lending industry and potential home buyers to estimate future use of electricity and qualification for home loans. This rating system should be consistent with that used for existing residential buildings. (see Bonneville action 1.9). This system shall be fully implemented on or before January 1, 1986.

2.8 Develop and implement a program which provides incentives for meeting these model standards in residential buildings for which building permits are issued before January 1, 1986. The program shall be designed to result in at least 25 percent of the new residential buildings being built to the Council's model standard between January 1, 1984 and January 1, 1986. This program shall include:

- Certification by the local utility, local government, or by independent appraisers of houses which meet or exceed the applicable model standard.
- A public education and marketing program which emphasizes the energy-savings features and value of houses that achieve the model standard.
- Efficiency awards to builders of houses which meet or exceed the applicable model standard.

2.9 Develop and initiate a program to provide financial incentives to homeowners where governmental entities have adopted and enforced the model standard, or a qualifying alternative plan, prior to January 1, 1986. The incentives provided in this program should be based on the estimated amount of electric energy to be saved by the dwelling (compared to an equivalent dwelling built to current code) between the time it receives its final certificate of occupancy and January 1, 1986. The incentive payment should be set at 4.0 cents per kilowatt-hour saved.

2.10 Pay for the incremental cost above that required to meet current code for a sample demonstration of houses built to the model standards. This program shall include:

- A sample of at least 1,000 single-family and 200 multi-family buildings which are separately metered for space heating, waste heating, and other appliance uses. The buildings should be located in proportion to population distribution across the region. The Council will consider a reduction in the sample size upon a demonstration that statistically significant results can be obtained with a smaller number of units.
- A measurement of the level of air infiltration and indoor air quality for the model houses.
- Occupant data, including the type and number of appliances owned, family size, use of wood heat, thermostat settings, indoor air temperature, and other information determined in consultation with the Council.
- A control group of comparable buildings built to current code or practice.

These demonstration houses shall be included in the number of houses built to the Council's model standards between January 1, 1984 and January 1, 1986, under the incentive program provided in action 2.7.

The program measures described in actions 2.3, 2.5, and 2.8 shall be carried out in cooperation with state and local governments, utilities, trade and professional associations, and other interested parties.

Council Actions

The Council will:

2.11 Investigate the feasibility of incorporating the Council's model standard for new residential buildings into the International Congress of Building Officials (I.C.B.O.) Uniform Building Code.

2.12 Investigate potential additions to the model standard for new residential buildings; in particular, the establishment of energy performance budgets for water heating.

Expected Cost and Savings of Electricity

The Council estimates that these model standards will produce at least 35 megawatts of space heat savings in new buildings built during the next five years, assuming the Council's medium-high growth rate. The Council estimates that the average cost of these savings will not exceed 2.0 cents per kilowatt-hour and projects that these standards will reduce space heating use by 60 percent. The Council further estimates that the cost to Bonneville of implementing these standards will not exceed 4/10 of a cent per kilowatt-hour. The marginal cost of any individual conservation measure needed to achieve these model standards shall not exceed 4.0 cents per kilowatt-hour.

3. Residential Sector—Conversion Standard

It does little good to require that all new residential buildings with electric space heating satisfy model conservation standards if houses that are not built with electric space heating can be converted to electricity freely. The region would be inviting consumers to circumvent the new building standards. On the other hand, it would be unreasonable to require that all houses meet the new building standard before they can be converted to electric space heating, because certain conservation measures are not structurally or economically feasible in older buildings. To reconcile these differences, the Council has developed a model conservation standard specifically for residential buildings that were granted building permits before January 1, 1986 and are being converted to electric space heating. Residential buildings that are granted building permits after January 1, 1986 will be required to meet the new building standards (Action 2) if and when they are converted to electric space heat.

This standard will ensure that buildings converted to electric space heat from other fuels will meet minimum energy-efficiency requirements. This standard may be adopted by state or local governments or by utilities where they are authorized to do so. Entities which choose not to adopt this standard should prepare an alternative plan that will result in savings which are comparable to the savings achievable through this model standard. Failure to implement this standard or achieve comparable savings will subject utilities to the surcharge provisions of this plan (see Method for Calculating Surcharges, Appendix D).

Actions

State governments, local governments, or utilities should:

3.1 By January 1, 1986, adopt and enforce the model conservation standard described in Appendix L for the conversion of residential buildings to electric space heating; or

3.2 By January 1, 1986, adopt and enforce an alternative plan for achieving savings comparable to those that would be achieved through implementation of the model standard.

Appendix L is contained in Volume II, which is available on request. The standard shall be effective for all conversions in which the electric space heating system is installed on or after January 1, 1986.

Bonneville Actions

Bonneville shall:

3.3 Develop a consistent procedure for certifying compliance with this model standard. The procedure shall be available on or before January 1, 1985, and shall be offered throughout the region.

3.4 Develop and implement an education program regarding the provisions of this model standard for electricians, furnace dealers, home builders, architects, designers, real estate appraisers, code officials, and lending institutions. This program shall be in place and operating by January 1, 1985, and shall be offered throughout the region.

3.5 Develop a procedure to review and evaluate alternative plans to achieve comparable savings. This procedure shall be available on or before January 1, 1985.

The program measures described in actions 3.3 and 3.4 shall be carried out in cooperation with state and local governments, utilities, trade and professional associations, and other interested parties.

Expected Cost and Savings of Electricity

The Council evaluated the potential conversion to electric heat of unweatherized oil and gas heated houses. This assessment revealed that each conversion could cost the region in excess of $8,300 per building in new resource requirements over the next twenty years. The Council estimates that the model standard will reduce the annual electric space heating needs in an average house by approximately 5,000 kilowatt-hours. These savings will reduce the cost of new resource requirements by more than $3,100 per building by requiring weatherization prior to conversion to electric heat. Total regional savings will vary depending on how consumers respond to future oil and natural gas prices.

4. Residential Sector—New Appliances

The Council decided against adopting model conservation standards for new appliances because appliances now on the market already meet the California appliance efficiency standard and any new standard for appliances should be coordinated with other states.

Nevertheless, a demonstration program would be useful to determine whether financial incentives could produce cost-effective appliance efficiency savings. Many consumers are unaware of the attractive economics of purchasing a slightly more expensive, but markedly more efficient, new refrigerator, freezer, or water heating system when they replace their current appliance. In addition, many major appliance purchases are made by third parties, such as builders and rental property managers, who have little incentive to select efficient models. This program is designed to encourage the purchase of new and replacement appliances which are more energy efficient. This program focuses initially on incentives, while investigating the necessity and desirability of adopting standards in the future.

Bonneville's program for new appliances shall:

4A. Focus intially on refrigerators, freezers, water heaters, space and water-heating heat pumps, and solar water heaters.

4B. Provide dealer and/or customer incentives based on the efficiency of new appliances compared to the shipment weighted efficiency of comparable models sold the previous year.

4C. Allow manufacturers and distributors to receive direct payments from Bonneville for appliance savings of electricity verified by actual appliance sales invoices.

4D. Offer financial incentives, including incentives to dealers, sufficient to reduce the number of older and less-efficient refrigerators and freezers that are being operated in the region.

Bonnneville Actions

Bonneville shall:

4.1 Develop and implement a regionwide appliance efficiency demonstration program which incorporates the features described above. This program shall achieve the following rate of acquisition:

- By September 30, 1985, acquire 2 megawatts.
- By September 30, 1988, acquire a total of 5 megawatts.

The program should assess the feasibility, cost-effectiveness, and effect on market penetration of (a) offering direct financial incentives to manufacturers, distributors, and/or dealers to encourage the sale of energy-efficient major electric appliances, and (b) offering third-party purchasers (e.g., builders, rental property managers, etc.) direct financial incentives to install energy-efficient major electric appliances.

4.2 Fund a field research project which assesses the effect of energy-efficient appliances, including heat pump water heaters, on the space heating requirements of fully weatherized residential buildings and new residential buildings that meet the Council's model standards.

4.3 Develop and implement (in cooperation with utilities, trade and professional associations, educational institutions, community organizations, and other interested parties) education and marketing programs regarding energy-efficient appliances for distributors, dealers, and purchasers (homeowners, rental property managers, etc.).

Council Actions

The Council will:

4.4 Assess the effect of incentive, education, and marketing strategies and programs on consumer purchases of energy-efficient residential appliances.

4.5 Investigate, in conjunction with other states (including California), the desirability and feasibility of establishing uniform appliance efficiency standards.

Expected Cost and Savings of Electricity

Bonneville shall acquire 5 megawatts of energy savings from more efficient appliances during the next five years. The Council estimates that the average cost of these savings will not exceed 1.6 cents per kilowatt-hour. The marginal cost of individual appliance conservation savings shall not exceed 4.0 cents per kilowatt-hour.

5. Commercial Sector— Existing Buildings

Bonneville does not currently offer any conservation program for existing commercial buildings (other than government or institutional buildings). This plan calls for the development of a program for this sector which will provide approximately 20 percent of all conservation savings over the next five years assuming the Council's medium-high growth forecast. The rate of acquisition for this program has been established at a minimum level to develop and maintain the region's ability to acquire conservation in this sector.

Bonneville's conservation program for this sector shall:

5A. Include all regionally cost-effective measures in existing commercial buildings that use electricity for space conditioning. A conservation measure shall be deemed to be regionally cost-effective if it has a cost of 4.0 cents per kilowatt-hour or less.

5B. Require, as a condition of receiving Bonneville financial assistance, an audit which meets Bonneville's current minimum requirements for commercial building audits. The audit shall identify all structurally feasible and regionally cost-effective measures that conserve electricity, and shall take into consideration the effect of those measures on the consumption of non-electric energy. Bonneville shall provide reimbursement for auditing costs incurred by commercial customers when audits are performed by qualified personnel according to Bonneville's current minumum requirements, and when the audits result in savings of electricity.

5C. Require, as a condition of receiving Bonneville financial assistance, the installation of all structurally feasible and regionally cost-effective conservation measures, including those operation and maintenance procedures which have simple payback periods of less than one year.

5D. Set financial assistance at a level which will achieve the expected savings of electricity at the lowest possible cost to Bonneville ratepayers, up to the full cost of the conservation measures, if necessary. In no event shall the amount of financial assistance for any measure exceed the regional cost-effectiveness level of 4.0 cents per kilowatt-hour.

5E. Provide technical assistance and training for commercial sector building operators.

5F. Provide for local utility inspection or other qualified inspection of the conservation measure before the payment of financial assistance to the contractor or release of the contractor's bond.

5G. Allow individual entities other than utilities (such as contractors, state and local governments, and private firms) to receive direct payments from Bonneville for verifiable commercial sector electric energy savings.

Bonneville Actions

Bonneville shall:

5.1 Develop and offer a regionwide commercial conservation program which incorporates the features described above. This program shall achieve the following rate of acquisition:

- By September 30, 1985 acquire 20 megawatts.
- By September 30, 1988, acquire a total of 90 megawatts.

5.2 Support the development and implementation of comprehensive education and training programs in energy-efficient commercial building design, construction, operation, and maintenance.

Expected Cost and Savings of Electricity

Through this program, Bonneville shall acquire 90 megawatts of savings from existing commercial buildings during the next five years. The Council estimates that the cost of these savings will not exceed 1.9 cents per kilowatt-hour. The marginal cost of any individual conservation measure shall not exceed 4.0 cents per kilowatt-hour.

The average savings in electricity per building is expected to be approximately 30 percent. These savings should be obtained through the implementation of equipment efficiency improvements such as lighting, heating, ventilation, cooking, air conditioning and refrigeration, and building envelope modifications.

6. Commercial Sector— New Building Standard

For the same reasons described under 2. Residential Sector—New Building Standards, it is vital to ensure that commercial buildings using electric space conditioning and/or lighting are built to efficient standards—even during periods of surplus. This commercial building standard has been developed to ensure that new commercial buildings are built to produce savings of electricity that are economically feasible for the consumer. To allow adequate time for adoption and implementation of this standard, the Council has decided that the standard will become effective for commercial buildings that receive building permits on or after January 1, 1986.

This standard is a modified version of the most recent model energy code of the American Society of Heating, Refrigeration and Air Conditioning Engineers (ASHRAE), ASHRAE 90-80. The standard includes equipment performance specifications, lighting budgets, and minimum building envelope efficiency requirements. The lighting budgets are identical to those now required by Seattle's Energy Code, with the exception of office and retail buildings. The standard for office and retail buildings is equivalent to the office standard currently proposed by the California Energy Commission (1.5 watts per square foot plus an additional 1.5 to 3.0 watts per square foot for task and spot lighting).

This model conservation standard may be adopted and enforced by a state or local government or by utilities where utilities are legally authorized to do so. Those entities which choose not to adopt and enforce the standard should prepare an alternative plan for achieving savings that are comparable to those achievable through the use of the standard. The alternative plan may employ electric service requirements, rate designs, or any other technique for achieving conservation. Failure to implement the standard or achieve comparable savings will subject utilities to the surcharge provisions of this plan (see Method for Surcharge, Appendix D).

Actions

State governments, local governments, or utilities should:

6.1 By January 1, 1986, adopt and enforce the model conservation standard described in Appendix J for new commercial buildings that use electricity for space conditioning; and

6.2 By January 1, 1986 adopt and enforce the model conservation standard described in Appendix J for lighting for new commercial buildings which do not use electricity for space conditioning; or

6.3 By January 1, 1986, adopt and enforce an alternative plan for achieving savings comparable to those that would be achieved through implementation of the model conservation standard for new commercial buildings. This plan should be developed by or in cooperation with the electric utilities serving the jurisdiction.

Appendix J is contained in Volume II, which is available on request.

Bonneville Actions

Bonneville shall:

6.4 Develop a consistent procedure for certifying compliance with this model standard. This procedure shall be available on or before January 1, 1985 and shall be offered throughout the region.

6.5 Develop and implement an education program regarding the provisions of this model standard for builders, building owners, architects, designers, real estate appraisers, code officials, and lending institutions. This procedure shall be available on or before January 1, 1985 and shall be offered throughout the region.

6.6 Develop a procedure to review and evaluate alternative plans to achieve comparable savings. This procedure shall be available on or before January 1, 1985.

6.7 Develop and implement a program which provides incentives for meeting this model standard in buildings for which building permits are issued between January 1, 1984 and January 1, 1986. The program shall be designed to achieve at least 15 average megawatts of savings. This program shall include:

- Certification by the local utility, local government, or by independent appraisers of buildings which meet or exceed the model standard.

- A public education and marketing program which emphasizes the energy-savings features and value of buildings that achieve the model standard.

- Financial incentives to architects and engineers to prepare energy-efficient alternative commercial designs which meet the Council's standard and are approved by local building officials. Payment of the incentive shall be contingent upon construction of the building according to the approved design.

- Efficiency awards to builders when their buildings meet or exceed the applicable model standard.

6.8 Develop and initiate a program to provide financial incentives to building owners where governmental entities have adopted and enforced the model standard, or a qualifying alternative plan, prior to the required implementation date. The incentives provided in this program should be based on the estimated amount of electric energy saved by the building (compared to current code) between the time it commences normal operation conditions and January 1, 1986. The incentive should be set at 4.0 cents per kilowatt-hour.

The program measures described in actions 6.4, 6.5, and 6.7 shall be carried out in cooperation with state and local governments, utilities, trade and professional associations, and other interested parties.

Council Actions

The Council will:

6.9 Investigate potential additions to the model standard for commercial buildings, in particular the establishment of total building energy performance budgets, more stringent lighting standards, and mechanical system specifications. This investigation will include a review of the ASHRAE 90-80E-LIG standard.

6.10 Investigate the feasibility of incorporating the Council's model standard for new commercial buildings into the International Congress of Building Officials (I.C.B.O.) Uniform Building Code.

Expected Cost and Savings of Electricity

This conservation standard should produce approximately 45 megawatts of savings from new commercial buildings during the next five years, assuming the Council's medium-high growth forecast. The Council estimates that the cost of these savings will not exceed 1.7 cents per kilowatt-hour. The marginal cost of any individual conservation measure shall not exceed 4.0 cents per kilowatt-hour.

7. Commercial Sector—Conversion Standard

As explained under 3. Residential Sector—Conversion Standard, it does little good to require that all new commercial buildings using electricity for space conditioning satisfy model conservation standards, if buildings that are not built with electric space conditioning can be converted to electricity freely. Accordingly, the Council has developed a model conservation standard specifically for commercial buildings that were granted building premits before January 1, 1986 and are being converted to electric space conditioning. Commercial buildings that are granted building permits after January 1, 1986 will be required to meet the new building standard if and when they are converted to electric space conditioning.

This standard will ensure that buildings converted to electric space conditioning from other fuels will meet minimum energy-efficiency requirements. This standard may be adopted by state or local governments or by utilities where they are authorized to do so. Entities which choose not to adopt this standard should prepare an alternative plan that will result in savings which are comparable to the savings achievable through this model standard. Failure to implement this standard or achieve comparable savings will subject utilities to the surcharge provisions of this plan (see Method for Calculating Surcharges, Appendix D).

Actions

State governments, local governments, or utilities should:

7.1 By January 1, 1986, adopt and enforce the model efficiency standard described in Appendix J for conversion of commercial buildings to electric space conditioning; or

7.2 By January 1, 1986, adopt and enforce an alternative plan for achieving savings comparable to those that would be achieved through implementation of the model efficiency standard.

Appendix J is contained in Volume II, which is available on request. The standard shall be effective for all conversions for which the building permit is issued on or after January 1, 1986.

Bonneville Actions

Bonneville shall:

7.3 Develop a consistent procedure for certifying compliance with this model standard. This procedure shall be available on or before January 1, 1985, and shall be offered throughout the region.

7.4 Establish a procedure for evaluating alternative plans for achieving implementation of the Council's model efficiency standard for conversion to electric space conditioning. This procedure shall be available on or before January 1, 1985.

7.5 Develop and implement an education program regarding the provisions of this model standard for builders, architects, designers, real estate appraisers, code officials, and lending institutions. This program shall be available on or before January 1, 1985, and shall be offered throughout the region.

The program measures described in actions 7.3 and 7.5 shall be carried out in cooperation with state and local governments, utilities, trade and professional associations, and other interested parties.

Expected Cost and Savings of Electricity

The Council evaluated the potential for conversion to electric space conditioning of existing oil and gas heated and cooled commercial buildings. This assessment revealed that each conversion could cost the region in excess of $6,000 per average kilowatt of new resource requirements over the next twenty years. This standard is expected to reduce that cost by requiring cost-effective lighting, heating, ventilation and air conditioning, and water heating efficiency improvements prior to conversion to electric space conditioning. Total regional savings will vary depending upon how consumers respond to future oil and natural gas prices.

8. Commercial Sector— Demonstration Program

The Council's model conservation standard for new commercial buildings is a slightly modified version of the ASHRAE 90-80 model energy code. That code does not attempt to capture all savings of electricity that are possible below a cost of 4.0 cents per kilowatt-hour, nor even all those that are economically feasible for consumers. The Council is confident, based upon its studies, that additional savings can be achieved at prices that are cost-effective to Bonneville and economically feasible for consumers. This program is designed to acquire some of those savings and develop better information about actual levels of use of electricity and potential savings of electricity in commercial buildings. As the need for additional resources develops, the Council will be in a better position to forecast the conservation available in this area, and Bonneville will be in a position to accelerate its program to acquire more savings.

The objective of this program is to develop a conservation program or model standard for acquiring energy-efficiency improvements in commercial buildings beyond those required by the model conservation standards in Action 6.

This program shall include:

8A. Financial incentives payable to architect/engineers, developers, contractor/builders, and others who design and build commercial buildings that operate below a specified energy performance budget.

8B. Technical and financial assistance to local governments to adopt model conservation standards for new commercial buildings which exceed the Council's standards by providing technical and financial assistance in the development and implementation of such standards.

8C. Incentive payments, set at an amount up to the regional cost-effective limit of 4.0 cents per kilowatt-hour, for the value of savings in electricity achieved beyond those that would be realized at the energy performance budget specified below. These incentives shall be offered for all buildings that use electricity, regardless of the type of space conditioning system.

Bonneville Actions

Bonneville shall develop a demonstration program for acquiring commercial conservation savings beyond the savings that would be realized under the Council's model standard. Specifically, Bonneville shall:

8.1 Design and initiate a demonstration program which offers financial incentives to secure construction of a total of 30 buildings, from at least five different building categories. Incentives of 4.0 cents per kilowatt-hour on a levelized life-cycle cost basis shall be paid for every kilowatt-hour of savings which exceeds the Council's model conservation standard for new commercial buildings. Only those buildings that meet or exceed the following total energy budgets under normal operating conditions will be eligible for the incentive.

8.2 Develop data on the construction cost, actual and projected energy consumption, and features of very efficient commercial buildings constructed in climates similar to those found in the region.

Expected Cost and Savings of Electricity

Savings from this program are not currently included in the Council's resource portfolio. This plan calls for developing, by 1988, a conservation program or model standards for acquiring savings of electricity in new commercial buildings in excess of the Council's model standard. The Council anticipates that this program could produce a 30 percent improvement in commercial building efficiency over the Council's model standards, at a cost of below 4.0 cents per kilowatt-hour.

9. Industrial Sector

The great variety of industrial uses of electricity in the Northwest and the inaccessibility of certain proprietary information make it difficult to develop model conservation standards or a uniform conservation program for the industrial sector. The Council has concluded that the most effective way to acquire industrial conservation may be through the use of financial incentives.

For this program to work effectively, Bonneville must fund technical assistance for industrial consumers to help them identify their potential savings, and must provide consistent guidelines in its acquisition requests. When Bonneville acquires conservation from this sector, Bonneville should publish a notice of its requirements and solicit conservation proposals from Northwest industrial consumers. Bonneville can then evaluate the proposals and select those that offer the most cost-effective savings.

Bonneville does not currently offer an industrial conservation program. This program is designed to develop the Council's and Bonneville's understanding of the potential for conservation in the industrial sector and place Bonneville in a position to acquire industrial conservation when it is needed.

Bonneville's program for this sector shall include:

9A. Solicitation of industrial conservation projects either by Bonneville or through retail utilities. The solicitation document shall describe the characteristics of the conservation that is needed, state a maximum acquisition price, and contain other terms and conditions that would be necessary in preparing a proposal.

9B. Payments at a level that will achieve the expected electricity savings at the lowest possible cost to Bonneville ratepayers, up to the full cost of the conservation measures, if necessary. In no event shall the payment for any measures exceed the regional cost-effectiveness level of 4.0 cents per kilowatt-hour saved.

9C. Independent verification of efficiency improvements.

9D. Technical assistance for industrial customers who request it, for the purpose of identifying industrial conservation projects.

Bonneville Actions

Bonneville shall:

9.1 Develop a regionwide industrial conservation program which incorporates the features described above. This program shall achieve the following rate of acquisition:

- By September 30, 1985, acquire 15 megawatts.
- By September 30, 1988, acquire a total of 45 megawatts.

Council Actions

The Council will:

9.2 Conduct, in cooperation with the region's industrial customers, a detailed survey to identify industrial conservation potential above the 545 megawatts contained in the Council's resource assessment. This survey should identify conservation potential up to a cost of 5.0 cents per kilowatt-hour.

Expected Cost and Savings of Electricity

This program shall produce 45 megawatts of savings during the next five years. The Council estimates that the cost of these savings will not exceed 1.6 cents per kilowatt-hour. The marginal cost of individual conservation measures shall not exceed 4.0 cents per kilowatt-hour.

10. Irrigation Sector

Developing conservation programs for the irrigation sector presents problems similar to those in the industrial sector. There are a wide variety of irrigation techniques, soil conditions, crop requirements, and other conditions that make it difficult to impose model conservation standards or develop a uniform conservation program for this sector. The Council therefore proposes a conservation acquisition program similar to the one proposed for the industrial sector.

The objective of this program is to acquire efficiency improvements in the use of electricity on new and existing irrigated acreage. Bonneville's program for this sector shall include:

10A. Solicitation for irrigation conservation projects either by Bonneville or through retail utilities. The solicitation document shall describe the characteristics of the conservation that is needed, state a maximum acquisition price, and contain other terms and conditions that would be necessary in preparing a proposal.

10B. Support for technical assistance to irrigation consumers through such existing agencies as the Agricultural Extension Service.

10C. Payments at a level which will achieve the expected savings of electricity at the lowest possible cost to Bonneville ratepayers, up to the full cost of conservation measures, if necessary. In no event shall the payment for any measure exceed the regional cost-effectiveness level of 4.0 cents per kilowatt-hour.

10D. Financial assistance to lending institutions and other agencies which provide below-market-rate loans or other forms of financial assistance to customers for the purchase and installation of energy-efficient irrigation systems or for efficiency improvements to existing irrigation systems.

10E. A requirement, as a condition of participating in incentive programs, that irrigation systems installed on newly irrigated lands be designed to produce all savings in electricity that are cost-effective to the region. Incentive payments shall be made available to defray increased capital costs associated with such installations. Irrigators who decline to participate shall not be eligible for subsequent retrofit payments covering efficiency improvements that could have been effected when their systems were installed.

Bonneville Actions

Bonneville shall:

10.1 Develop a regionwide irrigation conservation program which incorporates the features described above. This program shall achieve the following rate of acquisition:

- By September 30, 1985, acquire 15 megawatts.
- By September 30, 1988, acquire a total of 35 megawatts.

10.2 Initiate a demonstration project which assesses the feasibility and cost-effectiveness of working through agricultural lending institutions and other agencies to facilitate irrigation sector conservation.

10.3 Initiate a request for commercial demonstrations of irrigation system efficiency improvements, including but not limited to flow meter development, deficit irrigation, low-energy precision application systems, irrigation scheduling, and advanced pump designs.

10.4 Initiate a demonstration project to identify technically sound and practically valid soil monitoring and irrigation scheduling programs.

10.5 Develop and implement programs, through government agencies, universities, and other existing institutions, to train irrigation specialists in soil moisture monitoring and irrigation scheduling.

10.6 Develop and implement education programs to demonstrate the potential for electricity and cost savings through soil moisture monitoring and improved irrigation application techniques and systems.

10.7 Initiate a market and technical assistance program to aid farmers and irrigation investment decisionmakers in making sound, cost-effective investment decisions on conservation equipment.

Expected Cost and Savings of Electricity

This program shall produce 35 megawatts of savings during the next five years. The Council estimates that the cost of these savings will not exceed 1.6 cents per kilowatt-hour. The marginal cost of individual conservation measures shall not exceed 4.0 cents per kilowatt-hour.

11. Power System Conservation

The power system offers a number of opportunities for conservation through improvements in the efficiency of generation, transmission, and distribution. Bonneville and the Corps have continuing programs in this area. The Council is unaware of any comprehensive study of potential system conservation, but current information on improvements to hydropower generation indicates that at least 270 megawatts of savings can be achieved. Coordination of existing programs and a study of other potential improvements could identify substantially greater amounts of low-cost conservation.

The objective of this program is to improve the region's capability to acquire cost-effective conservation through improvements in the efficiency of electric power generation, transmission, and distribution.

Bonneville Actions

Bonneville shall:

11.1 Continue existing programs to improve the efficiency of power transmission and distribution in the region. These programs shall be modified to the extent necessary to gather data which might be used to identify further efficiency improvements.

11.2 Design and conduct studies of potential improvements that could be made in the efficiency of power generation, transmission, and distribution at a cost of up to 5.0 cents per kilowatt-hour. These studies shall be coordinated with the U.S. Army Corps of Engineers, the Bureau of Reclamation, and generating utilities. A report on these studies shall be submitted to the Council by January 31, 1985, in order to be considered in the first scheduled review of this plan.

12. State and Local Government

Bonneville's current programs for state and local governments include a street and area lighting efficiency improvement program and an institutional buildings program. Bonneville also offers technical assistance to local governments and small power users, and financial assistance to general purpose local governments and Indian tribes.

The objective of this program is to assist state and local governments to identify and achieve cost-effective electric energy savings and resource development.

Bonneville Actions

Bonneville shall:

12.1 Develop and implement a program to reimburse state and local governments for the full incremental cost of adopting and enforcing all model conservation standards under this plan, so long as enforcement of the model conservation standards program as a whole is cost-effective. This program shall be in place and operating by January 1, 1985 and shall be offered throughout the region.

12.2 Develop and implement a region-wide acquisition program which purchases savings of electricity from state and local government buildings and facilities. Payments for savings from local government projects shall be made at levels that will achieve savings of 10 megawatts by September 30, 1985, up to the full cost of the conservation measures, if necessary. In no event shall the amount of financial assistance exceed the regional cost-effectiveness level of 4.0 cents per kilowatt-hour.

12.3 Allow state and local governments to receive direct payments from Bonneville for cost-effective conservation savings.

12.4 Provide technical and financial assistance to those jurisdictions and communities wishing to identify conservation and resource development projects.

12.5 Provide technical and financial assistance in the revision and adoption of land-use plans and zoning and subdivision ordinances which affect on-site energy use, solar access protection, solar orientation, and local permitting processes for energy developments.

12.6 Initiate an assessment of energy conservation and resource development potential in state and local government owned or operated buildings and facilities. This assessment should take advantage of information already gained from Bonneville's Institutional Buildings Program, Financial Assistance Program, and Local Government Technical Assistance Program. The assessment should be completed by January 1, 1985.

12.7 Support the development of mechanisms to help state and local governments, utilities, and the private sector cooperate in conservation and resource acquisitions and to share energy management information, technical expertise, and experience.

12.8 Provide for continuation of Bonneville's Institutional Buildings Program and Local Government Technical Assistance Program at program levels at least equivalent to those provided in 1982-1983.

12.9 Modify its existing Institutional Buildings Program to accommodate more readily the savings in electricity from improvements in water and wastewater treatment systems, and simplify the application process for simple improvements which can be justified without a comprehensive audit.

12.10 Expand regionwide programs which provide technical and financial assistance to state and local government entities to provide assistance in implementing elements of this plan.

12.11 Consult with state and local governments and local government associations regarding the most appropriate mechanisms to provide for implementation of model conservation standards, technical and financial assistance, and the development and acquisition of local government resources and conservation programs, including those which affect local government buildings and facilities.

12.12 Provide maximum flexibility and full opportunity for state and local governments in the implementation of this plan.

12.13 Terminate financial assistance for street and area lighting improvements during the current period of surplus. Street and area lighting improvements have a short expected lifetime. These improvements would contribute unneeded savings during the surplus but would not last long enough to offset later deficits.

Council Actions

The Council will:

12.14 Assemble information on the use of electricity in public buildings and facilities and incorporate that information into its analytical system.

12.15 Continue to examine the roles for state and local governments, Bonneville, and the region's utilities, in the implementation of the plan. Disputes regarding these roles may be brought to the Council for clarification of the Council's intention.

Expected Cost and Savings of Electricity

The savings produced through efficiency improvements in new and existing government buildings and facilities were developed in conjunction with the commercial sector programs and total 10 megawatts for the next two years. By September 30, 1988, a total of 15 megawatts shall be acquired from this sector, of which 2 megawatts are expected to be produced by water and wastewater system efficiency improvements. These savings are in addition to the commercial sector. The Council's twenty-year target for this sector will be developed following completion of the assessments called for above. The Council estimates that the average cost of these savings will not exceed 1.9 cents per kilowatt-hour. The marginal cost of individual conservation measures shall not exceed 4.0 cents per kilowatt-hour.

Other Programs

Resource and Other Program and Policy Options

This section outlines additional short- and long-term goals and objectives established by the Council. Contained in this section are Council decisions on renewable resources; marketing interruptible power in the region; sales of firm surplus energy in the Southwest; policies on cogenerated electricity, surcharges, and rate design; combustion turbines; methods for quantifying environmental costs and benefits; and a brief summary of additional Council actions during the next two years. This section lists specific actions to be taken by Bonneville and the Council over the next two years and beyond.

One of the central features of this plan is the ability to acquire an option on resources. The current surplus of electricity will provide the region with time to conduct a thorough analysis of the options concept. The analysis, in consultation with Bonneville, utilities, and resource developers, will seek to identify federal, state, and local laws and regulations and to resolve conflicts that could pose barriers to implementation of resource options.

13. Options

The options concept offers significant opportunity for dealing with planning uncertainty. Like a new technology, this new concept will require demonstration and development before it can be depended on to provide planning flexibility. The objective of this program is to work with state siting authorities and federal and state regulatory agencies to resolve institutional, regulatory, legal, and technical barriers to the options concept.

This effort will help to resolve issues about the efficacy of the options concept, including the extent of control over a resource Bonneville can reasonably expect under an option. To accomplish this, regulatory uncertainties under state and federal laws which may impede development or restrict the usefulness of options must be identified and resolved.

The objectives of this effort are:

13A. to better define the elements of and degree of regional control available through an options arrangement by monitoring development of actual hydropower options;

13B. to identify and resolve constraints to effectiveness of options (including limitations on effective "shelf-life" of resources on which options have been obtained) which result from federal and state agency regulation and under other statutes;

13C. to identify potential for effecting sales of resources outside the region to overcome the problem of limited resource shelf-life, and otherwise permit timely development of resources which might otherwise be lost to the region;

13D. to identify appropriate risk factors and uncertainties which prevent resource options from being considered "available;" and

13E. determine the appropriate size of the inventory of options to provide appropriate planning insurance.

Bonneville Actions

Bonneville shall:

13.1 Enter into a comprehensive process of cooperation with the four Northwest states in order to exchange information on energy resource and energy facility siting. The purpose of this arrangement will be to coordinate information about projected regional energy needs and the types of resources that will satisfy those needs. This exchange will lead to consistent federal and state policies regarding projected resource acquisitions with due deference to state siting constraints and considerations.

13.2 Create a state options task force with representatives of the four states (and in particular, any state siting authority), Bonneville customers, public interest groups, and the Council. The purpose of this task force will be to develop provisions for options in each state. For example, the State of Oregon Siting Council has proposed a method of banking sites for regional resources within the State of Oregon. Although a great many questions remain to be resolved, this proposal provides a significant step toward the successful coordination of an options process in the region such that the authority of the state Siting Council is fully recognized while providing the region with a reliable plan for meeting its needs for resources through the options concept.

13.3 Identify, by project, specific resources which may be lost to the region if decisions to acquire an option or to acquire the resources are not made. This inventory should recognize each resource sponsor's requirements for keeping the resource available to the region.

13.4 Explore opportunities for marketing power and for removal of constraints to marketing power outside the region which could facilitate development of some resources.

Council Actions

The Council will:

13.5 Establish a task force composed of representatives of the Council, Bonneville, utilities, and other interested parties to identify for each resource type: (1) each significant potential federal and state regulatory impediment to success of the options program; and (2) proposed means of resolving that uncertainty through informal understandings with the affected agencies, amendments to statutes or regulations, or other means.

13.6 Adopt criteria for determining when resources under options are sufficiently firm to be counted as "available" within the meaning of the Act.

13.7 Determine, with the assistance of other analyses to be conducted as part of this two-year plan: (1) the optimum size of the options inventory to permit development of an adequate supply of available resources; and (2) the appropriate timing for concluding option agreements to permit adequate flexibility in the preconstruction process.

13.8 Develop alternative planning approaches if options prove to be unworkable. These approaches would have to reexamine the appropriateness of planning to a high demand forecast. Other methods of obtaining resource flexibility and shorter lead times will also be explored.

14. Hydropower

The objective of this program is to test the options concept by pursuing options for future hydropower development. The Council has concluded that hydropower is an important resource in this plan. In the high growth forecast up to 920 megawatts of hydropower would be needed and appear to be available at less than 4.0 cents per kilowatt-hour. The Council recognizes that modifications to regulatory processes may have to be made before hydropower can be treated as an option in the Council's planning strategy. Further, there is unresolved concern regarding the effects of hydropower development on fish and wildlife in the region. The Council's two-year actions address these concerns.

During this two-year action plan, Bonneville shall acquire an option on each of the following listed facilities only after a finding has been made that the construction and operation of each facility will have an insignificant adverse effect on fish and wildlife population and on habitat.

Such a finding may be made only after consultation among representatives of Bonneville, the U.S. Army Corps of Engineers, the Bureau of Reclamation, the Council, state and federal fish and wildlife agencies, Indian tribes, the region's utilities, and interested non-utility sponsors.

Bonneville Action

Bonneville shall:

14.1 Acquire options on the following six categories of hydropower facilities:

1. An existing dam, currently not generating electricity, with a capacity greater than 15 megawatts.
2. An existing dam, currently not generating electricity, with a capacity of between 5 and 15 megawatts.
3. A new facility with a capacity greater than 25 megawatts.
4. A new facility with a capacity between 10 and 15 megawatts.
5. A new facility with a capacity less than 10 megawatts.
6. A new facility with an exemption from the FERC licensing process.

In acquiring options on hydropower sites, Bonneville shall adhere to the provisions of Appendix E.

Council Actions

The Council will:

14.2 Design a study to identify and rank potential hydropower sites in the region. This study will include representatives from Bonneville, the U.S. Army Corps of Engineers, the Bureau of Reclamation, the

Council, state and federal fish and wildlife agencies, affected Indian tribes, the region's utilities, and interested non-utility resource sponsors. The organization of the study, specific tasks necessary to meet the study objectives and the funding sources will be determined after the adoption of the plan and in consultation with all of the parties identified above.

Potential hydropower sites will be ranked based on fish and wildlife concerns.

Category I. Sites at which the construction and operation of hydropower facilities will have insignificant adverse effects on fish and wildlife population and habitat.

Category II. Sites at which the construction and operation of hydropower facilities will have significant adverse effects on fish and wildlife populations and habitat, but may be reduced to an insignificant level by development and implementation of proven mitigation techniques.

Category III. Sites at which the construction and operation of hydropower facilities will have significant adverse effects on fish and wildlife populations and habitat which cannot be reduced satisfactorily because of the critical nature of the habitat or populations affected, the lack of proven mitigation techniques, expense and delay, or any other reason.

The study should be based on existing data, studies, and literature to the extent these are sufficient. The emphasis of the study should be to first identify sites within Categories I or II in order to facilitate early commitment to those sites.

The term 'sites' has been used in a broad sense to cover both specific sites and stream reaches. Although the comprehensive study might take two years or more, a progress report will be made to the Council on specific sites currently in the FERC licensing process by January 1985. This information will be used in the next revision of this plan, scheduled for adoption in November, 1985. This study shall be coordinated with other studies being done under the Council's fish and wildlife program and with the Council's efforts to refine current hydropower data bases.

14.3 Continue in its efforts to refine the data base on existing and potential hydropower sites that are environmentally sound and cost-effective. The Council will coordinate this effort closely with the hydropower ranking study discussed above.

15. Market Interruptible Energy in the Northwest

The objective of this program is to develop additional markets for interruptible energy in the Northwest. The effort to develop additional means of retaining the economic benefits of low-cost non-firm energy in the region is the most important energy-related economic issue over which the region has control, and it should be treated accordingly.

Bonneville Actions

Bonneville shall:

15.1 Initiate a policy to develop, to the fullest extent possible, regional markets for non-firm energy including industrial, commercial, and irrigation markets.

15.2 Set an initial goal of 900 to 1,400 megawatts of potential interruptible load in the industrial sector and conduct further investigations to determine whether more potential is available.

Council Action

The Council will:

15.3 Study whether the region should develop Northwest markets for conversion of existing firm loads to interruptible status. Such loads might include the second quartile of DSI power, some industrial loads of utilities, and certain irrigation loads. Bonneville could purchase the right to interrupt the load during a particular low-water event. In the case of irrigation loads, farmers could decide to use cheaper interruptible power to serve a portion of their existing firm loads. The interruptibility would be gained solely through voluntary contractual arrangements between Bonneville and the customer or utility and would not be a condition of service for any customer. This study will be done in consultation with Bonneville.

16. Sale of Firm Surplus Energy to the Southwest

Bonneville and other regional utilities are engaged in an effort to market the current firm surplus to the Southwest. The Council supports these efforts. The proposed sale of the region's firm surplus is entirely consistent with efforts to market interruptible energy within the region. Neither effort is a substitute for the other.

Council Action

The Council will:

16.1 Open discussions with the California Energy Commission regarding a sale of firm surplus power. The Council intends to consult with Northwest utilities and Bonneville as part of this process. The Council recognizes the potential benefits to both Northwest and Southwest and is prepared to use its regional power planning authority to encourage a sales agreement that benefits both regions.

17. Geothermal

The Council has concluded that a large geothermal potential exists in the region for both electric generation and direct applications that decrease the need for electricity. (Direct applications of geothermal and other renewable resources are considered in chapter 7, Conservation.) However, the precise size, characteristics, and technical potential of the geothermal resouces has not been determined. The objective of this program is to encourage confirmation of the region's geothermal resource for electric generation so it can be developed quickly when the need exists. The following actions are expected to provide a base for including geothermal resources in future plans.

Bonneville Action

Bonneville shall:

17.1 Develop and implement a geothermal demonstration program that guarantees the purchase of electricity from the first 10 average megawatts generated at the most promising environmentally acceptable geothermal site available in the region. The site should be estimated to be able to produce at a capacity of 100 megawatts or more over a 30-year period. There should be a clear agreement that if the field is developed it would be available to the region at competitive prices. The fixed purchase price should be tied to the cost to Bonneville of the energy from a new coal plant. Recognizing the demonstration nature of this venture, Bonneville should be prepared to pay a price up to 50 percent higher than the cost of energy from a new coal plant at the time of acquisition. If this program proves workable, and as need dictates, the Council will consider expanding this program to other promising sites in the region.

18. Wind

The objective of this program is to continue to assess the potential of wind resources, without investing in additional wind generation, so that this resource can be included in the plan when it becomes cost-effective. The action item listed below should not affect Bonneville's current efforts related to the wind resource assessment and development.

Bonneville Action

Bonneville shall:

18.1 Conduct a study of the cost and expected operating efficiency of wind generators using existing and potential wind demonstration projects. The Council is interested in determining the feasibility and cost-effectiveness of including 50 average megawatts in the next revision of the plan. The Council will be assisted in making this determination through the continued efforts of Bonneville in collecting and assessing data from existing demonstration projects. Bonneville's proposed feasibility studies of wind generators on the region's coast will also assist the Council in making this determination.

19. Combustion Turbines

The objective of this program is to study potential obstacles to the construction and operation of combustion turbines and to develop methods for overcoming those obstacles. Although the Power Plant and Industrial Fuel Use Act generally prohibits use of oil and natural gas in new power plants, it does provide for specific types of exemptions. Preliminary Council research suggests that one or more of these exemptions may be available for combustion turbines that are needed to meet unanticipated load growth and operate to "firm" hydropower. The most likely exemptions are those for:

- Peak loading;
- Cogeneration;
- Maintaining reliability of service;
- Lack of an alternate fuel at a cost not substantially exceeding that of imported oil; and
- Fuel mixtures involving alternate fuels.

State siting requirements present other potential regulatory hurdles that need to be investigated. Combustion turbines may need to be sited close to existing gas or oil pipelines, for example. Also, the Council needs to know how much energy existing combustion turbines can provide. The following actions will assist the Council in planning to use combustion turbines as a hedge against unexpected demand growth in the higher growth forecasts.

Bonneville Action

Bonneville shall:

19.1 Acquire an existing natural gas combustion turbine and petition the U.S. Department of Energy for an exemption under the provisions of the Fuel Use Act to allow use of the combustion turbine as described in chapter 5.

Council Actions

The Council will:

19.2 Study the likelihood of obtaining further exemptions under the Fuel Use Act for combustion turbines used pursuant to the Council's resource portfolio. If necessary, the Council may request from the Department of Energy formal interpretations of the exemptions as they would apply to specific combustion turbine proposals.

19.3 Study regulatory requirements, including state siting standards, that would apply to new combustion turbines.

19.4 Study the potential contribution of existing combustion turbines and evaluate the effect of the Fuel Use Act on their use.

19.5 Study the cost-effectiveness of combustion turbines as a resource for making use of the non-firm energy from the hydropower system.

19.6 Study and evaluate the impact of Bonneville's forthcoming displacement policy on the operation of combustion turbines and service to meet top quartile loads of the Direct Service Industries.

Based on the results of these studies, the Council will re-evaluate the role of combustion turbines in the resource portfolio and make changes as necessary in future revisions of the plan.

20. Cogeneration

The cogeneration included in the high growth forecast is not needed to serve regional loads until 1993. Nevertheless, the Council recognized the potential contribution of cogeneration to the region's power system and has decided that early actions by Bonneville are necessary to preserve the option of cogeneration in the mid-1990's. The objective of this program is to preserve cogeneration opportunities that are available before they are needed in the region.

The Council recognizes that the Federal Power Act and the Public Utility Regulatory Policies Act affects much of the development of cogeneration in the Northwest. The Council will work with appropriate agencies, Bonneville, utilities, and resource developers to coordinate activities under those statutes with the provisions of this plan.

Bonneville Actions

Bonneville shall:

20.1 Assist potential cogenerators in obtaining access to tielines which will enable them to market cogenerated electricity not currently needed by the region. Once tieline access is obtained, Bonneville should find ways to use the region's non-firm energy to displace cogenerated power. When non-firm energy is being sold for less than the cogenerator's variable operating cost, the cogenerator could substitute this energy for cogenerated power for sale to the tieline. The lower cost to the cogenerator could be reflected in a shared-savings price to the purchaser. Appropriate call-back provisions should be made by the cogenerator so that the region has access to the power when needed.

20.2 Assist potential cogenerators in their efforts to market cogenerated electricity in the region.

20.3 Develop a program for acquiring options that will assist potential cogenerators, when making regular scheduled plant modifications, to make appropriate investments that will permit addition of generating equipment at a later date. (An example would be replacing a worn-out low-pressure boiler with a high-pressure boiler.) This program should be ready to be implemented by the next revision of this plan.

21. Solar Generation and Advanced Thermal Technologies

New technologies will emerge that are not currently being counted on to provide firm energy. The region should be alert to any potential for new, cost-effective resources. The Council recommends that Bonneville keep abreast of emerging technologies, specifically solar. The Council and Bonneville should follow closely the solar demonstration projects that are currently underway in California.

Bonneville Action

Bonneville shall:

21.1 Work to improve the data base on solar insolation in the Northwest both on a broad basis and at specific promising sites.

22. Biomass

The objective of this program is to continue the Pacific Northwest Regional Bioconversion Program as presently administered by Bonneville to better develop data depicting the industrial and residential end use of biomass.

Bonneville Action

Bonneville, in consultation with the Council and the Pacific Northwest Bioconversion Policy Group, shall:

22.1 Continue the Pacific Northwest Regional Bioconversion Program as it is now described and funded by the U.S. Department of Energy.

23. Large Thermal Plants

Large thermal plants require from 10 to 15 years of lead time before they can produce power. Partly for this reason and because of the related risks inherent in beginning a long-lead-time plant, the Council has not included large thermal plants in the twenty-year plan except in the medium-high and high growth forecasts in the late 1990's. Should the Council's conservation programs not achieve the expected penetration or should the Council's options concept prove not to be effective, the region may have to rely on large coal and nuclear plants in the future. To prepare the region for this possibility, Bonneville, in cooperation with regional utilities, must undertake studies of methods to decrease the construction time of large thermal plants.

Council Action

The Council will:

23.1 Conduct a study, in cooperation with Bonneville, the region's public and private utilities, EPRI, representatives from architectural and engineering firms, and equipment manufacturers, to determine whether and how the planning and construction schedules of large thermal plants can be reduced.

24. Method for Determining Environmental Costs and Benefits

The Act requires that this plan include, "in such detail as the Council determines to be appropriate," a method for determining quantifiable (measurable) environmental costs and benefits. Those costs and benefits will then be used to determine the cost-effectiveness of various resources. Environmental costs and benefits that cannot be measured must be identified and given due consideration. The Council's method for determining quantifiable environmental costs and benefits is contained in Appendix C.

Bonneville Actions

Bonneville shall:

24.1 Prepare to implement the Council's method and be prepared to make full use of it for any contemplated resource acquisition.

24.2 Continue efforts to identify and create data bases and undertake studies that contribute to a better understanding of environmental costs and benefits and the techniques which may be used to evaluate them. Efforts should be aimed at improving the utility of the method as a planning tool and as a tool for evaluating specific resources. The method and the results of any studies should be used to evaluate any resource Bonneville proposes to acquire.

25. Method for Calculating Surcharges

The Act requires the Council to provide a method in the plan which the Administrator shall use in imposing surcharges. The Council's method for calculating surcharges is presented in Appendix D.

The Council recommends surcharges for the following model conservation standards:

- Model Standards for new residential buildings, Action 2;
- Model Standards for new non-residential buildings, Action 3;
- Model Standards for conversion to electric space heat in residential buildings, Action 6; and
- Model Standards for conversion to electric space conditioning in non-residential buildings, Action 7.

Surcharges must be calculated in accordance with the method provided in Appendix D.

The conservation standards must be adopted and enforced by January 1, 1986. Thereafter, utilities will be expected to achieve the energy savings obtainable through these standards or to demonstrate, through adoption of other conservation measures (including rate design), that equivalent savings have been accomplished.

Additional Council Actions During Next Two Years

It is important that the Council be kept aware of how this plan is being implemented and how the region's energy future is unfolding. Without this process the Council would be unable to respond to changing conditions.

The Council has developed a program to monitor implementation of the plan and to evaluate the plan's continuing suitability for the region's energy future. With this information, the Council can take corrective actions quickly.

Significant improvements to the region's energy planning capability have been accomplished over the last two years through the use of models developed by the region's utilities and the Council. It is prudent for the Council to improve energy planning skills, methods, and models so that the Council's planning activities are of the highest possible quality. The Council has identified special studies, enhancements to existing models, and the development of newer, more comprehensive energy planning techniques centered around the growth forecasting model, the system analysis model, and the strategic planning model.

The Council will continue to seek active public involvement in all these activites.

During the next two years, Council activities will occur in the following areas:

26. Monitoring

A major objective of the Council in developing the plan was to deal effectively with the obvious uncertainties facing the region. As a result, the plan is much more than just a document to be placed on a shelf; it establishes a continuing and adaptive process. Therefore, a crucial Council function will be to monitor any changes in the conditions and assumptions on which the plan depends, and Bonneville's implementation of the plan. This is important for two reasons: (1) to ensure that Bonneville's actions reflect the intent of the plan; and (2) to ensure that implementation of the plan is adaptive to changing circumstances and new information, while still adhering to the basic principles and objectives of the plan. A more detailed summary of the Council's program to monitor and evaluate progress is presented in Appendix A.

27. Demand Forecasting

27.1 *Coordination of Load Forecasting Activities*. The Council will continue to work toward a goal of coordinated demand forecasting activities among Bonneville, PNUCC, the Council, and other involved parties. There are significant opportunities for agreement on models, data, and basic assumptions, thereby eliminating unnecessary duplication of effort and achieving a common basis of understanding. The cooperative efforts in developing the demand models and forecasts for the plan were an excellent start toward this goal.

27.2 *Economic Forecasting Model*. The method by which forecasts of economic and demographic data are developed should be improved. The current model is not capable of capturing the complex interaction between industries within the region, between economic and population changes, and between regional and national economic changes. Bonneville has contracted to develop a regional economic model which would incorporate these interactions. The Council will monitor progress on model development so that this model can be used to develop Council forecasts in the future.

27.3 *Industrial and Irrigation Forecasting Model*. The Council will improve demand forecasting models in the irrigation and industrial forecasting sectors.

27.4 *Demand Model Validation*. An important area for the Council is the continued testing and evaluation of the demand models based on the latest demand data and conservation experience in the region. Such testing of the models will lead to the identification of areas where the models can be improved or the underlying data can be refined. In addition to models used for the plan, an alternative residential demand model will be evaluated which was developed by the Council.

27.5 *Short-Term Forecasting*. Although the Council's forecasting and planning activities are primarily concerned with the long-term forecasts, monitoring of the plan requires an understanding of short-term developments that affect the long-term forecasts used in the plan. The Council will become involved in the short-term forecasting activities of Bonneville, PNUCC, and others in the region and will integrate those activities into the monitoring of the plan. If necessary, the Council will develop its own short-term analysis capability to supplement the available information and to ensure an adequate monitoring program. The Council's goal is to have maximum involvement of interested parties, and to ensure coordination of short-term forecasting activities in the region as they relate to the monitoring activity.

27.6 *Residential Electricity Use Survey Data*. Bonneville has been developing plans for a new survey of residential use of electricity. This would be a follow-up on the survey that forms much of the data base for the Council's residential demand models. The Council has been participating actively in Bonneville's survey planning and expects to continue such consultation. New data, when available, will be used to update and refine the residential models and to reassess conservation actions that have taken place since the previous survey in 1979.

28. Conservation and Resources

28.1 *Conservation and Resources Data Development*. On a continuing basis, the Council will seek additional and better information related to all resources in the Council's data base. In the near future, this effort will concentrate on improving the quality of the Council's hydropower data.

In FY84 and FY85, a broad effort will be made to improve the Council's data base. Attention will be focused on specific resources as required. Emerging technologies such as wind, solar, and geothermal will be closely monitored.

29. System Reliability and Rates

29.1 ***Decision Analysis Model.*** The concept of risk analysis is a key element in the Council's planning philosophy. Decisions on resource mix, value of shorter resource lead times, appropriate levels of resource options, and the timing of options and resource acquisitions are all affected by the complex interaction of uncertain variables. While the planning models used by the staff in development of the plan are excellent tools for some purposes, they fall short in the area of risk analysis. This is due primarily to the inability of the model to adjust resource decisions internally as events unfold. The Council recognizes the need for, and will develop, a tool which provides the ability to rapidly examine the results of resource and option strategies applied during the planning period.

29.2 ***System Analysis Model Enhancement.*** While the system analysis model played an important role in development of the plan, it is still a very new tool and will continue to evolve to meet the needs of users. The Council expects to continue to play both an advisory and an active role in further model development.

30. Special Studies

During the process of developing this plan, the Council discussed in public meetings a series of issue papers and decision memos on specific issues of importance. This process has been particularly effective in stimulating public involvement in the Council's energy planning, and will continue throughout the next two years.

30.1 ***Conditions for Resource Acquisition Other than Hydropower.*** Appendix E of this plan lays out certain provisions that Bonneville must adhere to when acquiring hydropower resources. These provisions are included to protect fish and wildlife from adverse impacts. During the next two years, the Council will conduct a study to evaluate criteria for the acquisition of thermal plants.

30.2 ***Billing Credits.*** Bonneville is developing a billing credits policy which will be released after this plan is adopted. The Council will analyze the policy for conformance to the plan. Based upon that analysis, the Council may recommend modifications of the policy. The Council will continue to monitor and evaluate applications for billing credits to determine their effect upon the plan.

30.3 ***WPPSS Schedule and Costs.*** The plan assumes that the WPPSS No. 1, 2, and 3 plants will be completed on schedule and within current budget estimates and will contribute a large amount of power to the region's power supply. Changes from those assumptions could alter considerably the region's energy picture and necessitate modifications to the Council's plan. The Council will closely monitor the construction schedules and costs of all WPPSS plants, so that the region has early warning of potential problems.

30.4 ***DSI Loads.*** Recent changes in the world aluminum market and in Bonneville rates to Direct Service Industries (DSIs) have raised the question of the outlook for continued production by the aluminum industry and other DSI customers in the region. Because the DSIs account for a large segment of electrical loads and Bonneville revenues, it is important for the Council to keep abreast of change in the outlook for their future. The Council will review studies prepared by Bonneville, consultants, the DSIs, and other interested parties.

30.5 ***Rate Design Studies.*** The Council plans on studying alternative rate designs further to determine the potential for increasing the conservation penetration rates and maintaining actual conservation savings. These studies will be done in consultation with state public utility commissions, Bonneville, and public and private utilities in the region.

30.6 ***Additional Hydropower Flexibility.*** Current practice limits hydropower system flexibility to the amount of fall and winter drawdown that can be carried by the one-year critical streamflow level. The Council will explore the circumstances under which additional drawdown might be economically feasible.

30.7 ***Interruptible Power Markets.*** In a preliminary finding, the Council estimated a potential interruptible industrial electric boiler market of 900 to 1400 megawatts. The primary focus on this market study was the forest products industry. Because of the high expected availability of non-firm energy during the spring runoff, potential for serving additional, interruptible Northwest industrial loads exists. An additional, more detailed, study will be done by the Council.

30.8 ***Reserves and Reliability Analysis.*** The Council will continue to study the operating reliability of the region's power system, placing emphasis on the most cost-effective method of providing power system reserves. The Council will expand this analysis to include the peak energy needs of the system by using a new version of the system analysis model that simulates the hourly power requirements of the regional system.

31. Public Information and Involvement

The Council will continue its commitment to an active public involvement and information program. The Council believes that, for the plan to be implemented effectively, the public, state and federal agencies, Indian tribes, state and local governments, utilities, and other interested parties must be active participants. In addition, the Council will undertake consumer education programs on energy conservation and will develop a process for active public participation in revisions to the plan. These activities are further described in Appendix A.

"[the plan] may be amended from time to time, and shall be reviewed by the Council not less frequently than once every five years"

Chapter 11 Plan Revisions and Consistency Determinations

The Northwest Power Act recognizes the need for this plan to be flexible and adaptable to changing conditions. Section 4(d)(1) of the Act provides that "[t]he adopted plan, or any portion thereof, may be amended from time to time, and shall be reviewed by the Council no less frequently than once every five years." Section 4(i) of the Act further provides that:

> "The Council may from time to time review the actions of the Administrator pursuant to sections 4 and 6 of this Act to determine whether such actions are consistent with the plan and programs, the extent to which the plan and programs is [sic] being implemented, and to assist the Council in preparing amendments to the plan and programs."

Biennial Revisions

Recognizing that uncertainties and changing conditions will require frequent review of the plan, the Council has decided to review the plan formally every two years. During the first two-year period, the assumptions, forecasts, forecasting models, and resource selection tools used to develop this plan will be reviewed and improved as better data become available. Other recognized forecasting models will be examined in greater detail. Data collection activities will be undertaken to improve the data available to the Council and other regional organizations. Bonneville, utilities, state and local governments, and other interested groups and individuals will be consulted from time to time to gather and verify information. Forecasting and planning models will be revised to better reflect the conditions existing in the region, and implementation of the programs in this plan will be monitored.

On or before July 1, 1985, the Council will propose a revision of this plan. The revised plan will be made available for public comment, and hearings will be held in accordance with the requirements of the Act and such procedures as the Council may announce when the revised plan is proposed. As required by the Act, prior to developing the revised plan the Council will request fish and wildlife recommendations from the federal and state fish and wildlife agencies, the region's appropriate Indian tribes, and others. The revised power plan and fish and wildlife program will be adopted by December 15, 1985. Subsequent biennial revisions will be scheduled to coordinate with Bonneville's rate case and budget processes, to the extent practical.

The two-year planning cycle was adopted to allow the Council enough time to conduct detailed research yet respond to changing conditions. One year was considered too short to allow the Council to conduct the research needed to develop useful information and tools, to make the revisions to the plan, and to conduct the necessary public participation programs. On the other hand, a significantly longer period would not allow the Council to respond to the region's changing electric energy needs.

Interim Revisions

The Council may revise this plan on its own motion at any time. If proposed revisions are substantial and non-technical, within the meaning of section 4(d)(1) of the Act, the Council will make the revisions available for public comment; will consult with Bonneville, utilities, state and local governments, and other interested persons in the region; and will hold public hearings as required under the Northwest Power Act. The Council will request fish and wildlife recommendations regarding any major revision of this energy plan from the federal and state fish and wildlife agencies, appropriate Indian tribes, and others. The Council will publish its procedures at the time the revisions are proposed.

Council Review of Major Resource Proposals

Pursuant to section 6(c) of the Act, the Council will review each proposal by Bonneville to acquire a major resource. This review will include all proposals to acquire major resources, to implement major conservation measures, to pay or reimburse investigation and preconstruction expenses of major resources, or to grant billing credits or services for major resources. For each such proposal, Bonneville must provide the Council with a complete copy of the proposal and a written decision including Bonneville's determination regarding consistency with this plan. The Council may then determine by majority vote whether the proposal is consistent with this plan. Bonneville may not implement any major resource acquisition proposal if the Council finds the proposal inconsistent with this plan, unless Bonneville further finds that the resource is needed to meet its obligations and Bonneville obtains Congressional approval for that resource acquisition.

For purposes of section 6(c) of the Act, a major resource is any resource that:

- Has a planned capability greater than 50 average megawatts; and
- If acquired by the Administrator, is acquired for a period of more than five years. Such term does not include any resource acquired pursuant to section 11(b)(6) of the Federal Columbia River Transmission System Act. [Act, section 3(12).]

Council Request for Action

Section 4(j) of the Act authorizes the Council to request Bonneville to take an action under section 6 of the Act (regarding the acquisition of conservation and other resources) to carry out Bonneville's responsibilities under this plan. To the greatest extent practicable within 90 days after the Council's request, Bonneville must respond to the Council in writing specifying how Bonneville will take the requested action or any modification thereof or why such action would be inconsistent with this plan or with Bonneville's legal obligations under the Act or other law. If Bonneville decides not to take the requested action, the Council may, within 60 days after Bonneville's response, request Bonneville to hold an informal hearing and to make a final decision.

Fish and Wildlife Program Revisions

Section 4(h)(2) of the Act requires that the Council request fish and wildlife program recommendations from the federal and state fish and wildlife agencies, the region's appropriate Indian tribes, and others prior to any review or major revision of this plan. Section 1404(b)(1) of the fish and wildlife program states that the Council will accept recommendations for program amendments on November 15, 1983, and on November 15 every two years thereafter. Amendments must be adopted within one year after the deadline for submitting recommendations. The Council may also amend the fish and wildlife program on its own motion at any time, following the procedures prescribed in the Act and other applicable laws.

In order to coordinate the timing of the fish and wildlife program amendments with the revisions to this plan, the Council has amended Section 1404(b)(1) of the fish and wildlife program to accept recommendations for program amendments on November 15, 1983, December 15, 1984, and on December 15 every two years thereafter. The Council does not anticipate revising the power portion of this plan in conjunction with the November 15, 1983 fish and wildlife program amendment process.

To coordinate formal revisions of the fish and wildlife program and this plan, the following schedules will apply:

Deadline for Fish and Wildlife Recommendations	Revision of Fish and Wildlife Program	Revision of Energy Plan
November 15, 1983	November 15, 1983	None
December 15, 1984	December 15, 1985	December 15, 1985
December 15, 1986	December 15, 1987	December 15, 1987

Draft revisions of the fish and wildlife program and power plan will be distributed for public comment on or before July 1 of the year shown for revisions. Subsequent biennial revisions will be coordinated in a similar fashion.

available technology
The range of efficiency choices for electrical appliances or other equipment that are currently known technologies and are expected to be generally available in the marketplace at some time during the twenty-year planning period.

average cost pricing
A concept used in pricing of electricity. The average cost price is derived by dividing the total cost of production by the total number of units sold in the same period to obtain an average unit cost. This unit cost is then directly applied as a price.

average megawatt
A unit of energy output over a specified time period. It is equivalent to the total energy in megawatt-hours divided by 8,760 (the number of hours in a year.)

baghouse
An air pollution control device which uses a series of fabric bags to trap particles.

base load
The minimum load in a power system over a given period of time. Base load resources run continually except for maintenance and scheduled or unscheduled outages.

billing credit
Under the Northwest Power Act, a payment by Bonneville to a customer (in cash or offsets against billings) for actions taken by that customer to reduce Bonneville's obligations to acquire new resources.

"Blue Book"
See PNUCC "Blue Book."

Bonneville Power Administration (Bonneville)
A federal agency that markets the power produced at all federal hydropower dams in the Columbia River Basin. Bonneville sells power to public and private utilities, Direct Service Industrial customers, and various public agencies. The Northwest Power Act charges Bonneville with other duties including pursuing conservation, acquiring sufficient resources to meet its contract obligations, and implementing the Council's plan.

Btu (British thermal unit)
The amount of heat energy necessary to raise the temperature of one pound of water one degree Fahrenheit (3,412 BTUs are equal to one kilowatt-hour).

Buy-back
A conservation program that, in effect, purchases electric energy in the form of conservation measures installed by a consumer. The consumer is paid a certain amount per kilowatt-hour of energy saved.

capacity
Maximum power output, expressed in kilowatts or megawatts. In terms of transmission lines, this refers to the maximum load a line is capable of carrying.

call-back
A power sale contract provision that gives the seller the right to stop delivery of power to the buyer when needed to meet other specified obligations of the seller.

cogeneration
(1) The recovery of excess or "waste" energy created by various industrial and commercial applications to produce electricity; (2) the simultaneous production of electricity and other useful energy from a fuel source.

combined cycle
The combination of a steam turbine and a gas turbine in an electric generation plant. The waste heat from the first turbine cycle provides the heat energy for the second turbine cycle.

conservation
According to the Northwest Power Act, any reduction in electric power consumption as a result of increases in the efficiency of energy use, production, or distribution.

curtailment
An externally imposed reduction of energy consumption. Does not include response to price.

cyclone
An air pollution control device using gravity to remove large particles.

Direct Application Renewable Resource
The use of solar, wind, water, geothermal, or other similar sources of energy to directly reduce the electric power requirements of a consumer.

drawdown
Release of water from a reservoir for purposes of power generation, flood control, irrigation, or other water management activity.

electricity intensity
The level of electric use relative to some measure of size or activity for a specific sector of the economy. For example, consumption of electricity per household or use of electricity per employee.

electrostatic precipitator
An air pollution control device using an electric charge to remove particles from power plant stack emissions.

energy
That which does, or is capable of doing, work. Energy is measured in terms of the work it is capable of doing. Electric energy is commonly measured in kilowatt-hours.

Average annual energy is the total kilowatt-hours generated divided by the number of hours in one year. The Northwest "Power Year" extends from July through June.

equivalent availability
The ratio of the maximum amount of energy a generating unit can produce, after adjustment for maintenance and forced outage, to the capabity of the unit. It also represents an upper limit for a long-run (annual or longer) capacity factor for a generating unit. For example, a unit with an equivalent availability of 70 percent and a capacity of 500 megawatts could be relied on to produce 350 average megawatts of energy over the long term, if required.

Federal Energy Regulatory Commission (FERC)
A federal agency which regulates interstate aspects of electric power and natural gas industries. It has jurisdiction over the licensing of hydropower projects and the setting of some rates. The FERC was formerly the Federal Power Commission.

firm energy
Electric energy which is considered assured to the customers to meet all agreed upon portions of the customers' load requirements over a defined period.

firm surplus
An excess amount of firm energy for which there is no market in the region at any established rate.

forecast
An estimate of the level of energy that is likely to be needed at some time in the future.

generation
The act or process of producing electricity from other forms of energy. Also, the amount of energy so produced.

geothermal
Useful energy derived from hot rock, hot water, or steam in the earth's surface.

hydroelectric power (hydropower)
The generation of electricity using falling water to turn turbo-electric generators. In addition to providing energy, this type of generation is well suited to providing peak load power, due to the relative ease of changing the amount of power output.

incremental system cost
In the plan, this term refers to any additional cost to the region's ratepayers.

infiltration control
Conservation measures, such as caulking and weatherstripping, which are taken to reduce the amount of cold air entering or warm air escaping from a building through cracks around doors and windows and poorly sealed vent dampers.

Intercompany Pool (ICP)
An organization formed to coordinate the power operations of the investor-owned utilities of the Pacific Northwest. The ICP includes Portland General Electric, Pacific Power and Light, Puget Sound Power and Light, Washington Water Power, Montana Power Company, Idaho Power Company, Utah Power and Light, and Sierra Pacific Power Company.

interruptible power
Power that, by contract, can be interrupted in the event of a power deficiency.

intertie
A transmission line or system of lines permitting a flow of energy between major power systems.

kilowatt (kW)
The electrical unit of power which equals 1,000 watts.

kilowatt-hour (kWh)
A basic unit of electrical energy which equals one kilowatt of power applied for one hour.

leach
To be dissolved and washed out by percolating water.

level ditching
The construction of ditches around a reservoir so that when the reservoir's water level is lowered, some water remains to preserve wildlife habitat.

levelized cost
The present value of a resource's cost (including capital, interest, and operating costs) converted into a stream of equal annual payments and divided by annual kilowatt-hours saved or produced. For example, the amount borrowed from a bank is the present value of buying a house; the mortgage payment including interest on a house is the levelized cost of that house.

load
The amount of electric power required at a given point on a system.

major resource
According to the Northwest Power Act, a resource with a planned capability greater than 50 average megawatts, and if acquired by Bonneville, acquired for more than five years.

marginal cost
The cost of producing the last unit of energy (the long-run incremental cost of production). In the plan, "regional marginal cost" means the long-run cost of additional consumption to the region due to additional resources being required. It does not include consideration of such additional costs to any specific utility due to its purchases from Bonneville at average cost.

megawatt (MW)
The electrical unit of power which equals one million watts or 1,000 kilowatts.

mill
A tenth of a cent. The cost of electricity is often given in mills per kilowatt-hour.

net billed plants
Refers to the 30 percent share of the Trojan Nuclear Power Plant and all of WPPSS 1, 2, and 70 percent of WPPSS 3.

net billing
Refers to a financial arrangement that made it possible for the publicly owned utilities, which owned shares in thermal projects, to sell Bonneville all or part of the generating capacity of these resources. Bonneville credited and continues to credit the wholesale power bills of these utilities to cover the costs of their shares in the thermal resources. Bonneville then sells the output of the thermal plants, averaging the higher costs of the thermal power with lower cost hydropower.

non-firm energy
Energy which is subject to interruption or curtailment by the supplier. Same as secondary energy.

option
The purchase of a right to acquire a resource within a particular time on specified terms.

Pacific Northwest (The Region)
According to the Northwest Power Act, the area consisting of Oregon, Washington, Idaho, Montana west of the Continental Divide, and such portions of Nevada, Utah, and Wyoming as are within the Columbia River Basin. It also includes any contiguous areas not more than 75 miles from the above areas which are part of the service area of a rural electric cooperative customer served by Bonneville on the effective date of the Act and whose distribution system serves both within and without the region.

Pacific Northwest Coordination Agreement
An agreement between federal and nonfederal owners of hydropower generation on the Columbia River system. It governs the seasonal releases of stored water to obtain the maximum usable energy subject to other uses.

Pacific Northwest Utilities Conference Committee (PNUCC)
Formed by Pacific Northwest utility officials in order to coordinate policy on Pacific Northwest power supply issues and activities. It lacks contractual authority, but it does play a major role in regional power planning through its Policy, Steering, Fish and Wildlife, and Lawyers committees, and the Technical Coordinator Group. PNUCC publishes the Northwest Regional Forecast and the Blue Book, containing information on regional loads and resources.

peak capacity
The maximum capacity of a system to meet loads.

peak demand
The highest demand for power during a stated period of time.

penetration rate
The annual share of a potential market for conservation that is realized, as in "7 percent of the region's homes have been weatherized this year."

photovoltaic
Direct conversion of sunlight to electric energy through the concentration of solar radiation through thin layers of semi-conductor materials (silicon).

PNUCC "Blue Book"
Refers to a publication of the Pacific Northwest Utilities Conference Committee entitled *Long Range Projection of Power Loads and Resources to Resource Planning, Northwest Regional Area 1982-1983 Through 2001-2002*. It contains information on regional loads and forecasts.

present value
The worth of future returns or costs in terms of their value now. To obtain a present value, an interest rate is used to discount these future returns and costs.

quantifiable environmental costs and benefits
Costs and benefits capable of being expressed in numeric terms (for example, in dollars, deaths, reductions in crop yields).

quartile
The Direct Service Industries load is divided into four quartiles. The top quartile is the portion of that load most susceptible to interruption.

Region (See Pacific Northwest)

reliability
The ability of the power system to provide customers uninterrupted electric service at their point of service. Includes generation, transmission, and distribution reliability. The plan deals only with generation reliability.

renewable resource
Under the Northwest Power Act, a resource which utilizes solar, wind, water (hydro), geothermal, biomass, or similar sources of energy, and which either is used for electric power generation or which reduces the electric power requirements of a customer.

reserve capacity
Generating capacity available to meet unanticipated demands for power, or to generate power in the event of outages in normal generating capacity. This includes delays in operations of new scheduled generation. Forced outage reserves apply to those reserves intended to replace power lost by accident or breakdown of equipment. Load growth reserves are those reserves intended for use as a cushion to meet unanticipated load growth.

resource
Under the Northwest Power Act, electric power, including the actual or planned electric capability of generating facilities, or actual or planned load reduction resulting from direct application of a renewable resource by a consumer, or from a conservation measure.

retrofit
To weatherize an existing structure.

shipment weighted efficiency
The weighted average efficiency of similar appliances (e.g., 16- to 18-cubic foot frost-free refrigerators) sold in a given year, which is calculated by multiplying the unit efficiency by that unit's share of total sales.

simple payback
The time period required before the savings from a particular investment offsets its cost. For example, an investment costing $100 and resulting in a savings of $25 the first year would be said to have a simple payback of four years. Simple paybacks do not account for future cost escalation, nor other investment opportunities.

siting
The process of situating or locating a power plant on a site, including any applicable regulatory requirements.

space conditioning
Controlling the conditions inside a building in order to maintain human comfort and other desired environmental conditions through heating, cooling, humidification, dehumidification, and/or air quality modifications.

strategic planning model
The strategic planning model is a computer model that chooses the best set of resources to minimize the cost of expanding and operating the regional power system while taking account of variations in water conditions and long-term demand forecast variations.

sunk cost
A cost already incurred and therefore not considered in making a current investment decision.

surcharge
Under the Northwest Power Act, an additional sum added to the usual wholesale power rate charged to a utility customer of Bonneville to recover costs incurred by Bonneville due to the failure of that customer (or of a state or local government served by that customer) to achieve conservation savings comparable to those achievable under the Council's model conservation standards.

System Analysis Model (SAM)
One of the computer models used by the Council to determine resource cost-effectiveness. The model performs a detailed simulation of the Northwest generating system to estimate the cost associated with a specified set of loads and resources. It incorporates uncertainty associated with hydropower, thermal availability, resource arrival, and load fluctuation due to economic cycles.

system cost
According to the Northwest Power Act, all direct costs of a measure or resource over its effective life. It includes, if applicable, distribution and transmission costs, waste disposal costs, end-of-cycle costs, fuel costs (including projected increases), and quantifiable environmental costs and benefits Bonneville determines (using a methodology developed by the Council in its plan) are directly attributable to the measure or resource.

thermal resource
A facility that generates electricity by burning coal, oil, or other fuel, or by nuclear fission.

tieline
A transmission line connecting two or more regional power systems.

transmission
The act or process of transporting electric energy. In the Pacific Northwest, Bonneville operates a majority of the high-voltage, long-distance transmission lines.

Washington Public Power Supply System (WPPSS)
Municipal corporation and joint operation agency in Washington comprised of representatives of public utility districts and municipal utilities. Based on power purchase contracts of its members or other utilities, WPPSS has the power to acquire, construct, and operate plants and facilities for the generation or transmission of electric power.

wet scrubber
A pollution control device using a solution of water and limestone to remove sulfur and other pollutants from stack emissions.

Appendix A
Role of the Council

The Northwest Power Planning Council was created on April 28, 1981 in accordance with the Pacific Northwest Electric Power Planning and Conservation Act (the Act) (P.L. 96-501). The Council is a regional agency made up of eight members, two each from the states of Idaho, Montana, Oregon, and Washington, who are appointed by their governors and confirmed by their legislatures. The Council is not an agency of the United States government.

The Act's purpose is to encourage conservation and the development of renewable resources in the Northwest to assure an adequate, efficient, economical, and reliable power supply, and to provide for broad public participation and consultation in the development of a regional power plan and related fish and wildlife program.

The Council's major responsibilities under the Northwest Power Act fall into three categories: (1) the adoption of a regional energy plan and fish and wildlife program, (2) monitoring the implementation of the energy plan and fish and wildlife program and taking corrective action as necessary, and (3) informing the public about and involving the public in regional energy and fish and wildlife issues. This Appendix describes how the Council has met and will continue to meet these responsibilities.

I. Legal Role of the Council

Section 4(d)(1) of the Act requires the Council to prepare a regional conservation and electric power plan within two years after the Council is established.

The plan must give priority to resources which the Council determines to be cost-effective (defined in the Act to mean cheaper than the lowest-cost, similarly reliable, and available alternative measure or resource). "Priority shall be given: first, to conservation; second, to renewable resources; third, to generating resources utilizing waste heat or generating resources of high fuel-conversion efficiency; and fourth, to all other resources." [Section 4(e)(1).]

The plan must set forth a general scheme for implementing conservation measures and developing resources pursuant to the conservation and resource acquisition provisions of the Act. The plan must be designed to reduce or meet the Bonneville Administrator's obligations to provide power "with due consideration by the Council for (A) environmental quality, (B) compatibility with the existing regional power system, (C) and protection, mitigation, and enhancement of fish and wildlife and related spawning grounds and habitat, including sufficient quantities and qualities of flows for successful migration, survival, and propagation of anadromous fish." [Section 4(e)(2).]

To accomplish the priorities established by the Act, Congress required that the plan include the following elements to be set forth in such detail as the Council deems appropriate: (A) An energy conservation program, including model conservation standards; (B) Recommendations for research and development; (C) A method for determining quantifiable environmental costs and benefits; (D) A twenty-year forecast of electric energy demand and a twenty-year power resources forecast, including the portion of demand to be met by resources in each of the four priority categories; (E) An analysis of reserves and reliability requirements and cost-effective methods for providing reserves designed to ensure adequate electric power at the lowest probable cost; (F) A Columbia River Basin Fish and Wildlife Program pursuant to section 4(h) of the Act; and (G) A method for calculating surcharges to be imposed on a utility that fails to implement model conservation standards or programs that achieve comparable savings. [See section 4(e)(3) of the Act.]

The model conservation standards to be included in the plan "shall include, but not be limited to, standards applicable to (A) new and existing structures, (B) utility, customer, and governmental conservation programs, and (C) other consumer actions for achieving conservation. Model conservation standards shall reflect geographic and climatic differences within the region and other appropriate considerations, and shall be designed to produce all power savings that are cost-effective for the region and economically feasible for consumers, taking into account financial assistance made available to consumers under [the Conservation and Resources Acquisition] section 6(a) of the Act." [Section 4(f)(1).]

Following adoption of the Council's plan, all actions of the Bonneville Administrator pursuant to the Conservation and Resource Acquisition section of the Act must be consistent with the plan. [See section 4(d)(2).]

The Act requires that in the preparation, adoption, and implementation of the plan, the Council and the Administrator must encourage the cooperation, participation, and assistance of appropriate federal agencies, state entities, local governments, and Indian tribes. [Section 4(g)(3).]

Columbia River Basin Fish and Wildlife Program

The Act requires the Council to obtain recommendations and prepare a comprehensive program to protect, mitigate, and enhance fish and wildlife, including related spawning grounds and habitat on the Columbia River and its tributaries pursuant to section 4(h) of the Act. This program was developed on the basis of the recommendations and comments from Indian tribes, fish and wildlife agencies, the utility community, and others. After extensive public comment, hearings, and consultation with affected parties, the Council adopted its Columbia River Basin Fish and Wildlife Program on November 15, 1982. The power plan presented here is compatible in all respects with the fish and wildlife program. A detailed description of the process used in developing the Columbia River Basin Fish and Wildlife Program is in Section 102 of that document.

Implementation Oversight

The Act also provides an oversight role for the Council. Under section 6(c) of the Act, the Council has the authority to determine if major resource acquisitions (more than 50 average megawatts) proposed by Bonneville are consistent or inconsistent with this Regional Conservation and Electric Power Plan. If the Council determines that a proposed major resource acquisition is inconsistent, Bonneville will be unable to acquire the resource unless (1) it finds the resource is needed to meet its obligations, and (2) expenditure of funds for that purpose is specifically authorized by an act of Congress.

The Council will also review Bonneville's actions under the provisions of the Act to determine the extent to which its plan is being implemented. (See Section II of this Appendix.) In addition, the Council may request Bonneville to take actions under the conservation and resource acquisition provisions of the Act. [See section 4(j).]

II. Program for Monitoring and Evaluating Progress

Regional planning is an ongoing process. Because of the major uncertainties associated with long-term electric power planning, the power plan must be flexible and adaptable to changing conditions. Uncertainties have been identified and dealt with as an inherent part of the Council's power planning activities. However, adapting to uncertainty and changing conditions requires not only that uncertainties be identified and the plan have the flexibility to react to deviations, but also that the planning process have the capability to monitor implementation of the plan to provide advance information and warning of deviations so that appropriate Council responses can be taken.

The need for the plan to be flexible and adaptable to changing conditions is recognized in the Act. Section 4(d)(1) of the Act states:

> The adopted plan, or any portion thereof, may be amended from time to time, and shall be reviewed by the Council not less frequently than once every five years.

Section 4(i) specifies:

> The Council may from time to time review the actions of the Administrator pursuant to section 4 and 6 of this Act to determine whether such actions are consistent with the plan and programs, the extent to which the plan and programs is being implemented, and to assist the Council in preparing amendments to the plan and programs.

In addition, section 4(k)(1) states:

> Not later than October 1, 1987, or six years after the Council is established under this Act, whichever is later, the Council shall complete a thorough analysis of conservation measures and conservation resources implemented pursuant to this Act during the five-year period beginning on the date the Council is established.

Thus, the Council's program for monitoring and updating the power plan has three major features:

1. The plan will be formally updated and reissued on a regular basis.
2. The assumptions and forecasts used to develop the plan as well as the implementation and effectiveness of the plan will be monitored.
3. If necessary, additional Council actions will be taken and the plan modified prior to the formal plan revision.

Monitoring and updating the plan will be an integral part of the regional planning process. The major interactions among the various regional planning, legislative, and regulatory organizations involved in implementing and monitoring the power plan are illustrated in figure A-1. As shown, the Council is responsible for developing, monitoring, and updating the power plan. The Council plans on maintaining programs to encourage public participation and continued consultation of regional organizations in all phases of its activities. (Section III of this appendix describes past public information and involvement activities and future plans.)

Bonneville and a number of regional and federal organizations are responsible for implementing the recommendations of the Council. [Section 4(j).] Bonneville is responsible for developing and administering the recommendations and programs and for providing proper signals to other regional organizations. These organizations are responsible for responding to the program's incentives, surcharges, or other signals provided.

In turn, the Council will periodically monitor the progress that both Bonneville and other regional and federal organizations have made toward achieving the goals of the plan. The method used to monitor progress will be to compare the actual program development and administration activities of Bonneville and the response of the various regional and federal organizations and the public to these programs with the recommendations stated in the power plan.

The key aspects of this monitoring program are outlined in the following sections.

Purpose

The purpose of the monitoring program is to provide the Council with the information necessary to determine whether or not the forecasts, assumptions, analyses, and recommendations contained in the power plan are developing or evolving as anticipated. If the provisions of the plan are being met, then there is no reason for changing the plan or for future evaluation. If the provisions are not being met, then additional investigation and evaluation will be required to determine the cause of the deviation and to develop an appropriate response. The purpose of the monitoring program is to point out areas of possible discrepancy, not to provide a complete evaluation of the causes for a discrepancy. Monitoring information is necessary but not sufficient for evaluation.

Process

The key to any tracking and monitoring system is the ability to compare forecast or desired system behavior with actual behavior. In the case of the plan, it is necessary to develop indicators of actual demand growth, conservation program effectiveness, resource acquisition status, etc., to compare with the assumption and forecasts made as part of the planning process. This concept is illustrated in figure A-2.

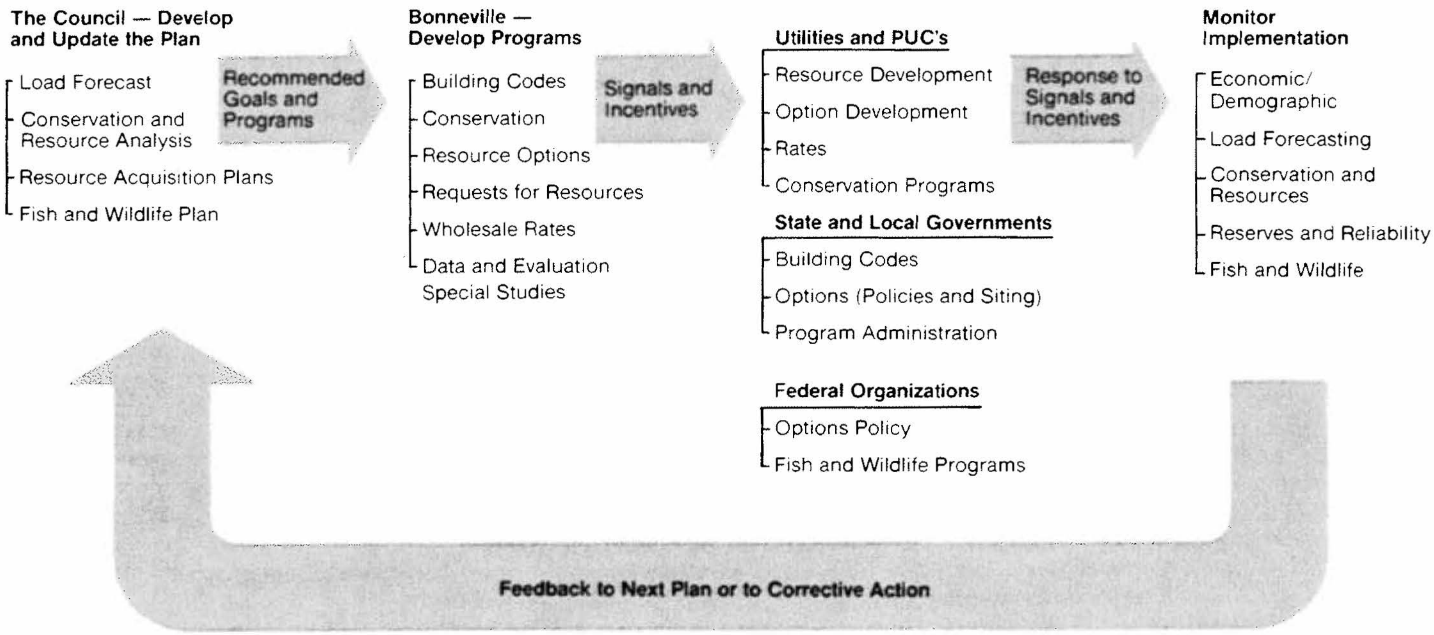


Figure A-1.
Power Plan Organizational Activities

As shown in figure A-2, "indicators" are used to compare actual or historical behavior with forecast or assumed behavior. Indicators have three attributes: (1) actual data must be available for them, (2) they must either be forecast or have had values assumed for them, and (3) they should be parameters to which the forecasting process is sensitive.

Examples of indicators of system performance shown in figure A-2 are: electrical use per household, state population growth, number of resource options with final permits, and actual numbers of migrating fish. The desired or assumed values would result from the planning process while the actual values result from data collected by other regional entities or by the Council as part of the monitoring functions.

Comparing actual with forecast behavior requires an adjustment or reconciliation process to account for other factors such as economic activity and annual weather conditions that may cause differences between assumed or forecast indicator values

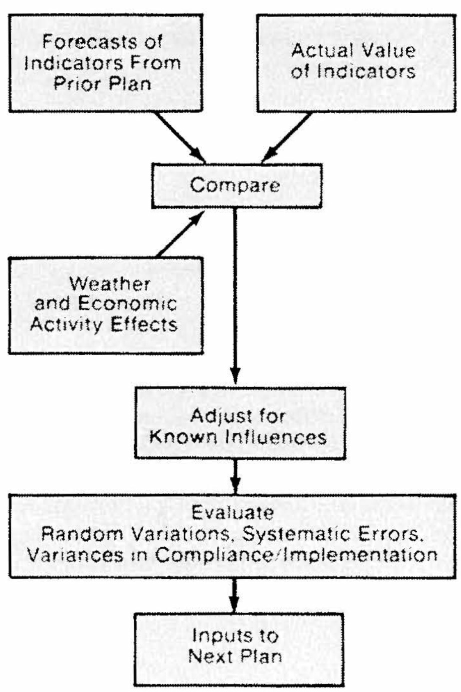


Figure A-2.
Conceptual Overview of Monitoring Process

and actual indicator values. Even after adjustments have been made for these factors, however, differences may exist between actual and forecast indicators. Sources of these differences may result from random variations, systematic errors in forecasting methodology, or variations in implementation/compliance of programs specified in the plan.

If deviations cannot be explained by looking at these sets of indicators, and the deviations represent a significant influence which may require a change in policies or programs, it may be necessary to undertake some special data collection efforts (surveys or studies) to understand what is happening.

While the monitoring process presented in figure A-1 is shown as a linear process, it utilizes an information "feedback loop" whereby the evaluation and analysis done during one planning cycle will lead to improved methods and data during the next planning cycle. When properly utilized this feedback of information will allow the

Council and other regional power planning organizations to do a better job in regional energy planning with each successive plan update.

Emphasis

Because of the large number of uncertainties influencing supply and demand for electricity, and the lack of prior experience in working with a monitoring system, the initial emphasis will be on monitoring the institutional response to the programs and recommendations contained in the plan. While the data collection system and indicators can be established and utilized at this time, it is likely that the major monitoring function will be to see what programs are actually established by institutions such as Bonneville, utilities, state and local governments, and consumers, in response to the goals and policies established in the plan.

Strategic and Tactical Goals

One of the problems associated with the design of the monitoring system stems from the difference in the time period between the long-term plan (twenty years) and the short-term monitoring period (two years). Long-term plans and forecasts include techniques, data, and assumptions suitable for the long-run trends. These data, and assumptions are typically significantly different in character and detail than those intended for short-term planning and techniques, forecasting. Accordingly, care must be exercised when evaluating a long-term plan and forecast over a short-term period.

To help overcome this problem, the plan has two levels of detail. The first level, the twenty-year plan, is the strategic or policy level. Factors considered at this level include long-term socio/demographic trends, power demand, strategic resource availability, and general objectives and measures of performance. In general, the long-term strategic plan is prepared first; this is followed by shorter range two-year action plans which are tactical and operational in nature and include greater detail. The two-year plan presents the steps that must be accomplished in the near term to reach the goals set forth in the long-term strategic plan.

It is at this second, more detailed level, that the majority of the monitoring activities take place. Since the ongoing planning activities will be based on a two-year planning cycle, it is logical that the monitoring efforts focus on the two-year action plan (chapter 10).

Status Reports

The status of all conservation and generating resources, programs, and recommendations contained in the plan will be monitored. A monitoring status report has been developed outlining the monitoring process to be followed for each important program and recommendation contained in the plan that lends itself to this report format. The information contained in each program monitoring statuss report includes:

- ***Program Identification***. This section identifies the program or recommendation (conservation, resource option, model building standard,fish and wildlife measure, etc.).
- ***Program Description***. This section gives a brief description of the program or recommendation.
- ***Program Goals***. Both the long-term strategic goals and the shorter-term tactical goals of the program are presented in this section.
- ***Implementation Organizations and Responsibilities***. The purpose of this section is to define the responsibilities and actions required by various organizations to achieve the program goals.
- ***Program Evaluation Summary***. The purpose of this section is to summarize the actual status or cost-effectiveness of the program.
- ***Data and Information Sources***. The sources of data and information used to monitor the program are listed in this section.
- ***Trigger Action/Response Plan***. This section will outline, if possible, the actions that will be taken by the Council in response to various levels of deviation of the actual program implementation from the goals specified.

Functional Areas

The functional organization of the tracking and monitoring system closely follows conventional electric power planning functions and the organization of the Council. There are five major functional areas included in the overall monitoring system. The monitoring activities to be conducted under each of these areas are summarized in figure A-3 and briefly described below.

Economic/Demographic

The purpose of the economic/demographic monitoring activity will be to track a number of indicators of regional economic and demographic conditions. Since economic activity within the Pacific Northwest is partly determined by national economic conditions, indicators of national economic activity will also be monitored.

Demand Forecasting

The objective of monitoring demand forecasting is to compare the forecasts and assumptions contained in the plan with the actual demand and conditions experienced.

Conservation and Resources

The objective of the conservation and resource monitoring area is to monitor the performance, cost-effectiveness, and impacts of all conservation and generating resource programs as well as to track and monitor the status of resources in the option and acquisition phases. Resources not included in the plan but potentially available in the region will also be monitored.

Rates and Reliability

The primary function of the reserves and reliability monitoring area is to develop revised resource acquisition schedules using the conservation and resource data bases and the power system planning and optimization models. The Council will also monitor the implementation of rate recommendations.

To develop a new resource acquisition schedule, data on the actual status and performance of the resources and the new twenty-year demand forecast are used in conjunction with the demand/resource matching methods to develop a new twenty-year resource acquisition plan.

Fish and Wildlife

The Council's fish and wildlife program contains a number of measures for research design, construction, operation, and maintenance of hydropower facilities. The monitoring activities associated with the fish and wildlife program, including the oversight activities of the Council's Fish and Wildlife Committee, are presented as an integral part of the fish and wildlife program. Additional measures relating to the impacts of hydropower resources on the fish and wildlife in the region are planned and progress will be monitored over the next two years.

III. Public Information and Involvement Program

One of the fundamental purposes of the Act is to provide for the participation and consultation of the four Northwestern states, local governments, consumers, Bonneville customers, users of the Columbia River system, and the public in the development of regional energy and fish and wildlife plans and programs. [Section 2(3)(1).] The four-state regional Council plays a crucial role in this process. The Council is specifically directed by the Act to

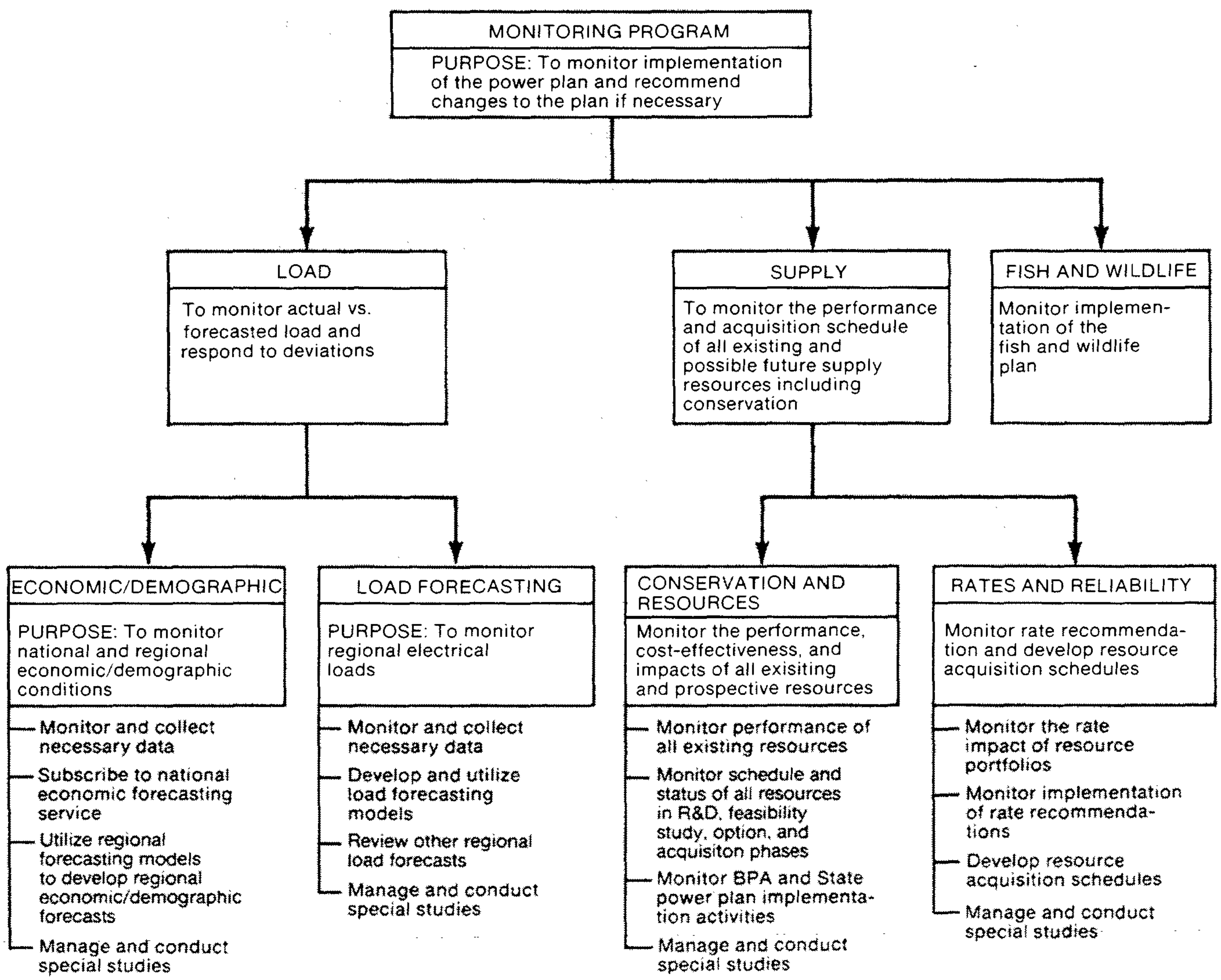


Figure A-3.
Monitoring Areas and Activities

inform the Pacific Northwest public about major regional power issues, obtain public views concerning major power issues, and secure the advice and consultation of Bonneville's customers and others. [Section 4(g)(1).] The Act also requires the Council to form a voluntary Scientific and Statistical Advisory Committee to assist in the collection of relevant information in formulating the energy plan and fish and wildlife program. [Section 4(c)(11).] The Council fulfilled each of these obligations in adopting the fish and wildife program and energy plan and will continue to fulfill its role in involving and informing the public about regional energy and fish and wildife issues in the future.

The process which the Council used in developing the Columbia River Basin Fish and Wildlife Program is set forth in that program which is integrated into the plan as Volume III. The process which the Council used in developing this energy plan is summarized below.

The Council, from the time of its formation, has committed itself to an active public information and involvement program. This commitment has included regular public meetings and workshops throughout the region, publication of a monthly newsletter, and a variety of other efforts outlined below.

Immediately after its formation, the Council began holding public meetings throughout the Northwest. These meetings, held approximately twice each month, provided opportunities for the public to present their views to the Council on energy and fish and wildlife issues. The Council also consulted with the utility and industrial customers of Bonneville, consumer and environmental groups, state and local governments, and Bonneville throughout the development of the draft plan.

The Council, as authorized by section 4(c)(11) of the Act, formed a voluntary Scientific and Statistical Advisory Committee (SSAC) in August 1981. The Committee had 68 members from throughout the Pacific Northwest representing federal, state, local, and Indian tribal governments, consumer and environmental groups, and customers of Bonneville. The committee worked through five subcommittees: Forecasting, Conservation, Resource Assessment, Reserves and Reliability, and Fish and Wildlife. Subcommittee meetings were open to the public and were attended by Council members and Council staff. An Executive Committee coordinated the activities of the subcommittees. Approximately 1,500 individuals and organizations received subcommittee agendas and minutes.

In the fall of 1981, the Council issued a Request for Proposals (RFP) for six major studies: electricity-demand forecast modeling, conservation and resource assessment, policy options and programs, rate design and analysis, reserves and reliability analysis, and quantification of environmental costs and benefits. The members of the Advisory Committee and Bonneville reviewed the RFP before it was issued. Council members, staff, and Advisory Committee members participated in contractor interviews. During the spring of 1982 contractors were required to make public presentations to the Council and to the Scientific and Statistical Advisory Subcommittees. Final contractor reports were submitted in the summer of 1982, and the Council began using these tools to develop elements of the draft plan. The contractor reports were announced in the Council newsletter. They were distributed to approximately 400 individuals and organizations that requested them.

In developing its electric demand forecast, the Council requested projections of economic growth from over 200 businesses and industries in the region. These responses were used in developing the Council's economic and demographic projections, which are the backbone of the Council's electric demand forecast.

In March of 1982, the Council began publishing a monthly newsletter, *Northwest Energy News*. The newsletter focuses on regional energy news, major energy issues (i.e., rates, forecasting, conservation, and fish and wildlife), and Council activities. The newsletter is also used to notify the public of Council meetings, subcommittee meetings, public involvement activities in the states, and the availability of Council publications. The newsletter circulation is currently about 12,000. Meeting notices were also published in the *Federal Register*.

To encourage broad public involvement in the preparation of the draft plan, the Council identified 24 key issues to be addressed in the draft. Papers were prepared on each of these issues for review by the Scientific and Statistical Advisory Committee and other interested parties. Availability of the issue papers was announced in the Council's newsletter. Approximately 900 sets of the issue papers were distributed to the public. The Council revised the issue papers and developed decision memoranda based on the comments of the Advisory Committee and the public at large. The Council then made decisions, incorporating the extensive public comment it received.

From March through June of 1982, the Council sponsored town hall meetings on regional power issues in 22 locations throughout the Northwest. These public meetings were planned and organized by the Council members from each state. The Council produced a slide/tape show for the meetings which explained the role of the Council, its planning process, and major issues to be addressed. The town hall meetings provided an opportunity for the public to become acquainted with the Council and its decisionmaking process. All of the town hall meetings were widely publicized and well attended.

The town hall meetings were followed by more intensive energy workshops during the months of October and November. These sessions served as a forum for the public to discuss with Council members a number of key issues facing the Council.

The Council worked closely with local governments through the local government associations in the four states. A paper on local governments and the Act was distributed to all cities and counties in the region.

The Council expanded its public information and involvement effort with the adoption of the draft plan in late January. During February, the Council organized a series of energy briefings to inform the public about the draft plan. The Council produced a film on the draft plan which was used for the briefings and also distributed to utilities, industries, and groups for their use. Viewgraphs and background papers were also produced for the briefing and then distributed widely. The Council also conducted an extensive direct mailing effort to various interested groups about the plan. In late February, the Council inserted a tabloid in all of the region's daily newspapers (circulation 2.6 million) to explain the major issues in the draft plan and to encourage participation in the hearings. The tabloid was also distributed to libraries and to a number of organizations. The Council also produced and distributed a public service announcement to announce the availability of the draft. Over 14,000 copies of the draft plan were distributed.

A series of public hearings to receive comments on the draft energy plan were held beginning in Pocatello, Idaho (Idaho Field Hearing) on March 7, followed by Missoula, Montana on March 9; Boise, Idaho on March 11; Coeur d'Alene, Idaho on March 14; Salem, Oregon on March 16 and 17; and Seattle, Washington on March 17 and 18.

Approximately 400 individuals and organizations presented testimony at the hearings. By the close of the public comment period on March 21, the council had received 18,000 pages of comments from over 1,200 individuals and groups.

The Council maintains a public reading room at its central office in Portland where the public can review contractors' studies and other reports as well as comments received relating to the development of the fish and wildlife program and the energy plan. Council agendas and newsletters are mailed to approximately 12,000 organizations and individuals. The Council maintains toll-free telephone lines (1-800-222-3355 for Idaho, Montana, and Washington and 1-800-452-2324 for Oregon) to encourage public access to the Council.

With the adoption of the plan, the Council reaffirms its strong commitment to an active public involvement and information program. The Council will continue to hold regular public meetings throughout the region. These meetings will be a forum for the Council to discuss ideas and to receive recommendations during the planning process from state and federal agencies, Indian tribes, Bonneville and Bonneville customers, local governments, and the public on major energy and fish and wildlife issues. Consultations with these interested parties on major issues will also continue.

Recognizing that all citizens who are interested in the Council's activities cannot always attend public meetings, the Council will maintain an extensive public information and public involvement program. The Council will continue to publish and make available to the public, through an expanded mailing list, *Northwest Energy News*, along with other information on regional energy and fish and wildlife issues. All of this material, as well as educational films produced by the Council, will also be distributed through utilities, public schools, universities, and public libraries. Also, the Council will maintain regular contact with regional news media and maintain and upgrade its library and public reading room. The Council's Scientific and Statistical Advisory Committee, which served the Council so well in developing this plan, will be reorganized to better support the Council in the implementation phase of the plan.

The Council knows that this plan is not a static document. As conditions change, or if resources do not perform as expected, revisions to the plan may be needed. The Council will widely publicize its process for making revisions to the energy plan and fish and wildlife program to encourage increased public involvement. The public will be informed of proposed revisions to the plan through published material and through public briefing sessions. Throughout this process, comments will be solicited from the public on proposed changes to the plan prior to Council adoption.

The Council is committed to making the planning process they have developed work. Since conservation, the major feature of the Council's energy plan, is implemented at the local level by many individuals, the Council will work closely with local governments on the implementation of the plan. In addition, the Council will establish consumer education programs on energy conservation.

The Council's public involvement calendar of the last two years is reproduced on the following pages.

Public Involvement Calendar

All of the meetings on this calendar were open to the public. There was an opportunity for public comment at each meeting.

April 1981
April 28 — Council Meeting, Portland, Oregon

May 1981
May 13 — Council Meeting, Helena, Montana
May 20-22 — Council Meeting, Seattle, Washington

June 1981
June 2 — Council Meeting, Boise, Idaho
June 9-10 — Council Meeting, Portland, Oregon
June 23-24 — Council Meeting, Missoula, Montana

July 1981
July 13-14 — Council Meeting, Seattle, Washington
July 29-30 — Council Meeting, Coeur d'Alene, Idaho

August 1981
August 11 — Council Meeting, Portland, Oregon
August 31 — Council Meeting, Seattle, Washington

September 1981
September 1 — Council Meeting, Seattle, Washington
September 11 — Conservation Subcommittee (SSAC)
September 17 — Fish and Wildlife Subcommittee (SSAC)
September 21 — Reserves and Reliability Subcommittee (SSAC)
September 30 — Council Meeting, Butte, Montana

October 1981
October 13 — Executive Committee (SSAC)
October 14 — Council Meeting, Portland, Oregon
October 16 — Forecasting Subcommittee (SSAC)
October 23 — Fish and Wildlife Subcommittee (SSAC)

November 1981
November 4 — Council Meeting, Seattle, Washington
November 17 — Executive Committee (SSAC)
November 17 — Conservation Subcommittee (SSAC)
November 18 — Council Meeting, Idaho Falls, Idaho
November 30 — Resource Assessment Subcommittee (SSAC)

December 1981
December 2-3 — Council Meeting, Portland, Oregon
December 4 — Fish and Wildlife Subcommittee (SSAC)
December 8 — Forecasting Subcommittee (SSAC)
December 15 — Conservation Subcommittee (SSAC)

January 1982
January 7 — Council Meeting, Olympia, Washington
January 11 — Resource Assessment Subcommittee (SSAC)
January 13 — Forecasting Subcommittee (SSAC)
January 15 — Executive Committee (SSAC)
January 19 — Resource Assessment Subcommittee (SSAC)
January 20 — Council Meeting, Richland, Washington
January 26 — Conservation Subcommittee (SSAC)
January 29 — Fish and Wildlife Subcommittee (SSAC)

February 1982
February 3-4 — Council Meeting, Portland, Oregon
February 16 — Executive Committee (SSAC)
February 17-18 — Council Meeting, Portland, Oregon
February 18 — Resource Assessment Subcommittee (SSAC)
February 19 — Reserves and Reliability Subcommittee (SSAC)
February 19 — Fish and Wildlife Subcommittee (SSAC)
February 23 — Conservation Subcommittee (SSAC)
February 25 — Forecasting Subcommittee (SSAC)

March 1982
March 1 — Resource Assessment Subcommittee (SSAC)
March 4 — Council Meeting, Missoula, Montana
March 13 — Public Hearing on Fish and Wildlife Program, Boise, Idaho
March 15-16 — Public Hearing on Fish and Wildlife Program, Portland, Oregon
March 16 — Conservation Subcommittee (SSAC)
March 16 — Forecasting Subcommittee (SSAC)
March 17 — Council Meeting, Portland, Oregon
March 18 — Public Hearing on Fish and Wildlife Program, Toppenish, Washington
March 26 — Public Hearing on Fish and Wildlife Program, Missoula, Montana
March 30 — Conservation Subcommittee (SSAC)

Town Hall Meetings
March 23 — Kalispell, Montana
March 25 — Missoula, Montana
March 29 — Billings, Montana
March 30 — Pocatello, Idaho
March 31 — Helena, Montana

April 1982
April 2 — Resource Assessment Subcommittee (SSAC)
April 9 — Forecasting Subcommittee (SSAC)
April 20 — Reserves and Reliability Subcommittee (SSAC)
April 20 — Executive Committee (SSAC)
April 20 — Forecasting Subcommittee (SSAC)
April 21-22 — Council Meeting, Seattle, Washington
April 22 — Fish and Wildlife Subcommittee (SSAC)
April 22-23 — Conservation Subcommittee (SSAC)
April 23 — Resource Assessment Subcommittee (SSAC)

Town Hall Meetings
April 2 — Butte, Montana
April 5 — Pendleton, Oregon
April 12 — Medford, Oregon
April 13 — Coos Bay, Oregon
April 13 — Lewiston, Idaho
April 14 — Eugene, Oregon
April 15 — Coeur d'Alene, Idaho
April 19 — Portland, Oregon
April 27 — Boise, Idaho
April 29 — Spokane, Washington

May 1982
May 5 — Forecasting Subcommittee (SSAC)
May 6 — Council Meeting, Portland, Oregon
May 11 — Reserves and Reliability Subcommittee (SSAC)
May 21 — Conservation Subcommittee (SSAC)
May 21 — Forecasting Subcommittee (SSAC)
May 21 — Resource Assessment Subcommittee (SSAC)
May 28 — Fish and Wildlife Subcommittee (SSAC)

Town Hall Meetings
May 4 — Bellingham, Washington
May 10 — Tacoma, Washington
May 18 — Seattle, Washington
May 20 — Longview, Washington
May 25 — Yakima, Washington

June 1982
June 2-3 — Council Meeting, Boise, Idaho
June 14 — Forecasting Subcommittee (SSAC)
June 15 — Executive Committee (SSAC)
June 17 — Council Meeting, Seattle, Washington
June 18 — Resource Assessment Subcommittee (SSAC)
June 18 — Fish and Wildlife Subcommittee (SSAC)
June 21-22 — Conservation Subcommittee (SSAC)

Town Hall Meeting
June 21 — Portland, Oregon

July 1982
July 13 — Conservation Subcommittee (SSAC)
July 15 — Reserves and Reliability Subcommittee (SSAC)
July 15 — Resource Assessment and Program (SSAC)
July 16 — Fish and Wildlife Subcommittee (SSAC)
July 21 — Forecasting Subcommittee (SSAC)
July 21-22 — Council Meeting, Portland, Oregon
July 30 — Fish and Wildlife Subcommittee (SSAC)

August 1982

August 10	Conservation Subcommittee (SSAC)
August 11	Reserves and Reliability Subcommittee (SSAC)
August 20	Resource Assessment Subcommittee (SSAC)
August 26	Forecasting Subcommittee (SSAC)

April 1982

September 1982

September 1	Council Meeting, Portland, Oregon
September 9	Fish and Wildlife Subcommittee (SSAC)
September 14	Conservation Subcommittee (SSAC)
September 16	Council Meeting, Helena, Montana
September 17	Reserves and Reliability Subcommittee (SSAC)
September 24	Resource Assessment Subcommittee (SSAC)
September 27	Forecasting Subcommittee (SSAC)
September 29	Executive Committee (SSAC)

October 1982

October 4	Energy Briefing, Eugene, Oregon
October 6	Council Meeting, Spokane, Washington
October 12	Conservation Subcommittee (SSAC)
October 12	Public Hearing on Fish and Wildlife Program, Portland, Oregon
October 15	Public Hearing on Fish and Wildlife Program, Boise, Idaho
October 18	Public Hearing on Fish and Wildlife Program, Missoula, Montana
October 20-21	Council Meeting, Seattle, Washington
October 22	Resource Assessment Subcommittee (SSAC)
October 22	Public Hearing on Fish and Wildlife Program, Yakima, Washington
October 28	Forecasting Subcommittee (SSAC)

Energy Workshops

October 4	Butte, Montana
October 5	Spokane, Washington
October 11	Eugene, Oregon
October 19	Seattle, Washington
October 25	Dillon, Montana
October 26	Missoula, Montana

November 1982

November 3-4	Council Meeting, Portland, Oregon
November 5	Conservation Subcommittee (SSAC)
November 15-16	Council Meeting, Portland, Oregon
November 19	Resource Assessment Subcommittee (SSAC)
November 22	Forecasting Subcommittee (SSAC)
November 29	Reserves and Reliability Subcommittee (SSAC)

Energy Workshops

November 17	Libby, Montana
November 18	Kalispell, Montana

December 1982

December 1-2	Council Meeting, Portland, Oregon
December 2	Council Fish and Wildlife Committee, Portland, Oregon
December 8	Conservation Subcommittee (SSAC)
December 10	Resource Assessment Subcommittee (SSAC)
December 15	Council Fish and Wildlife Committee, Portland, Oregon
December 15-16	Council Meeting, Portland, Oregon
December 17	Council Fish and Wildlife Committee, Portland, Oregon
December 20	Forecasting Subcommittee (SSAC)
December 21	Council Meeting, Portland, Oregon
December 21	Council Fish and Wildlife Committee, Portland, Oregon
December 28-29	Council Meeting, Portland, Oregon

January 1983

January 7	Council Meeting, Portland, Oregon
January 11	Conservation Subcommittee (SSAC)
January 24	Forecasting Subcommittee (SSAC)
January 26-27	Council Meeting, Portland, Oregon
January 27	Council Fish and Wildlife Committee, Portland, Oregon

February 1983

February 9	Council Fish and Wildlife Committee, Portland, Oregon
February 28	Resource Assessment Subcommittee (SSAC)
February 28	Council Fish and Wildlife Committee, Seattle, Washington

Energy Plan Briefings

February 22	Boise, Idaho
February 22	Missoula, Montana
February 23	Idaho Falls, Idaho
February 23	Kalispell, Montana
February 24	Spokane, Washington
February 25	Butte, Montana

March 1983

March 1	Conservation Subcommittee (SSAC)
March 2	Forecasting Subcommittee (SSAC)
March 3	Reserves and Reliability Subcommittee (SSAC)
March 14	Council Meeting, Coeur d'Alene, Idaho

Energy Briefings

March 2	Seattle, Washington

Public Hearings on the Energy Plan

March 7	Pocatello, Idaho (Idaho Field Hearing)
March 9	Missoula, Montana
March 11	Boise, Idaho
March 14	Coeur d'Alene, Idaho
March 16-17	Salem, Oregon
March 17-18	Seattle, Washington

April 1983

April 6-7	Council Meeting, Portland, Oregon
April 7	Council Fish and Wildlife Committee, Portland, Oregon
April 12	Council Meeting, Portland, Oregon
April 27	Council Meeting, Seattle, Washington

Appendix B
Reliability and the Hydropower System

Introduction

This appendix provides additional detail on reliability issues and, in particular, on the effects of hydropower variability on system planning, operations, and reliability. First, it describes the reliability questions: How reliable and at what cost? Next, it discusses some outage cost studies performed by Council contractors, and Council decisions about the issues raised. Finally, it describes in more detail hydropower system variability, critical water planning, and the Council's decision to maintain that reliability standard for the current plan. When the term "reliability" is used in the plan, it refers to generation reliability unless qualified by the terms "transmission" or "distribution."

Reliability Issues

The kind of system reliability that is dealt with in the Council's energy plan is reliability of energy supply: whether the system can meet the total monthly energy load imposed upon it. The Council has not reviewed existing utility standards for peak reliability of the system although it plans to do so in the next two years. Recent history and continuing studies indicate that peak demand on the Northwest system is not the major consideration in initiating major plan expenditures.

The primary existing reliability standard for energy supply in this region is the critical water standard. There are other rules of thumb used in such documents as the PNUCC "Blue Book" (the annual utility planning document) such as the additional half-year's energy load growth reserve. These have not been employed in the Council's planning process since they represent merely additional reserve margins on a long-term planning basis, and are superseded by the Council's options approach to long-term planning. Energy reserve standards are also supported by using realistic plant availabilities for large thermal plants, which recognize down time for both planned maintenance and unforeseen outages.

There are two general issues to be dealt with in reliability analysis. The first is the decision about the appropriate level of reliability for the system, and the second concerns the mechanism for ensuring that level of reliability is achieved. The first problem is by far the more difficult to analyze. The appropriate level of reliability is a function both of the cost of additional energy supplies and the cost imposed on consumers should energy supplies be inadequate. More reliable service requires more backup resources simply to meet the same load, while less reliable service means increasing chances that some customers may not have all they want and are willing to pay for. The Council conducted a study of the costs to the different consumer classes of energy shortages of various amounts. These costs were based on a study defined by energy shortages having a duration of approximately 2 to 6 months with substantial prior notice of the onset of the shortage. The outage costs under these circumstances, when customers are free to reduce their least-valued uses, were relatively low, particularly for residential and commercial customers.

The Council's Reserves and Reliability Subcommittee raised several questions about the results of that study. The first question was about the use of consumer surplus alone rather than total willingness to pay (consumer surplus plus price) as relevant measure of outage cost.

The second question, raised by the Reserves and Reliability Subcommittee, was the need for what might be termed a "threshold cost" attached to the shortage cost estimates provided by the Council's study. The study implicitly presumes a smooth transition from normal circumstances in which customers are not faced with shortages to the situation in which customers are faced with very small shortages, going on to situations in which customers are faced with larger shortages. The Subcommittee pointed out that in the past (for instance in 1973 and 1977, two recent low-water episodes) there has been a substantial buildup of political and administrative activity before the first calls for voluntary curtailment to the public were made. Because of the nature of the hydropower system and our dependency upon the vagaries of precipitation, the end of low-water conditions tends to be relatively unpredictable. All expressions of danger to system operations have to be expressed in terms of probability rather than clear-cut assurances. The complexity of the actual situation, given these conditions, was perceived by those responsible for managing the shortage in the region to lead to substantial credibility problems if a correctly perceived probable danger fails to occur because of abrupt changes in weather patterns. Because of this, the Reserves and Reliability Subcommittee argued that the smooth transition postulated by the report between normal conditions and shortage conditions would not occur, and that there was an additional real, though difficult to measure, cost which had not been evaluated in the study.

Beyond that, however, there is a significant policy issue involved. Should the Council, on the basis of a study of aggregated consumer costs, plan a set of resources that could require individual customers in different circumstances to face a shortage of electricity? The Council believes the answer to that question is "no." If worse than historical critical-water conditions should occur, coupled with abnormally bad resource performance, the Council anticipates that high-cost resources would be run and drought surcharges imposed so that those whose requirement for continued service is high would be able to have it, while those whose requirement is less stringent would have additional incentive for short-term conservation efforts. An alternative solution that could be employed in those circumstances would be a "buy-back" of energy from consumers at the short-run marginal cost.

Reliability Issues in Current Plan

The Act, in section 4(e)(3)(E) requires the plan to include "in such detail as the Council determines to be appropriate" [4(e)(3)]:

> an analysis of reserve and reliability requirements and cost-effective methods of providing reserves designed to insure adequate electric power at the lowest probable cost.

The Council has determined that the primary reliability issue in this first twenty-year plan is the appropriate treatment of forecasting uncertainty. A secondary issue is the appropriate water criterion to use. The Council has determined that, for this first plan, no change from the current water standard will be made.

The Council does not intend to plan for any shortages. The primary focus of the Council's analysis has been the appropriate way of dealing with the major uncertainty facing the region—the level of future demand. Traditional methods include setting a planning reserve level over the expected demand to cover demand uncertainty and planning additional generating resources to provide this reserve. The Council's approach to the problem of the appropriate planning reserve level is completely different. First, there is no "expected" demand against which planning is done. Rather, a range of demand forecasts is the target, and the combination of flexible, short-lead-time resources and options provides the same level of reliability that is provided by the traditional planning reserves. The Council's approach is explained in more detail in the discussion of options, demand forecasting, and the resource portfolio in chapters 3, 4, and 5. Because of the current firm surplus, the large availability of conservation resources in the region, and the low likelihood of the high growth forecast occurring, the Council has not felt the need to analyze further for this first plan the consumer costs of shortages or the risks and possible benefits from pushing hydropower system operation beyond the current flexibility embodied in the critical-water standard.

The Council has determined that no analysis of the operating reserves provided through the DSI contracts is required in this first plan due to the expected duration of the current firm surplus.

Because of the nature of the regional hydropower system, the reliability criterion that has the largest consequence for resource choice and resource operation is the choice of water condition to use in resource planning. The nature of the hydropower system and the implications of critical-water planning are described below.

The Regional Power System

The electric power system in the Pacific Northwest is dominated by hydropower.

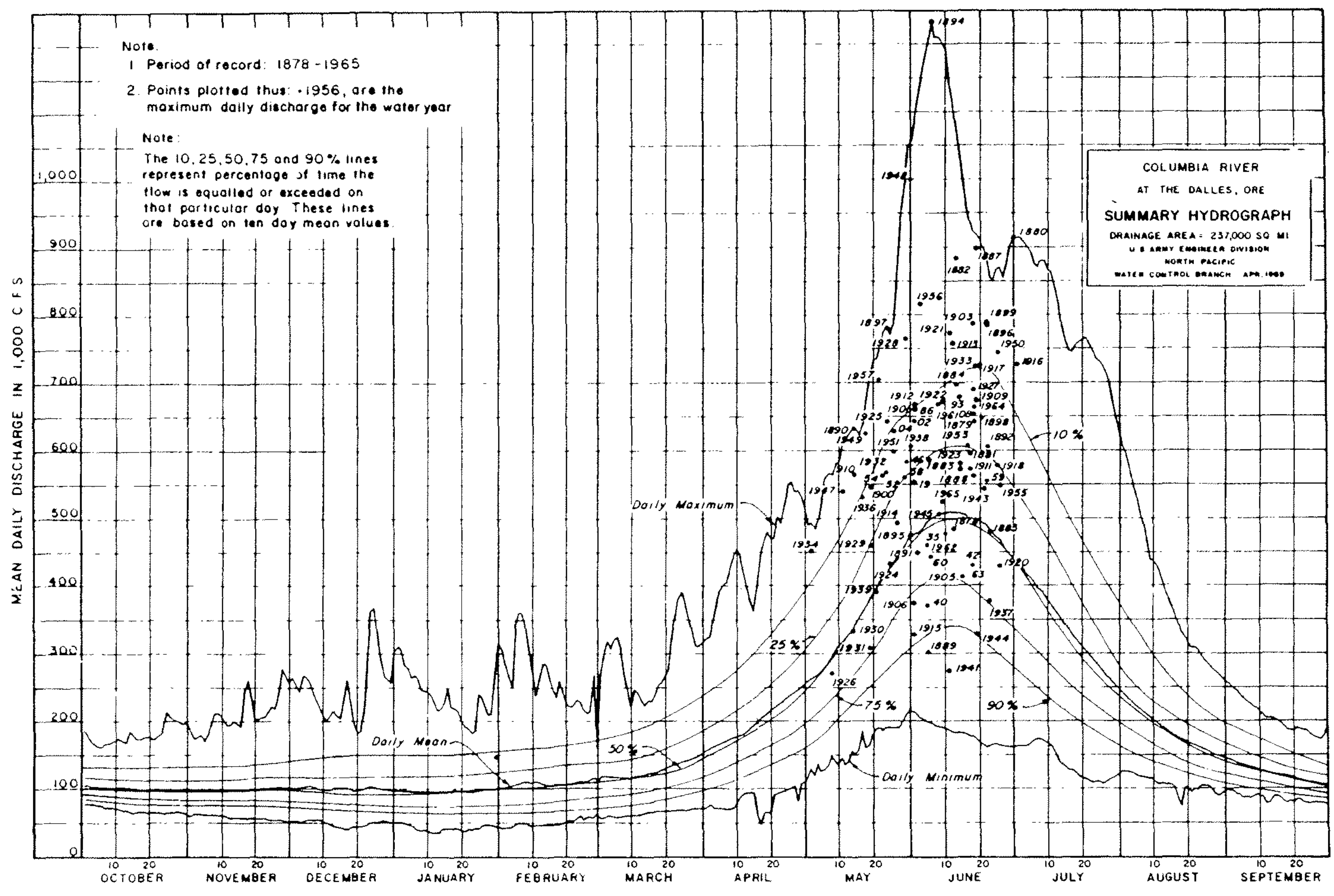


Figure B-1.
Variation in Natural Streamflow at the Dalles

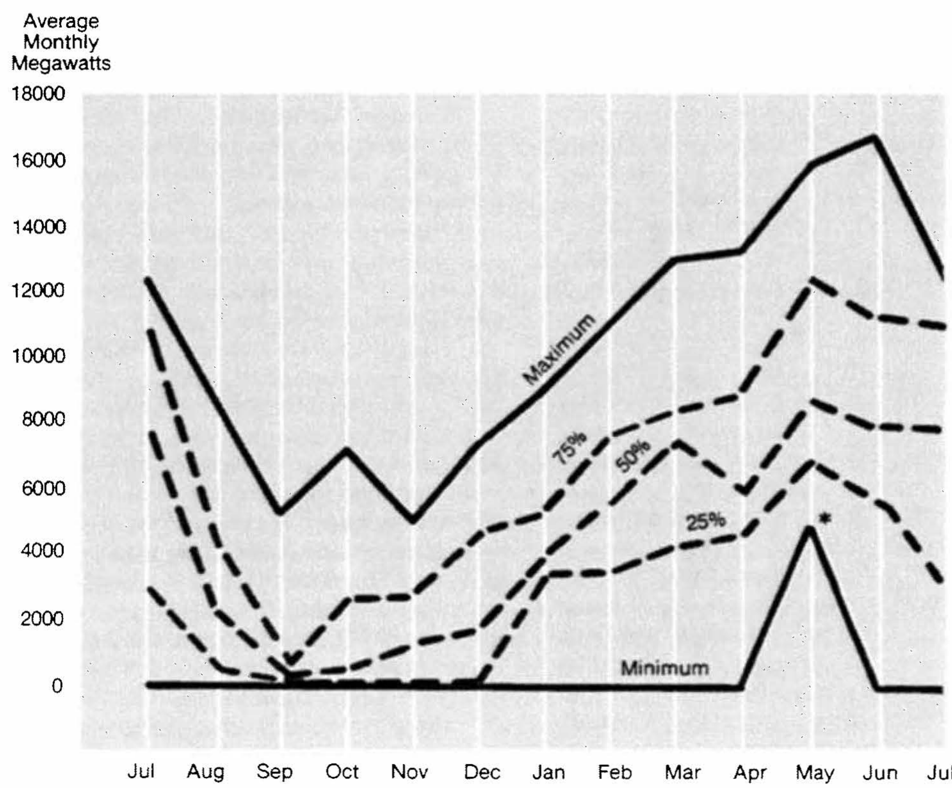
The Northwest system is unique in the United States because of this characteristic. Currently the hydropower system produces approximately two-thirds of the total electricity used by the region. Even with demand growth at the medium-high level, hydropower would still be producing about half of the region's electricity at the turn of the century. There are two key characteristics to the Northwest hydropower system. First, there is a large variation in annual energy capability depending upon rainfall and the snowpack accumulated in the region each year. The average annual output of the hydropower system is approximately 15,650 megawatts, which is about 3,300 megawatts or 25 percent greater than the critical period energy capability, and during a good year the annual capability can be as much as 50 percent greater than critical period capability. "Critical period" refers to that sequence of water conditions during which the lowest amount of firm load can be carried. A second characteristic, which is equally important, is that the variation within the year can be even greater than the variation across the water conditions.

Over half of the annual firm energy from the Northwest hydropower system comes from natural streamflows; less than half comes from reservoir storage. Figure B-1 shows the variation in natural streamflow at The Dalles on the lower Columbia. The relatively low amounts and low variability of natural streamflows between about September and the onset of the spring runoff in about April are important in considering the risks that can be taken in using the reservoir storage.

The reservoir storage itself is significantly limited. A large part of the hydropower system water supply comes from the snowpack in the upper Columbia and upper Snake river basins, in the mountains of British Columbia, Montana, and Idaho; but only 40 percent of even the average runoff is storable in the system's reservoirs. This means that large portions of the total annual water supply come during the spring runoff of April, May, June, and July. Moreover, most of the water from the melting snow must pass through the generators or over the spillways if it cannot be used in the springtime, because it cannot be stored for use in the following fall and winter when demand is higher. Figure B-2 shows the amounts of electric energy available at various probability levels above the critical period quantities over the 102-year historical record for which data are available. The variability of the hydropower system has major effects on the economics of other existing and new resources because it influences the way they operate.

Critical Period Planning

Power system planning is currently conducted on a critical period basis. The total amount of energy resources required assumes that the hydropower system will produce no more energy than it did during the worst conditions of the past. Critical periods run from the beginning of a drawdown season in August or September to the beginning of the refill season with the onset of the spring runoff in March or April. The number of annual cycles of sequential dry years the system can stand is a function of the amount of reservoir storage and generating resources (both existing and new facilities coming on-line during the period being studied). Currently, the worst conditions are either the four-year sequence from August 1928 to March 1932, or the more severe but shorter two-year sequence from September 1943 through April 1945. For this operating year, 1982-1983, the two-year critical period is being used. The common reference to a four-year critical period in regional planning documents does not mean that the region will necessarily have four years to work out problems before the system's reservoirs are empty. Nor does it mean that an exact repetition of the water sequence from 1928 through 1932 is required for the system to be in trouble. In November of 1977, following the 1977 spring runoff, which was the worst runoff since recordkeeping was begun in 1879, the region was only one



Non-firm electric energy available above critical period amounts

* Unshapeable firm surplus due to fish flow requirements.

Figure B-2.

Non-Firm Energy Availability — 102 Year Record

Percentages Indicate Percent of Time Less Than Amount Is Available year past the wet fall of 1976 when the region's reservoirs were high enough to sell secondary non-firm energy and was within five months of having empty reservoirs under continued bad-water conditions.

Planning to critical water as described above does not guarantee that demands will always be met. Even worse water conditions could occur. The Northwest Power Pool currently uses the 1928-68 historical water sequence for planning, and the critical period currently being used is the worst four-year, two-year or occasionally three-year sequence of flows during that period. To determine if that period is representative of the longer term, an independent statistical examination of the complete historical record from 1879 to the present was made by University of Washington researchers. They concluded that the currently used critical period is not an unlikely event, and in fact it is by no means the worst possible sequence that could occur. For instance, a two-year sequence worse than the 1943-45 water sequence (two-year critical period) could occur with something over 2 percent probability and would have a recurrence interval of approximately every 45 years. Moreover, approximately 16 percent of the years in the 102-year record start with reservoirs less than 95 percent full indicating potential critical-water problems for system operators. There will generally be no non-firm energy in the years that do not refill.

Within the confines of system planning, the hydropower system does have some ability to take advantage of the expected increased availability of energy above that available during the critical period. This flexibility in the hydropower system's operation means that, although the total number of megawatts of energy resources planned over the critical period will be determined by the critical period energy capability, the kinds of resources that are used in that resource mix should take into account the expected higher availability over the various water conditions and the seasonal pattern of that water availability.

Because the hydropower system's storage capability is only about 40 percent of the average annual runoff, the system's flexibility is limited. The ability of the system to take advantage in the fall of the large quantities of secondary energy available on an expected basis in the spring, is limited by the risk that system operators are willing to take before the spring runoff begins. The maximum drawdown of the reservoirs for energy generation in the fall and winter is limited by the natural streamflow during the one-year critical period, 1936-37, the lowest single natural streamflow in the historical record. The hydropower system ran against this one-year critical period up until the late 1960's when the building of the Canadian treaty projects increased the storage capability of the system and increased the length of the critical period beyond one drawdown season.

The increased drawdown in the fall and winter to the limits of 1936-37 water adds approximately 1,000 megawatts to the average hydropower system firm energy capability over that eight-month period before the first year's runoff. This 1,000 megawatts may be generically called "provisional draft" since it is borrowed from the following spring against the expectation of greater than critical runoff from the snowpack. Going beyond 1,000 megawatts moves the risk of emptying the reservoirs one year forward in time, from before the second year's runoff to before the first year's runoff. Doing this would require additional backup resources (probably combustion turbines) and would substantially increase the variability of power costs. In addition, increased "provisional" draft would decrease the probability of refilling reservoirs at the end of the year. This could have adverse affects on other reservoir uses, such as resident fish and wildlife, recreation and drafts for irrigation, fish flows, and other purposes. The Council has not investigated the economics of this additional risktaking and does not feel it needs to be investigated unless the region is looking at a significant resource deficit.

The hydropower system has one additional characteristic that is very important for the analysis of resources. The total amount of water available to the hydropower system establishes a limit to the amount of energy that can be produced. In a thermal-based power system, energy is not limited. If energy demand exceeds projections, it can still be met if adequate capacity is available, simply by providing more fuel to the power plants. In such a system, capacity is the most critical component, and providing sufficient capacity is the major consideration in generation planning. Conversely, in the hydropower system, if energy loads exceed the firm energy capability of the system during a period of adverse flows, there is no way in which demands can be met, regardless of how much installed hydropower capacity is available. Hence, firm energy capability is the critical quantity in planning a hydropower-based system. In the Pacific Northwest power system, hydropower plants have been expanded to ensure that system peak loads can be met, that system capacity reserves will be adequate, and that a substantial portion of the secondary energy potential can be utilized, but this capacity would be of limited usefulness unless system firm energy resources were sufficient to meet energy demand. Although the regional power system is evolving from a hydropower-based system to a hydrothermal system, hydropower is still the dominant source. Our experience has been, and further investigation is indicating that it will continue to be, that the binding constraint on the Northwest power system is the total firm energy load rather than the maximum peak load.

Appendix C
Method for Determining Quantifiable Environmental Costs and Benefits

Priority is given in the plan to resources that are cost-effective. [Act, section 4(e)(1).] The Administrator is required to "estimate all direct costs of a resource or measure over its effective life" in order to determine if a resource or measure is cost-effective. [Act, section 3(4)(A) and (B).] Quantifiable environmental costs and benefits are among the direct costs of a resource or measure. Section 4(e)(3)(C) of the Act required the Council to include "a methodology for determining quantifiable environmental costs and benefits under section 3(4)" in the plan. This methodology will be used by the Administrator to quantify all environmental costs and benefits that are directly attributable to a measure or resource.

Proposed Method

A. Identify the characteristics (technical, economic, environmental, and other) of the resource or measure in question. Quantify each identified environmental effect in terms of the physical units involved (e.g., acres of habitat, tons of SO_2, change in water temperature).

B. Identify all potential environmental costs and benefits (e.g., the economic valuation of the effects of changes in the environment) which will result from the resource or measure. Each one of the environmental studies previously completed by the Council should be continually subjected to public review, comment, and improvement. Research to identify the environmental costs and benefits of each resource in light of advancing knowledge about environmental impacts and of technical changes in resources should be continued by Bonneville.

C. Screen the identified environmental costs and benefits to determine whether a meaningful economic evaluation can be performed. In making this determination, reference should be made to the work products of the *Council—Study Module VI, Nero and Associates, Inc., Reports to Council (Tasks 1-6) on Quantification of Environmental Costs and Benefits, Contract 82-020*. In particular, consideration should be given to whether economic techniques exist in a sufficiently developed state to allow for a meaningful analysis of the environmental cost or benefit.

D. Determine whether environmental costs and benefits which can be meaningfully evaluated in monetary terms will be so analyzed. This determination should include consideration of:

1. whether sufficient information exists or can reasonably be obtained to allow for an analysis of the environmental cost or benefit;

2. whether the relative cost-effectiveness of alternative resources is such that the as yet unquantified environmental costs and benefits would likely affect the decision on resource cost-effectiveness; and

3. whether significant costs or benefits remain after considering the effect state, or local standards may have on reducing the environmental cost.

E. For each environmental cost and benefit that will be quantified, an information base should be assembled by the Administrator which analyzes the amount of information available to quantify each cost or benefit and assesses the uncertainty affecting the ultimate quantity estimates. Federal, state, and local studies of such environmental costs and benefits, scholarly and professional quantifications, and data obtained as a result of public comment should be utilized to the extent appropriate.

F. A specific economic evaluation method should then be selected by the Administrator based on the type of environmental cost or benefit, data available on characterizing the environmental effect and related environmental cost or benefit, experience with the method (e.g., has it been successfully used in the past), and type of uncertainties involved. The strengths and limitations of the evaluation method vary with each environmental impact and should be documented. More than one evaluation method may be necessary in order to cross check and verify results.

G. For those environmental costs and benefits where it is not possible to develop monetary values, key physical and biological parameters should be described and, if possible, quantified.

H. To the extent that no quantification on any terms is possible, the environmental costs and benefits should be identified and described and an assessment as to their probable magnitude in relative terms should be made. The environmental costs and benefits of a resource should be given due consideration by the Administrator before the resource is acquired. Such environmental costs and benefits may be found to be sufficient to bar the acquisition. (See chapter 2, Policy on Environmental Quality/Fish and Wildlife.)

I. The application of the evaluation methods should then take place. A record should be compiled which describes the resource, indicates what impacts were identified and which measurement methods were selected, documents each aspect of the calculation, and supports the final result. Throughout this process, the Administrator should consult with the Council; the resource sponsor, interested persons, Bonneville customers, consumers, states, and local political subdivisions. The Administrator should involve the public to the maximum extent appropriate.

J. All quantified environmental costs and benefits should then be included in the decision on resource cost-effectiveness. Where the environmental cost or benefit has been quantified in other than monetary terms, the Administrator should make a decision about the cost-effectiveness of each resource or measure by comparing the dollar cost of resources or measures with such costs or benefits to the dollar cost of competing resources or measures. A determination should then be made as to whether the quantifiable but unpriceable costs or benefits are sufficient to make an otherwise less-expensive resource or measure, with such unpriceable environmental costs or benefits, more "costly" than the next most "costly" resource or measure.

Appendix D
Method of Surcharge

Section 4(f)(2) of the Act provides for surcharges on customers for those portions of their loads within the region that are within states or political subdivisions which have not, or on customers which have not, implemented conservation measures that achieve savings of electricity comparable to the model conservation standards. The Council is responsible for drafting a "methodology" for the calculation of surcharges. Moreover, no surcharge may be imposed by the Administrator unless the Council recommends it by a majority vote. The following is the "methodology" for calculating surcharges:

1. The following model conservation standards are subject to surcharges:

   - Model Standards for new residential buildings, Action 2;
   - Model Standards for new non-residential buildings, Action 3;
   - Model Standards for conversion to electric space heat in residential buildings, Action 6; and
   - Model Standards for conversion to electric space conditioning in non-residential buildings, Action 7.

2. The Administrator shall identify those customers, states, or political subdivisions which have not:

   a. implemented the model standards listed in paragraph 1; or

   b. achieved comparable savings of electricity through other conservation methods.

3. The Surcharge shall then be calculated by Bonneville as follows:

   Step 1. Determine the Administrator's increased load to be served due to the failure to implement model standards and/or *achieve comparable savings*. The Council's estimate of the actual savings that will be achieved by the implementation of the model standard shall be the basis for this determination. (NOTE: The Regional Act refers to "energy savings attributable to such conservation measures which have not been achieved." It is that "energy savings" that is meant by "increased load" in this methodology.)

   Step 2. Identify the incremental Bonneville system costs and benefits resulting from Bonneville service to the increased load in the service area which did not implement the standards or achieve comparable savings. The Council's plan shall serve as the basis for selecting any additional resources needed to serve these increased loads.

   Step 3. Calculate the annual net cost in any given year that will be incurred by Bonneville because the savings calculated in step 1 are not achieved. The net cost equals the costs identified in step 2 less any related benefits, such as revenues obtained through Bonneville's sales, to meet increased load or other benefits as determined by the Administrator. Where these costs include the acquisition of resources necessary to serve the "avoidable" load, the Council's resource plan shall serve as the basis for identifying the cost of needed resources.

   Step 4. Divide the annual net cost incurred by Bonneville in any given year by the non-complying customer's (or jurisdiction's) forecast total load on Bonneville for the given year to determine that year's surcharge per unit of sales.

   Step 5. If the computed surcharge is below 10 percent "of the Administrator's applicable rates for such load or portion thereof," then a 10 percent surcharge should be imposed. Any surcharge above 50 percent will be limited to 50 percent of the applicable rates.

   Step 6. Bonneville shall then impose the computed surcharge.

4. Any entity that chooses not to adopt a particular model conservation standard within the allotted period for adoption and wishes to avoid a surcharge must declare, before that period expires, how it intends to achieve comparable savings. In addition, that entity must indicate how it intends to demonstrate attainment of comparable savings. Bonneville shall determine, in consultation with the Council, whether the alternative conservation plan of an entity will achieve comparable savings. If Bonneville determines that it will not, Bonneville shall notify the Council and the entity and shall give the entity an opportunity to cure the defect. A surcharge shall not be imposed for any period prior to the deadline for curing the defect. The alternative conservation plan, including monitoring and evaluation procedures, shall be included in Bonneville's conservation or other contracts with the utilities who serve the area covered by the alternative plan. The conservation savings to be achieved by the alternative conservation plan may be offered to Bonneville for acquisition under a utility conservation contract or a billing credit contract as desired by the entity. The method of determining the energy savings of such an alternative conservation plan shall be included in the Bonneville surcharge policy, as well as the method for terminating the surcharge once model standards have been implemented or comparable savings are achieved.

Appendix E
Conditions for Bonneville Financial Assistance to Hydropower Development in the Region

The Council includes the following conditions in its plan in response to section 4(e)(2)(C) of the Northwest Power Act, which requires due consideration of protection, mitigation, and enhancement of fish and wildlife and related spawning grounds and habitat, including sufficient quantities and qualities of flows for successful migration, survival, and propagation of anadromous fish.

1. Protection, mitigation, and enhancement of fish: Bonneville shall not agree to acquire power from, grant billing credits for, or take any other actions under section 6 of the Act concerning any hydropower development in the region without providing for:

   (A) Consultation with the fish and wildlife agencies and tribes, state water management agencies, and the Council throughout study, design, construction, and operation of the project;

   (B) Specific plans for flows and fish facilities prior to construction;

   (C) The best available means for aiding downstream and upstream migration of salmon and steelhead;

   (D) Flows and reservoir levels of sufficient quantity and quality to protect spawning, incubation, rearing, and migration;

   (E) Full compensation for unavoidable fish or fish habitat losses through habitat restoration or replacement, appropriate propagation, or similar measures which give preference to natural propagation over artificial production of fish;

   (F) Assurance that the project will not inundate the usual and accustomed fishing and hunting places of any tribe;

   (G) Assurance that the project will not degrade fish habitat or reduce numbers of fish in such a way that the exercise of treaty rights will be diminished; and

   (H) Assurance that all fish protection and mitigation measures will be fully operational at the time the project commences operation.

2. Protection, mitigation, and enhancement of wildlife: Bonneville shall not agree to acquire power from, grant billing credits for, or take other actions under section 6 of the Act concerning any hydropower development in the region without providing for:

   (A) Consultation with the wildlife agencies and tribes, state water management agencies, and the Council throughout study, design, construction, and operation of the project;

   (B) Avoiding inundation of wildlife habitat, such as winter range or migration routes essential to sustain local or migratory populations of significant wildlife species, insofar as practical;

   (C) Timing construction activities, insofar as practical, to reduce adverse effects on nesting and wintering grounds;

   (D) Locating temporary access roads in areas to be inundated;

   (E) Constructing subimpoundments and using all suitable excavated material to create islands, if appropriate, before the reservoir is filled;

   (F) Avoiding all unnecessary or premature clearing of all land before filling the reservoir;

   (G) Providing artificial nest structures when appropriate;

   (H) Avoiding construction, insofar as practical, within 250 meters of active raptor nests;

   (I) Avoiding critical riparian habitat (as defined in consultation with the wildlife agencies and tribes) when clearing, riprapping, dredging, disposing of spoils and wastes, constructing diversions, and relocating structures and facilities;

   (J) Replacing riparian vegetation if natural revegetation is inadequate;

   (K) Creating subimpoundments by diking backwater slough areas, creating islands, level ditchings, and nesting structures and areas;

   (L) Regulating water levels to reduce adverse effects on wildlife during critical wildlife periods (as defined in consultation with the fish and wildlife agencies and tribes);

   (M) Improving the wildlife carrying capacity of undisturbed portions of new project areas (through such activities as managing vegetation, reducing disturbance, and supplying food, cover, and water) as compensation for otherwise unmitigated harm to wildlife and habitat in other parts of the project area;

   (N) Acquiring land or management rights where necessary to compensate for lost wildlife habitat at the same time other project land is acquired and including the associated costs in project cost estimates;

   (O) Funding operation and management of the acquired wildlife land for the life of the project;

   (P) Granting management easement rights on the acquired wildlife lands to appropriate management entities; and

   (Q) Collecting data needed to monitor and evaluate the results of the wildlife protection efforts.

3. All proposals for Bonneville support of hydropower development should explain in detail how these provisions will be accomplished or, where exceptions are allowed, the reasons why the provisions cannot be incorporated into the project.

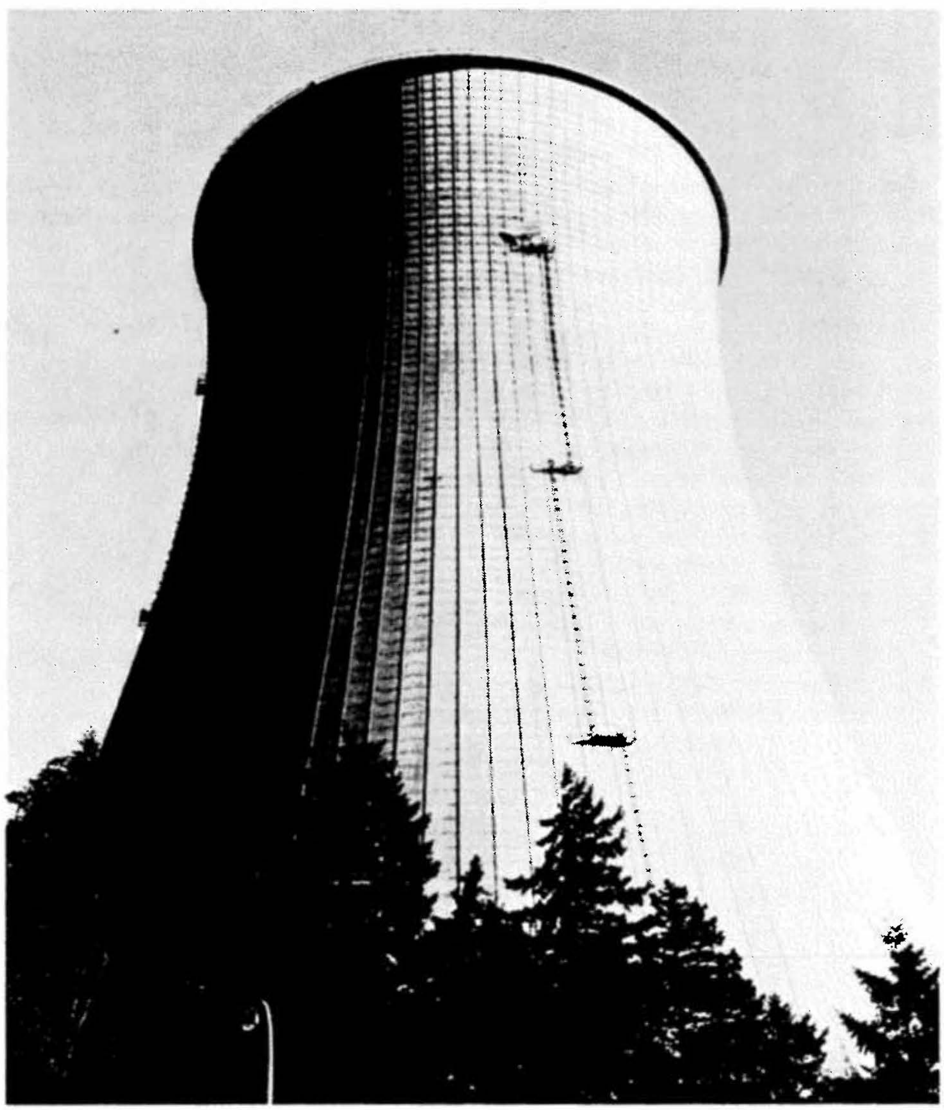
Appendix F
Economic Analysis of Resource Costs

To compare the cost of different energy resources, two types of analysis must be performed. The first is a cost analysis, which measures the various costs of different resources on a comparable basis. The second is a system analysis, which demonstrates how various resources interact with an existing power system. This appendix describes the first type, cost analysis.

Inflation distorts the cost decisions involved in the provision of any energy resource. Inflation makes the resource appear to cost more if it is purchased at a later point in time. To control for this distortion, three concepts are utilized: *Nominal dollars* are "actual" dollars, and include the effects of inflation. These are the dollars that, at the time that they are spent, no adjustments are made for the amount of inflation that has affected their value over time. *Real dollars*, on the other hand, do not include the effects of inflation. By removing the impact of inflation on a dollar's purchasing power, a real dollar represents constant purchasing power. That is, a real dollar has the same value in 1989 that it had in 1949. To convert nominal dollar costs to real dollar costs, a *base year* is chosen, and all costs are converted to that year's dollars; i.e., the inflation that occurs between years is removed. The Council uses a base year of 1980 and a forecast inflation rate of 6 percent per year.

Even after costs are converted to real 1980 dollars, it is difficult to compare the costs of different resources because costs occur in different years. For instance, a hydropower project involves a large outlay at the beginning for construction, but the fuel (water) is essentially free after completion. An oil or gas-fired combustion turbine, though, has a low construction cost, but the fuel cost is high and may even escalate in real terms (that is, it may get more expensive to run even after removing the effect of inflation).

Because of the various resources available in the region and the different capital and operating cost structures associated with each, two methods must be used to place them on even footing for cost comparison purposes. *Present value* and *levelized cost* are the methods utilized. Present value implies that money has a time value. That is, *when* money is held is as important as the *amount* of money held. A dollar is worth more today than it is a year from now because it could be invested during the year to earn a financial return. For example, it could be deposited in a bank and earn interest; a year from now, it would be worth more than a dollar due to the interest earned. Hence, the dollar a year from now is converted back to its present value by calculating, over the year, the interest or return foregone. Present value then allows the equal comparison of costs of energy resources by using a standard interest rate and converting those costs back to a base year. The series of costs that represent an equal annual amount that will be converted to the present value is called *levelized cost*. For instance, the amount borrowed from a bank is the present value of buying a house; the mortgage payment is the levelized cost. The standard interest rate used in calculating present value and levelized cost is called the *discount rate*. The discount rate used for the Council's analyses was an inflation-free real rate of 3 percent. Interest rates consist of a real rate and an inflation premium. Since all costs were converted to base 1980 dollars and inflation removed, a real interest rate was used for the discount rate.



The application of all the concepts to a generic nuclear plant, is illustrated in figures F-1, F-2, and F-3. Figure F-1 shows the *nominal* (actual) expenditures for the plant through construction and during its operation. The line labeled "construction" represents the cumulative construction costs from the start of the project in 1984 to the time it comes on-line in 1993. The total capital cost is $6.3 billion, which includes labor and materials of $4.2 billion and interest of $2.1 billion. For the purposes of this example, the assumption has been made that those costs are repaid to lenders at a uniform rate of $800 million a year beginning in 1993. Those annual payments are represented by the "debt service line." The line labeled "O & M" (operations and maintenance) rises slightly faster than the rate of inflation due to increased costs of nuclear fuel. O & M starts at $200 million a year and rises to $1.6 billion per year by the end of the plant's thirty-year life. Again, all costs in this chart include the effects of inflation over time.

Figure F-2 takes the debt service line from Figure F-1 and demonstrates the conversion of nominal dollars to real dollars applying the present value and levelized cost concepts. The line labeled "nominal" represents the repayment of the construction costs from 1993 forward. Those costs include inflation. By converting to real costs, hence removing inflation (line labeled "real 1993$"), the effect of inflation upon the nominal repayment costs is illustrated. Starting in 1993, debt service commences at a fixed payment of $800 million per year. Over the years, repayment is subject to general inflation, but cannot rise to reflect it. Therefore, by the end of the repayment period, the nominal repayment amount of $800 million is worth $200 million in actual 1983 dollars. Inflation has decreased the

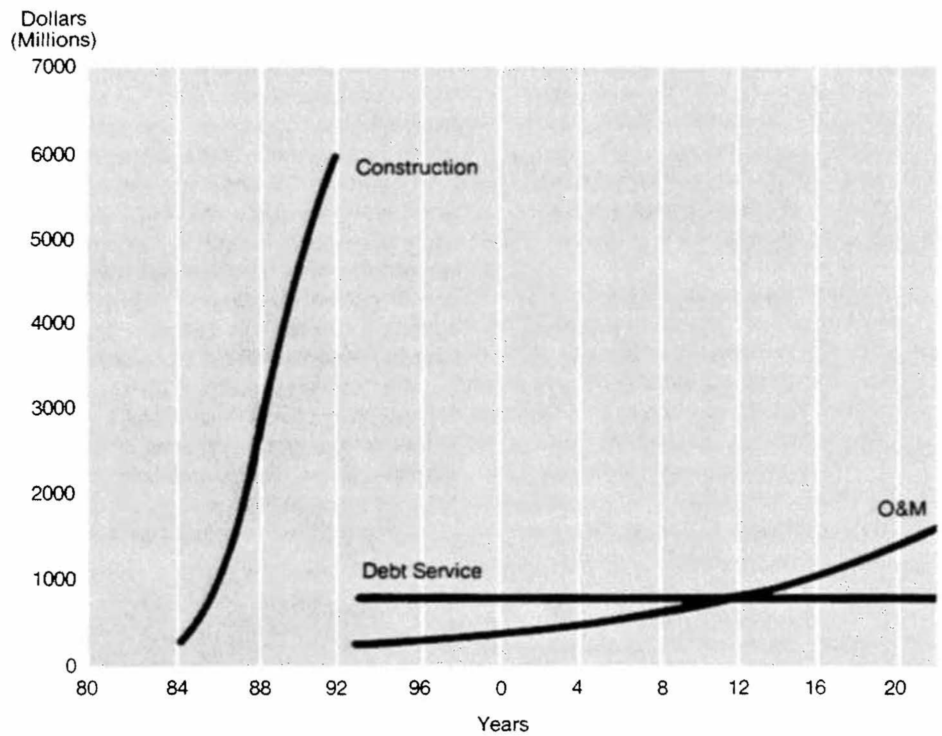


Figure F-1.
Actual Nominal Dollar Expenditures

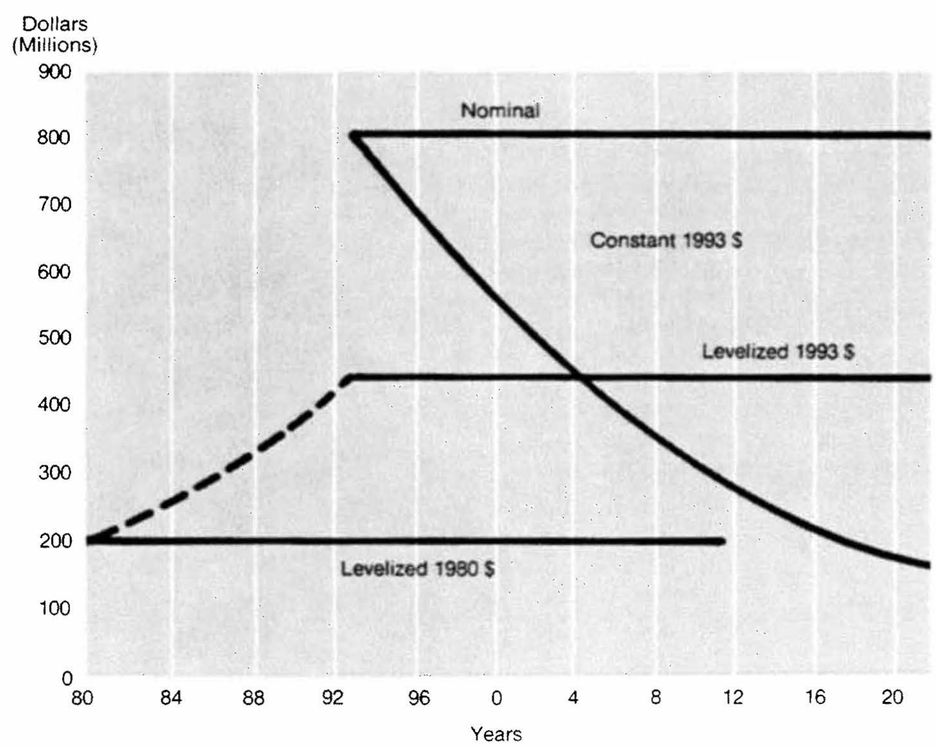


Figure F-2.
Capital Costs

value of a fixed payment because other wages and costs have risen with inflation. The declining real costs are then annualized to levelized real costs (line labeled "levelized 1993$"). This line represents the constant debt service payments restated to control for inflation. Finally, using the line labeled "levelized 1980$," the debt service payments are restated to the base year 1980 dollars by removing inflation from 1980 to 1993 and calculating the present value for shifting the costs back in time. This process allows the comparison of capital costs of different resource projects by controlling for timing, inflation, and interest rates.

Figure F-3 goes through the same process, but uses the O & M line from figure F-1 to analyze operating costs. Operating costs start at $200 million a year in 1993, and rise in nominal terms (line labeled "nominal") to $1.6 billion by the end of the plant's life. The assumption is made that these costs rise faster than general inflation due to the costs of nuclear fuel. Those nominal costs are controlled for inflation, and represented by the line labeled "real 1993$" which reflect the slightly higher (than inflation) cost increases of fuel over time. Levelizing those costs yields the "levelized 1993$" line. This restates the stream of real dollar costs to an annualized amount. "Levelized 1980$," then, takes the levelized 1993 costs back to 1980 levelized costs by controlling for inflation for those years and using present value.

The various numbers that can describe the same plant are summarized in table F-1. The capital cost in nominal dollars is $6.3 billion. The first-year cost, as it would actually affect rates in 1993, the first year of operation, is 14.5 cents per kilowatt-hour. Levelized in 1993 dollars for comparison with other resources that come on-line in 1993, the cost is 9.3 cents per kilowatt-hour. Finally, converted to the base year used in the Council analysis, the levelized cost is

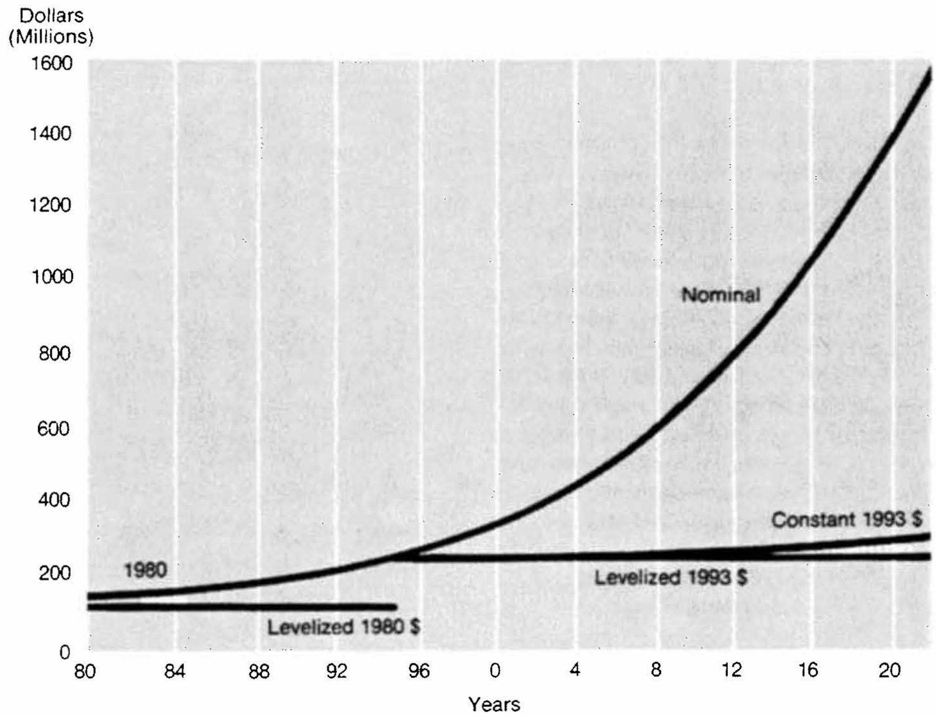


Figure F-3.
Operations Costs

Table F-1.
Cost Anaysis Summary

Total Capital Cost	$6.3* Billion
Direct Construction	$4.2* Billion
First Year Cost	14.5 cents per kilowatt hour
Levelized 1993 dollars (first year of operation)	9.3 cents per kilowatt hour
Levelized 1980 dollars	4.6 cents per kilowatt hour

*Billions of nominal dollars.

4.6 cents per kilowatt-hour. Table F-2 gives a sample calculation of the levelized cost of a conservation measure.

It is important to remember that the process described above is used to put resource cost estimates on a consistent basis; it is not a prediction of the impact of any given resource on consumer rates in a given year. In fact, the two example resources mentioned above (the hydropower plant and the combustion turbine) could have quite different effects on rates in any given year. The hydropower plant is the most expensive in the first year; since the capital cost is fixed, its real cost declines through time as other costs and wages rise with inflation. Grand Coulee was a very expensive project when it was finished in the early 1940's. It is only the succeeding forty years of inflation that made the cost of about 0.2 cent per kilowatt-hour relatively cheaper compared to the cost of new power plants. A combustion turbine, on the other hand, has a large percentage of its total cost in its fuel cost. If operated at reasonable levels of annual output, its total cost (capital plus fuel) could be lower in the first years of its operation than the hydropower plant. However, its fuel cost will continue to rise with inflation, if not faster, and its relative rate impact will be much higher twenty years from now than would that of a hydropower plant built now. A resource like the hydropower plant could have the lowest present value and levelized cost even though it has the highest first-year cost. The Council's resource choice was not based on the rate impacts in any given year but was based on the present-value cost, taking into account the costs and their timing over the life of the resources.

Levelized cost numbers are appropriate for rough comparison of resources. For the final analysis, the resources' operating characteristics were simulated in the system analysis model, and the costs from that simulation converted to present values.

Table F-2.
Sample Calculation of Levelized Cost of Conservation Measure

$$\text{Levelized Unit Cost} = \frac{\text{Measure Cost in 1980 dollars x Annual Capital Recovery Factor}}{\text{Annual Savings in kWh}}$$

Measure Life (years)	Annual Capital Recovery Factor (3% Real Discount Rate)
5	0.218
10	0.117
15	0.084
20	0.067
25	0.056
30	0.051

Formula for Annual Capital Recovery Factor:

$$\frac{i(1 + i)^N}{(1 + i)^N - 1}$$

Where N = Measure Life
i = Real Discount Rate

Example: Water Heater Wraps

Measure Cost = $32
Annual Savings = 435 kWh
Annual Capital Recovery Factor = .117 (10 years)

$$\text{Levelized Unit Cost} = \frac{\$32 \times 0.117}{435 \text{ kWh}}$$

= $0.0086/kWh or 8.6 mills/kWh

NOTE: To convert from levelized 1980 dollars to levelized 1983 dollars, multiply by 1.163. This factor represents the overall effects of inflation between January 1980 and January 1983.