BY THE COMPTROLLER GENERAL

Report To The Congress

OF THE UNITED STATES

REGION AT THE CROSSROADS--THE PACIFIC NORTHWEST SEARCHES FOR NEW SOURCES OF ELECTRIC ENERGY

The Pacific Northwest no longer is able to meet increasing energy needs with inexpensive hydroelectric power. Regional consumers will have to pay higher rates, but:

--How much new power will be needed?

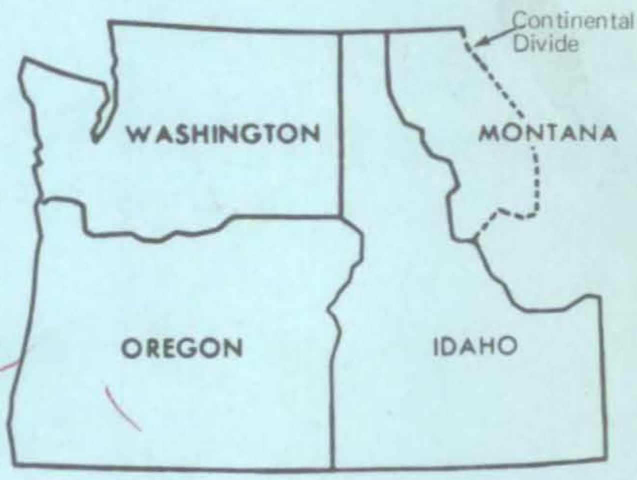
--What sources of power should be developed?

--How much should new power cost?

--How should the region finance its energy future?

These controversial issues are being intensely debated within the region. Objective answers are elusive.

The Congress should charge the Bonneville Power Administration with responsibility for working with State and regional interests to conserve electric power, institute more realistic pricing of electricity, develop renewable energy technologies, and increase public involvement in power planning and policy-making.



UNITED STATES GENERAL ACCOUNTING OFFICE

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COMPTROLLER GENERAL OF THE UNITED STATES
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To the President of the Senate and the
Speaker of the House of Representatives

This report discusses options for the Pacific Northwest in meeting its electric energy needs through the year 2000 and the Bonneville Power Administration's role in meeting those needs.

We made our review pursuant to the Budget and Accounting Act, 1921 (31 U.S.C. 53).

We are sending copies of this report to the Director, Office of Management and Budget; the Secretary of Energy; the Administrator of the Bonneville Power Administration; Governors, Senators, and Representatives of Pacific Northwest States; and the House and Senate committees and subcommittees having oversight responsibilities for the matters discussed in the report.

Elmer B. Staats
Comptroller General
of the United States

COMPTROLLER GENERAL'S REPORT TO THE CONGRESS

REGION AT THE CROSSROADS--THE PACIFIC NORTHWEST SEARCHES FOR NEW SOURCES OF ELECTRIC ENERGY

D I G E S T

The Pacific Northwest region has entered a difficult transition period. Most large hydroelectric sites have been developed. Additional large hydropower supplies, long the mainstay of regional electrical supply, are no longer available. Yet power demand will no doubt continue to rise as the population expands and new industrial growth occurs.

Coal-fired and nuclear powerplants are advocated by many power planners as practical ways to meet future electrical needs. But conservation options are also being proposed, as are the potentials for using other renewable energy sources, including geothermal energy; solar radiation; and secondary solar energy forms, such as wood wastes, wind, and small hydro developments. Regional institutions are struggling to develop new electricity management policies which can reconcile future energy needs with the environment and economy.

The region's traditional decisionmaking processes are ill equipped to deal with the problems of transition. No single Federal, State, or local organization is responsible for regionwide electricity management. Futhermore, coordination and planning groups generally do not represent the broad spectrum of regional interests.

In the absence of strong and unified leadership, energy management objectives have not been established and regional institutions are in conflict over forecasting methods, conservation potentials, future energy sources, and power-planning practices. Conflicts have also developed over customers' rights to Federal hydropower and utility requests for Federal assistance in financing new powerplants. These conflicts have prevented the cooperation needed to develop a regional electricity management program.

THE FEDERAL ROLE

The Federal role in constructing and operating power generation and transmission facilities has been significant. Federal dams, built, operated, and maintained by the Bureau of Reclamation and the U.S. Army Corps of Engineers, furnish over 50 percent of the electricity generated in the region. The power generated at these dams is marketed and transmitted throughout the region by the Bonneville Power Administration.

To a great extent, Bonneville represents the Federal presence in energy policymaking. It markets half of the region's electricity and owns and operates high voltage transmission lines capable of carrying up to 80 percent of the region's power. Many regional electric distributors depend exclusively on Bonneville for their power supplies.

Within the region, Bonneville serves publicly owned utilities, Federal agencies, investor-owned utilities, and direct service industries. It is required by law to give publicly owned utilities and Federal agencies first call (preference) on the Federal energy it markets. In fiscal year 1976 preference customers accounted for 41 percent of Bonneville power sales; investor-owned utilities accounted for 10 percent; and direct service industries accounted for 32 percent, which included 29 percent sold to the region's aluminum industry. Another 17 percent of 1976 sales were to customers outside the region, principally California utilities.

Development of the region's major hydro sites, coupled with Bonneville's marketing of Federal power has produced the region's unique energy environment: the Nation's lowest priced electricity, a per capita electricity consumption rate nearly twice the national average, and a high degree of electrical self-sufficiency based on renewable energy sources within the region.

THE SEARCH FOR NEW ENERGY SUPPLIES

In the late 1960s Bonneville and regional utilities forecasted that electrical demand would triple between 1970 and 1990 and concluded that the region needed to supplement its hydro capacity with new forms of generation. From that time regional power planning has emphasized the need for thermal powerplants. According to a 1976 Bonneville report, thermal plants could account for 99 percent of the region's new energy supplies between 1977 and 1997.

Such an aggressive move toward thermal generation represents a significant departure from the region's historic reliance on renewable hydropower. Groups concerned about the high costs and potential environmental hazards of nuclear and coal-fired plants are asking whether conservation measures, together with development of nonconventional renewable energy sources, could reduce the need for thermal facilities. Regional evaluations of these alternatives, for the most part, are fragmented and inconclusive.

Bonneville and the region's electric utilities have taken only limited steps to encourage energy conservation and use of renewable energy sources. These alternative supply sources represent major objectives in the National Energy Plan, and considerable interest in these alternatives exists within the region. Concern about the planned move to thermal generation heightened this interest and has led to conflict over energy supply options and other policy issues. This conflict, along with disagreements over the equity of Federal hydropower distribution and new powerplant financing, has virtually deadlocked regional power planning.

ALTERNATIVE ELECTRICAL ENERGY POLICY SETS

To assist the committees of the Congress and Pacific Northwest policymakers in making choices about the region's electrical energy future, the General Accounting Office (GAO) employed a team of energy consultants to describe and analyze three alternative electrical energy policies for electricity management.

These cover a broad spectrum of energy policy options and explore the economic, environmental, and social impacts of each through the year 2000. The three policies are the

--thermal/traditional, which characterizes an extension through the year 2000 of energy policies used in the region's hydrothermal power program;

--intermediate, characterized by mild policies to encourage conservation and development of renewable energy sources; and

--renewable/transition, characterized by aggressive policies to encourage energy conservation and develop renewable energy sources.

The consultants used two forecasts: (1) the prediction of regional utilities that electrical energy demand will grow at an annual rate of about 4.8 percent and (2) the forecast used by the Northwest Energy Policy Project, considered the most likely to occur, a growth rate of 2.7 percent.

CONCLUSIONS

The Pacific Northwest region needs improved leadership in electric power planning and policymaking. Although many problems and opportunities inherent in this transition period can be dealt with most effectively on a regional basis, no regional entity is responsible for developing a coordinated regional electricity management program.

Yet a mandate for regionwide policymaking is required so that power planners can chart the region's energy future. Representative planning is needed to develop an acceptable regional electricity management program to include

--increased opportunities for State and local governments to participate in power planning and

--participation also by environmentalists, utility customers, and other interested parties.

Citizen participation should not be limited to after-the-fact reviews of plans developed by Federal agency and electric utility officials. If more open and representative planning is not provided, regional power programs increasingly will be disrupted by legal actions to protect citizen interests.

Forecasting is an issue that will continue to polarize regional opinion until an accepted process is devised. Long-range energy demand forecasts are essential to planning and policy analysis; however, they are so inconsistent that decisionmakers must make every effort to test their objectivity and reasonableness. Even after they are accepted for planning and policymaking use, demand forecasts should be monitored and reevaluated in view of actual demand experience, improvements in forecasting techniques, and load management goals.

It would be unwise for regional policymakers to rush decisions on when and where to build new thermal generation facilities. Some regional power planners contend that shortages are imminent. GAO policy set analysis showed that if the 2.7-percent growth rate proved more realistic than the 4.8-percent growth rate and moderate conservation incentives were adopted, the thermal generating plants already approved for construction would be sufficient to meet regional demand through 1995. The uncertainties associated with utility load forecasts, together with evidence of significant conservation and renewable energy potentials, require a thorough assessment of the alternative supply sources available.

The pricing of electrical energy at true replacement cost would result in greater consumer awareness and greater potential for voluntary conservation. Gradually increasing the rates for Federal hydropower would help accomplish this objective.

Arguments that higher energy prices will automatically lead to economic disaster are not supported by the available facts. Because electric costs are generally a small portion of the total operating costs of commercial enterprises and industries, they rarely become critical to decisionmaking.

Conservation and renewable energy technologies deserve thorough consideration as alternatives to thermal powerplants. These alternative energy sources can be added in smaller increments, require less capital and shorter construction schedules, and generally involve fewer serious environmental risks than nuclear and coal-fired plants. The region may be able to capitalize on its extensive renewable energy potentials more quickly than most power planners predict.

RECOMMENDATIONS

Because of the resources, experience, and expertise represented by Bonneville, the Congress should use Bonneville as a cornerstone in building an updated Federal presence in the region. This need not and should not displace those public and private organizations which have served the region effectively for over 40 years. Federal leadership should build on the coordination and cooperation which have long characterized regional utility operations. Where necessary to help the region meet new energy priorities, institutional changes should be encouraged by new incentives which encourage initiatives and self-direction. The Congress should:

--Relieve Bonneville of its charter responsibility for encouraging the widest possible use of electricity and, instead, charge the agency with regionwide responsibility for leading the development of electricity management plans and programs, encouraging conservation and the most efficient use of energy, and assuring adequate public involvement in energy planning and policymaking.

--Charge Bonneville with a long-term objective of working with private organizations and citizens of the Pacific Northwest to achieve electric self-sufficiency through energy conservation and renewable energy resource use--i.e., a return to the electric self-sufficiency which existed in the region until the development of thermal powerplants. Bonneville should work with regional commissions, State regulatory and planning bodies, electric utilities, and consumer groups to encourage the adoption--on a regionwide or State-by-State basis--of information/education and incentive programs to encourage conservation and further development of the region's renewable energy resources.

--Direct Bonneville to continue to market Federal hydropower to preference customers in accordance with existing legislation. It would be inequitable to abruptly discontinue deliveries of Federal power to preference customers that have become so dependent on this supply source.

--Direct Bonneville to develop and implement a plan for moving the region toward pricing at replacement cost, encourage conservation, and reduce the disparities in regional power rates through the marketing of Federal hydropower. As a first step, an annual surcharge could be added to the price of Federal power in an amount sufficient to bring the total price of hydropower, prior to the year 2000, into parity with the average cost of power produced in the region. The revenues collected by Bonneville through this surcharge could be used to finance a loan and grant fund for regional conservation programs and renewable energy projects. The fund should be managed by Bonneville so as to return surcharge revenues, in the forms of loans and grants, to those that pay the surcharge.

--Amend the Federal Columbia River Transmission System Act (16 U.S.C. 838) to permit Bonneville to use its bond authority to obtain money needed in the loan and grant fund for those early years when the surcharge is not adequate to meet demands on the fund--contingent upon the surcharge on Federal hydropower being sufficient to repay all advances made under this authority by no later than the year 2000.

--Until more information is available, avoid making firm commitments in the near future to help finance conventional thermal powerplants in the Pacific Northwest. However, were it to become clear, given more information, that load growth would be so high as to require additional thermal generation, the Congress could reconsider this issue.

--Direct the Secretary of Energy to take the lead in establishing a representative regional power-planning board to exercise regionwide electricity management and to advise the Secretary of Energy; the Administrator of Bonneville; and the Governors of Washington, Oregon, Idaho, and Montana on the development of power plans and policies. The regional power-planning board should include representatives of Federal agencies, State governments, investor-owned and publicly owned utilities, environmental groups, industry, and energy consumers generally, as well as Presidential appointees, one of whom would serve as chairperson. At the board's request, Bonneville would conduct or contract for studies and reports needed to test and evaluate demand forecasts; review decisions involving the selection of new supply sources, including conservation; and determine the adequacy of public participation in energy planning and policymaking.

--Direct Bonneville, working in conjunction with State energy offices, regulatory bodies, and regional utilities and industries, to develop by 1980--and update every 5 years thereafter--a comprehensive electricity management plan for the region.

The electricity management plan should extend 25 years into the future and identify potentially important developments possible within 50 years. The plan should also include specific objectives and action plans to enhance conservation of electricity, development of renewable energy sources, industrial efficiency in electrical use, techniques for reducing the environmental impacts of powerplants and transmission facilities, and public participation in energy planning and policymaking. The comprehensive electricity management plan should include contingency plans outlining early warning systems and practical regional responses to such potential risks as fuel supply interruptions, unscheduled plant failures, transmission line failures, or adverse water or weather conditions. Bonneville's electricity management plans should be submitted to the regional power-planning board for advice and review and to the Secretary of Energy for his concurrence.

--Direct Bonneville to conduct or participate with other Federal agencies in conducting the studies and tests needed to assess more accurately regional potentials for energy conservation and renewable resource development. These studies should include, for both centralized and decentralized applications, more thorough identification of regional sites with high potential for wind energy development; reassessment of the region's untapped hydroelectric potentials, considering new hydro sites, improvements at existing sites, and nonconventional hydroelectric technologies; evaluation of potential solar radiation applications; and more thorough assessment of geothermal development opportunities. At the conclusion of these tests and studies, recommendations for energy conservation or development programs should be made through the regional power-planning board to the Secretary of Energy.

--Require Bonneville to prepare and publish annual financial reports and to report annually to the people of the Pacific Northwest region, the Congress, and the President on progress and problems in implementing the regional electricity management plan.

AGENCY COMMENTS

The Department of Energy believes the report does an excellent job of assembling a variety of data on the energy situation in the Pacific Northwest and should be useful to the Department of Energy, regional leaders, and the Congress in understanding the various energy options and developing those most appropriate to the region.

Because of items pointed out by the Department, GAO revised the report where applicable. Differences remaining on the impacts of replacement cost pricing on the region's economy and the electric system reliability are discussed in chapter 7.

Contents

ABBREVIATIONS

BPA	Bonneville Power Administration
Btu	British thermal unit
CRA	Charles River Associates, Inc.
ERDA	Energy Research and Development Administration
GAO	General Accounting Office
EIS	environmental impact statement
kW	kilowatt
kWh	kilowatt-hour
MW	megawatt
MWh	megawatt-hour
MWy	megawatt-year
NEP	National Energy Plan
NEPP	Northwest Energy Policy Project
NRDC	National Resources Defense Council
PNUCC	Pacific Northwest Utilities Conference Committee
PUD	public utility district
RPPB	regional power-planning board
WPPSS	Washington Public Power Supply System

GLOSSARY

anadromous fish	Species of fish (such as salmon) that are hatched in fresh water, mature in salt water, and return to fresh water to spawn.
average cost pricing	1. In an economic context, the dividing of total cost by the number of units sold in the same period to obtain a unit cost and then applying this unit cost directly as a price. 2. In a public utility context, the pricing of the service without regard for the structure of the market, to recover those portions of total costs associated with each service in order to make total revenues equal to total costs.
baseload	The minimum load in a power system over a given period of time.
biomass conversion	The process by which plant materials are burned for direct energy use or electrical generation or by which these materials are converted to synthetic natural gas.
blackout	The disconnection of the source of electricity from all the electrical loads in a certain geographical area brought about by insufficient generation, an emergency-forced outage, or other fault in the generation/transmission/distribution system servicing the area.
British thermal unit (Btu)	The standard unit for measuring quantity of heat energy in the English system. It is the amount of heat energy necessary to raise the temperature of 1 pound of water 1 degree Fahrenheit (3,412 Btu's are equal to 1 kilowatt-hour).

brownout — An intentional reduction of energy loads in an area by the partial reduction of electrical voltages, which results in lights dimming and motor-driven devices slowing down.

capacity — Maximum power output, expressed in kilowatts or megawatts. Equivalent terms: peak capability, peak generation, firm peakload, and carrying capability. In transmission, the maximum load a transmission line is capable of carrying.

capacity factor — The ratio of the average load on a generating resource to its capacity rating during a specified period of time, expressed in percent.

conservation — Improving the efficiency of energy use; using less energy to produce the same product.

constant dollars — Dollars whose purchasing power is expressed in terms of the monetary values which prevailed in a specified base year after adjusting for the effects of general inflation. Constant dollar values are often obtained using the consumer price index (CPI) to deflate current dollar values, the values (prices) actually quoted in a given year. For example, suppose the 1975 current dollar price of regular gasoline were $0.60 per gallon. In addition, assume that the CPI for 1975 with 1967 as the base year was 160. The real price in 1967 constant dollars would equal $0.60/160 x 100, or $0.38. The price of any product in constant dollars is often referred to as the real price.

cooperative — Private nonprofit corporations, operating within State laws, but essentially self-regulating. Each cooperative is a preference customer of BPA and is controlled by a board of directors elected from its membership. It is a private business and not a unit or subdivision of government.

critical period	An application of historical lowest streamflows to current storage capacity to determine the maximum firm load-carrying capability of the present system under worst-case conditions; the interval during which all reservoirs are drafted from maximum to minimum elevation without failing to meet a given firm load requirement.
energy curtailment	Temporary mandatory load reduction reflecting emergency conditions, following after all possible conservation action and load management techniques and prompted by problems of meeting baseload, rather than peaking deficiencies.
demand	1. In an economic context, the quantity of a product that will be purchased at a given price at a particular point in time. 2. In a public utility context, the rate at which electric energy is delivered to or by a system, expressed in kilowatts, megawatts, or kilovoltamperes over any designated period.
disturbance	Any occurrence that adversely affects normal power flow in a system, such as a lightning surge on a line or a short circuit.
econometrics	The application of mathematical and statistical methods to the study of economics.
emission	A discharge of pollutants into the atmosphere, usually as a result of burning or the operation of internal combustion engines.
energy	The ability to do work; the average power production over a stated interval of time; expressed in kilowatt-hours, megawatt-hours, average kilowatts, or average megawatts. Equivalent terms: energy capability, average generation, and firm-energy-load-carrying capability.

energy capability	The net average output ability of a generating plant or plants during a specified period, in no case less than a day. Energy capability may be limited by available water supply, plant characteristics, maintenance, or fuel supply.
firm power	Power intended to be available at all times during the period covered by a commitment, even under adverse conditions, except for reason of certain uncontrollable forces or service provisions. Equivalent terms: prime power, continuous power, and assured power. Component terms: firm energy, firm capacity, and dependable capacity.
flat plate collector	A solar energy collector characterized by nonconcentration of solar radiation.
forced outage	An outage that results from emergency conditions directly associated with a component requiring that the component be taken out of service immediately or as soon as switching operations can be performed.
forced outage reserves	An amount of peak generating capability planned to be available to serve peak-loads during forced outages of generating units.
fossil fuels	Coal, oil, natural gas, and other fuels originating from fossilized geologic deposits and depending on oxidation for release of energy.
fuel cycle	The series of steps involved in supplying fuel for nuclear power reactors. It includes mining, processing, and enriching; the original fabrication of fuel elements; their use in a reactor; chemical processing to recover the fissionable material remaining in the spent fuel; reenrichment of the fuel material; and refabrication into fuel elements.

head	Essentially the vertical height of the water in the reservoir above the turbine, that is, the difference between the elevation of the forebay of the reservoir and the tailrace at the foot of the dam.
hydrocarbons	Any of a vast family of compounds containing carbon and hydrogen in various combinations, found especially in fossil fuels. Hydrocarbons in the atmosphere resulting from incomplete combustion are a major source of air pollution.
hydroelectric plant	An electric powerplant in which the turbine-generator units are driven by falling water. --A conventional hydroelectric plant is one in which all the power is produced from natural streamflow as regulated by available storage. --A pumped storage hydroelectric plant is one in which power is produced during peakload periods by using water previously pumped from a lower reservoir to an upper reservoir during offpeak periods.
hydrologic cycle	The continual exchange of moisture between the earth and the atmosphere, consisting of evaporation, condensation, precipitation (rain or snow), stream runoff, absorption into the soil, and evaporation in repeating cycles.
hydropower	A term used to identify a type of generating station, or power, or energy output in which the prime mover is driven by water power.
industrial energy use	In general, energy use by customers engaged primarily in a process which creates or changes raw or unfinished materials into another form or product. A more specific definition is used in chapter 3.

industrial firm power	Power intended to have assured availability but which can be curtailed or restricted to the industrial customer on a contract demand basis.
insufficiency	The lack of sufficient Federal capacity or energy resources to serve BPA's firm load capacity and/or energy commitments.
interruptible loads (interruptible power)	Loads (power) that, by contract, can be interrupted in the event of a capacity deficiency on the supplying system. The interruptible loads are usually heavy industrial segments on the BPA system.
investor-owned utility	A utility which is organized under State laws as a corporation for the purpose of earning a profit for its stockholders.
irradiation	Exposure to radiation, as in a nuclear reactor.
kilowatt (kW)	The electrical unit of power which equals 1,000 watts.
kilowatt-hour (kWh)	A basic unit of electrical energy, which equals 1 kilowatt of power applied for 1 hour.
lifeline rates	A low uniform charge for a specific basic level of electrical or other energy consumption by the residential customer for the purpose of welfare.
load	The amount of electric power delivered to a given point on a system.
load factor	The ratio of the average load to the peakload during a specified period of time, expressed in percent.
load growth reserves	A supply of electric power and energy held in reserve for the unanticipated load growth of a utility having limited resources. If such reserves are available when requested, BPA may sell them to qualified utilities under Schedule EC-7 (Reserve Power Rate).

load management	Influencing the level and state of the demand for electrical energy so that demand conforms to individual present supply situations and longrun objectives and constraints.
load shedding	A method whereby loads in isolated areas are dropped by automatic relays to provide protection for the bulk power system. This could occur when generation is insufficient to meet load.
longrun incremental cost pricing	Pricing associated with meeting the cost of customer requirements for additional increments in utility service on a continuing basis, when the utility has fully adjusted its operation and facilities to the most efficient means of meeting the increased total demand. It includes the immediate expenses the utility incurs in taking on new customers, as well as the cost of utility plant and associated costs necessary to provide and maintain utility service.
marginal cost pricing	A system of pricing whereby each additional unit of a product is priced equal to the incremental cost of producing that unit, or charging a price for all units of a product equal to the incremental cost of producing the last unit.
megawatt (MW)	The electrical unit of power which equals 1,000,000 watts or 1,000 kilowatts.
megawatt-hour (MWh)	A basic unit of electrical energy which equals 1 megawatt of power applied for 1 hour.
mill	A monetary unit equaling one-tenth of a cent ($0.001).
mitigate	In environmental usage the reduction or control of adverse environmental impact through various measures which seek to make the impact less severe, less obvious, more acceptable, etc.

modified firm power — Power sold on a firm basis except that in the event of loss of generation or transmission facilities or occurrence of uncontrollable forces which make it impossible to serve total loads, delivery of modified firm power is restricted to the extent necessary to prevent or minimize restriction of firm power. The extent of the restriction in delivery of modified firm power may be limited regarding amount and duration.

municipal utility — A utility owned and operated by a city.

nameplate rating — The full-load continuous rating of a generator under specified conditions as designated by the manufacturer. It is usually indicated on a nameplate attached mechanically to the individual machine or device.

net-billing —

1. Offsetting payments due one party against payments due the other party under various contacts between those parties.

2. The method used by BPA to acquire preference customers' entitlement to the Trojan, WPPSS 1, 2, and 3 nuclear plants. This acquisition is accomplished by net-billing the preference customers' costs in those nuclear plants against power sales revenues due BPA from the preference customers.

nitrogen oxides (NOx) — Compounds produced by combustion, particularly when there is an excess of air or when combustion temperatures are very high. Nitrogen oxides are primary air pollutants.

nonfirm energy — Energy which is subject to interruption or curtailment by the supplier and hence does not have the guaranteed continuous availability feature of firm power.

nonfirm power	Electric power available during surplus periods, which can be interrupted by the supplying party for any reason. One class of nonfirm power currently available from BPA is called Authorized Increase.
nuclear reactor	A device in which a fission chain reaction can be initiated, maintained, and controlled. Its essential component is a core with fissionable fuel.
ocean thermal gradient	Differences in the temperature of ocean water at various depths.
offpeak	A period of relatively low system demand for electrical energy as specified by the supplier, such as in the middle of the night.
outage	In a power system, the state of a component (such as a generating unit or a transmission line) when it is not available to pérform its function due to some event directly associated with the component.
particulates	Finely divided solid or liquid particles in the air or in an emission. Particulates include dust, smoke, fumes, mist, spray, and fog.
peaking	Operation of generating facilities to meet maximum instantaneous electrical demands.
peaking capability	The maximum peakload that can be supplied by a generating unit, station, or system in a stated time period. It may be the maximum instantaneous load or the maximum average load over a designated interval of time.
peaking capacity	Generating equipment normally operated only during the hours of highest daily, weekly, or seasonal loads. Some generating equipment may be operated at certain times as peaking capacity and at other times to serve loads on a round-the-clock basis.

peakload	The maximum electrical load consumed or produced in a stated period of time. It may be the maximum instantaneous load (or the maximum average load) within a designated interval of the stated period of time.
photovoltaic generation	A method for direct conversion of solar to electrical energy.
pollutant	A residue (usually of human activity) which has an undesirable effect upon the environment (particularly of concern when in excess of the natural capacity of the environment to render it innocuous).
postage stamp rate	Rates for electric service which are unchanged by distance from the source of the power supply, regardless of the purchaser's location within the utility's service area. (Compare with parcel post rate).
power	The time rate of transferring or transforming energy; for electricity, expressed in watts. Power, in contrast to energy, always designates a definite quantity at a given time.
preference	The preferential use of Federal resources by public bodies and cooperatives, as accorded to such entities in the Bonneville Project Act.
PUD	Public Utility District (in Washington) or Peoples' Utility District (in Oregon). These are separate units of government established by voters of the proposed district. The PUDs hold preference customer status in buying BPA power.
radiation	Particulate or electromagnetic energy emitted from atomic or nuclear processes. Examples are neutrons, gamma rays, and light.
radioactivity	The spontaneous radioactive decay or change in energy state of an unstable atomic nucleus, usually accompanied by the emission of ionizing radiation.

reliability	Generally the ability of an item to perform a required function under stated conditions for a stated period of time. In a power system, the ability of the sytem to continue operation while some lines or generators are out of service.
reserve capacity	Extra generating capacity available to meet unanticipated demands for power or to generate power in the event of loss of generation resulting from scheduled or unscheduled outages of regularly used generating capacity. Reserve capacity provided to meet the latter is also known as forced outage reserve.
reserves	Resources which are known in location, quantity, and quality and which are economically recoverable under currently available technologies.
residential energy use	In general, energy use by domestic dwellings for space heating, air-conditioning, cooking, water heating, and other domestic uses.
run of river	A hydroelectric plant with little or no ability to regulate flow.
salmonid	Fish belonging to the family salmonidae, including salmon, trout, char, and allied freshwater and anadromous fishes.
scrubber	Equipment used to remove pollutants, such as sulfur dioxides or particulate matter, from stack gas emissions.
secondary energy	Electric energy surplus to the needs of a supplier, the delivery of which may be interrupted for any reason by the supplier.
secondary power	Power not having the assured availability of firm power; power that is available from a system intermittently and that is used to serve markets that can accommodate such power. Equivalent terms: nonfirm power, surplus power, and secondary energy.

self-financing	The method by which BPA now finances its operation and construction program through all revenues received and through revenue bonds arranged by the Treasury.
self-liquidating (or repayment) policy	The policy that BPA revenues must be sufficient to pay for all costs of operation, maintenance, and administration of the Federal Columbia River Power System; interest on the outstanding power investment; and amortization of investment within 50 years in hydroelectric powerplants and within the normal useful life (now 40 years) for transmission facilities.
solar cell	A semiconductor device that produces a voltage when exposed to the sun; a form of photovoltaic generation.
storage reservoir	A reservoir in which storage is held over from the annual high-water season to the following low-water season. Storage reservoirs which refill at the end of each annual high-water season are annual storage reservoirs. Those which cannot refill all usable power storage by the end of each annual high-water season are cyclic storage reservoirs.
sulfur oxides	Compounds of sulfur combined with oxygen that have a significant influence on air pollution.
surplus energy	Electric energy generated at Federal hydroelectric plants in the Pacific Northwest which cannot be conserved. This energy would otherwise be wasted because of the lack of market for it in the Pacific Northwest at any established rate. When the nonfirm energy needs of the Pacific Northwest entities are satisfied, surplus energy then becomes available for marketing outside the Pacific Northwest.

surplus power	Power that is in excess of the needs of the producing system. For the region surplus power would be exported to serve markets in adjacent areas. Sometimes used as an interchangeable term with "secondary power."
system reserve capacity	The difference between the available dependable capacity of the system, including net firm power purchases, and the actual or anticipated peakload for a specified period.
thermal efficiency	The ratio of the electric power produced by a powerplant to the amount of heat produced by the fuels; a measure of the efficiency with which the plant converts thermal to electrical energy.
thermal generation	Generation of electricity by applying heat to a fluid or gas to drive a turbine generator.
thermal pollution	The warming of the environment, especially streams and other bodies of water, by waste heat from powerplants and factories. Drastic thermal pollution endangers many species of aquatic life.
tieline	A transmission line connecting two or more power systems together, permitting a flow of energy between them.
time-of-day pricing	Rates imposing higher charges during those periods of the day when the higher costs to the utility are incurred.
transmission grid	An interconnected system of electric transmission lines and associated equipment for the movement or transfer of electric energy in bulk between points of supply and points of demand.
turbine	A rotary engine activated by the reaction and/or impulse of a current of pressurized fluid (water, steam, liquid metal, etc.) and usually made with a series of curved vanes on a central rotating spindle.

propeller turbine	A turbine having propeller-shaped blades generally used for lower head projects. These can be either fixed blade (designated as "Prop") or adjustable blade (designated as "Kaplan") turbines.
Francis turbine	A hydroturbine having fixed vane-type blades and used for medium to high heads of water.
two-tier rate	Rates retaining a previously established lower rate level for the current level of service to existing customers and use of a higher rate for the remaining system output, served either for additional requirements of existing customers or for all requirements of new customers.
volt	The unit of electromotive force or electric pressure analogous to water pressure in pounds per square inch. It is the electromotive force which, if steadily applied to a circuit having a resistance of 1 ohm, will produce a current of 1 ampere.
waste, high-level radioactive	Wastes having radioactivity concentrations of hundreds to thousands of microcuries per gallon or cubic foot.
waste, low-level radioactive	wastes having radioactivity concentrations in the range of 1 microcurie per gallon or cubic foot.
watershed	The area from which water drains to a single point. In a natural basin, the area contributing flow to a given place on a stream.
wheeling	The use of the transmission facilities of one system to transmit power of and for another system. As applied to BPA, the transmission of large blocks of electric power over the BPA system from non-Federal hydro and/or thermal generating plants to points of use by utilities owning or purchasing the output of such plants.

CHAPTER 1

INTRODUCTION

The Pacific Northwest region has entered a difficult transition period. Most large hydropower sites in the region have been developed, and additional large supplies of inexpensive hydroelectric power, long the mainstay of regional electric supply, are not available. The remaining damsites are less desirable and often involve substantial detriment in terms of environmental and recreational impacts. Yet power demand will likely continue to rise as the population expands and new industrial growth occurs.

Coal-fired and nuclear powerplants are advocated by many as the only practical way to meet future electrical needs. Conservation options are also being debated, as are the potentials for using other renewable energy sources, including geothermal energy; solar radiation; and such secondary solar energy forms as wood wastes, wind, and smaller hydro developments. Regional institutions are struggling to evolve new policies for electricity management which can reconcile future energy needs with environmental and economic consequences.

The region's traditional decisionmaking processes are ill equipped to deal with the problems of transition. No single institution, Federal or regional, is responsible for electricity management regionwide. Furthermore, regional coordinating and planning groups generally do not represent the broad spectrum of regional interests. Many factions, including State and local governments, environmentalists, and conservationists, are seeking more active roles in energy policymaking.

PURPOSE OF REVIEW

The Federal Government, primarily through the Department of Energy's Bonneville Power Administration (BPA), plays a major role in energy management for the region. Because of the Federal role, the General Accounting Office (GAO) undertook a review to:

--Identify and evaluate the principal electricity management issues facing the region.

--Determine whether adequate decisionmaking structures and processes exist to effectively resolve the issues.

--Evaluate regional electricity management practices to determine if they provide (1) consistency with national energy priorities, (2) environmentally sound development of unique regional resources, and (3) a forward-looking approach to managing energy supplies and demands.

--Identify actions needed to assure adequate and timely decisionmaking on electricity management issues.

SCOPE OF WORK

We discussed electrical energy management problems with BPA officials and met with representatives of various State and local agencies, institutes of higher education, utilities, and other regional electrical energy organizations. In addition, we employed a team of energy consultants (see app. XI) to develop sets of alternative electrical energy policies for the region and to analyze the economic, social, and environmental impacts of such policy sets. The alternative electrical energy profiles for the region are described through the year 2000 and can be compared for their various impacts on the region and its citizens. We also contracted with Charles River Associates, Inc. (CRA), a consulting firm, to study what effects electricity price increases might have on the region's aluminum industry since this industry uses about one-fourth of all electricity in the Northwest.

Energy policy options available to the region have been examined in a number of studies. We reviewed the results of several studies, including:

--"BPA Draft Role Environmental Impact Statement" (Role EIS)--prepared in conjunction with independent consultants, this 1977 report evaluates the past, present, and future availability and use of electrical energy in the region and discusses alternative future roles for BPA in regional power planning.

--"Choosing an Electrical Energy Future for the Pacific Northwest: An Alternative Scenario"--prepared by the National Resources Defense Council (NRDC) and other environmental groups at BPA's request, this 1977 study is designed to "stimulate further dialogue and planning concerning the Pacific Northwest's future needs for electrical energy and the optimum means of meeting those needs."

--Long-Range Projection of Power Loads and Resources for Thermal Planning, West Group Area, 1977-78 through 1996-97--prepared annually by the Pacific Northwest Utilities Conference Committee (PNUCC), the report forecasts load growth and resource requirements of the Federal hydro system and regional utilities over the next 20 years.

--Northwest Energy Policy Project (NEPP)--sponsored by the Federal Government and the States of Idaho, Oregon, and Washington through the Pacific Northwest Regional Commission, this 1977 study analyzes policy options available to the three States for influencing future patterns of energy production and consumption in the region.

Our review also considered the principles and strategies of the administration's National Energy Plan (NEP) (see table 1.1), as well as applicable laws and regulations and proposed Federal legislation recently introduced to restructure the region's electricity planning and management.

TABLE 1.1

Basic Principles Cited in NEP

Principle	
1.	The energy problem can be effectively addressed only by a Government that accepts responsibility for dealing with it comprehensively and by a public that understands its seriousness and is ready to make necessary sacrifices.
2.	Healthy economic growth must continue.
3.	National policies for the protection of the environment must be maintained.
4.	The United States must reduce its vulnerability to potentially devastating supply interruptions.
5.	The United States must solve its energy problems in a manner that is equitable to all regions, sectors, and income groups.
6.	The cornerstone of national energy policy is that the growth of energy demand must be restrained through conservation and improved energy efficiency.
7.	Energy prices should generally reflect the true replacement cost of energy.
8.	Both energy producers and consumers are entitled to reasonable certainty as to Government policy.
9.	Resources in plentiful supply must be used more widely, and the Nation must begin the process of moderating its use of those in short supply.
10.	The use of nonconventional sources of energy must be vigorously expanded.

CHAPTER 2

BACKGROUND AND PERSPECTIVE

For this study the Pacific Northwest region was defined as Washington, Oregon, Idaho, and western Montana. The region may be divided into six topographic zones: the coastal mountains (I), the Puget Sound-Willamette lowlands (II), the Cascade Mountains (III), the Columbia River plateau (IV), the Snake River plateau (V), and the Rocky Mountains (VI). (See fig. 2.1.)

While the entire region experiences the same general climatic pattern--cool, wet winters and warm, dry summers--the mountain ranges create wide variations in precipitation and water runoff. Precipitation is fairly heavy west of the Cascades and occurs mainly as winter rainfall. Streamflows in this part of the region reach a series of peaks, each associated with a winter storm. Summer flows are usually quite low. East of the Cascades, the climate is generally dry, with only the mountains receiving appreciable precipitation in the form of snowfall. As a result, natural streamflow is very low during the winter, with a relatively long annual peak during the late spring and early summer caused by melting snow.

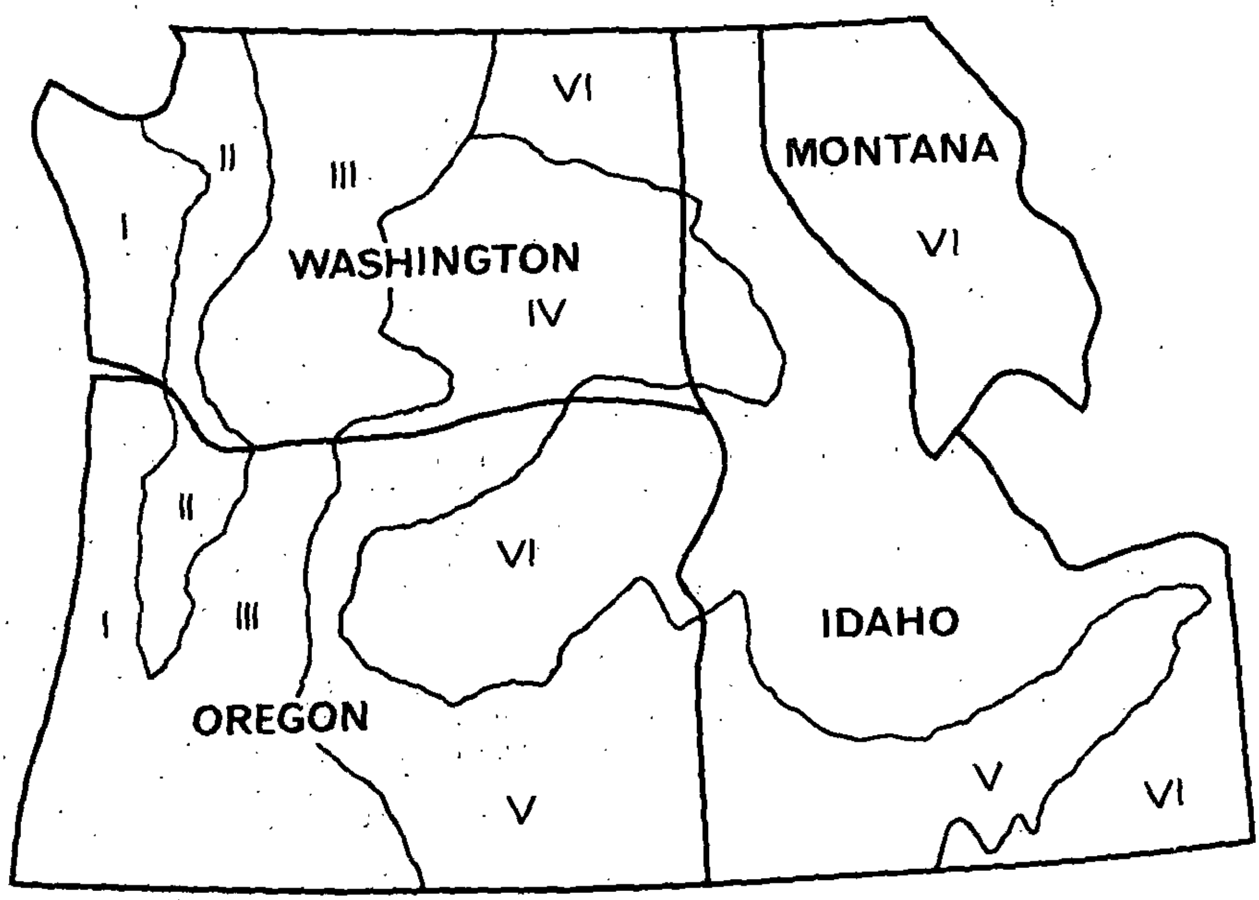
The Northwest is sparsely populated with only 23.8 persons per square mile compared with the Nation's average of 57.5 persons per square mile (based on 1970 census data). Almost 4 million of the region's 6.5 million people live in zone II, which includes the major urban centers of Seattle, Washington, and Portland, Oregon. The population grew 17 percent in the 1960s compared with the Nation's 14 percent.

EMPLOYMENT AND ECONOMY

The work force of the region reached 2.8 million in 1975. Approximately 5.4 percent were employed in agriculture, compared with the Nation's 4 percent. Lumber and wood products workers accounted for 28.8 percent of the work force in the manufacturing sector, compared with the Nation's 3 percent. These figures reflect the region's economic reliance upon extensive forest and agricultural resources. The region had a higher than average percentage of workers employed in construction, transportation, public utilities, wholesale and retail trade, and government and a lower percentage in mining, manufacturing, finance, insurance, and services.

FIGURE 2.1

MAP OF PACIFIC NORTHWEST



Regional per capita income in 1975 of $5,930 was higher than the Nation's $5,902, though unemployment was also 0.9 percent higher.

ENERGY RESOURCES

The region has several other renewable energy sources, such as windpower, solar radiation, wood wastes, and geothermal activity, in addition to its extensively developed hydro resources. Current studies emphasize using windpower and solar radiation in the future. The extensive hydroelectric system enhances possibilities for use of wind or solar energy sources, since they can provide storage capacity and backup generating facilities when intermittent wind and sunshine are unavailable.

The region has no known reserves of oil or natural gas, some uranium reserves, and only one economically feasible source of coal. This means that most fuels used in the region's thermal generating plants are imported from outside the region and will continue to be in the foreseeable future.

IMPORTANCE OF ELECTRICITY

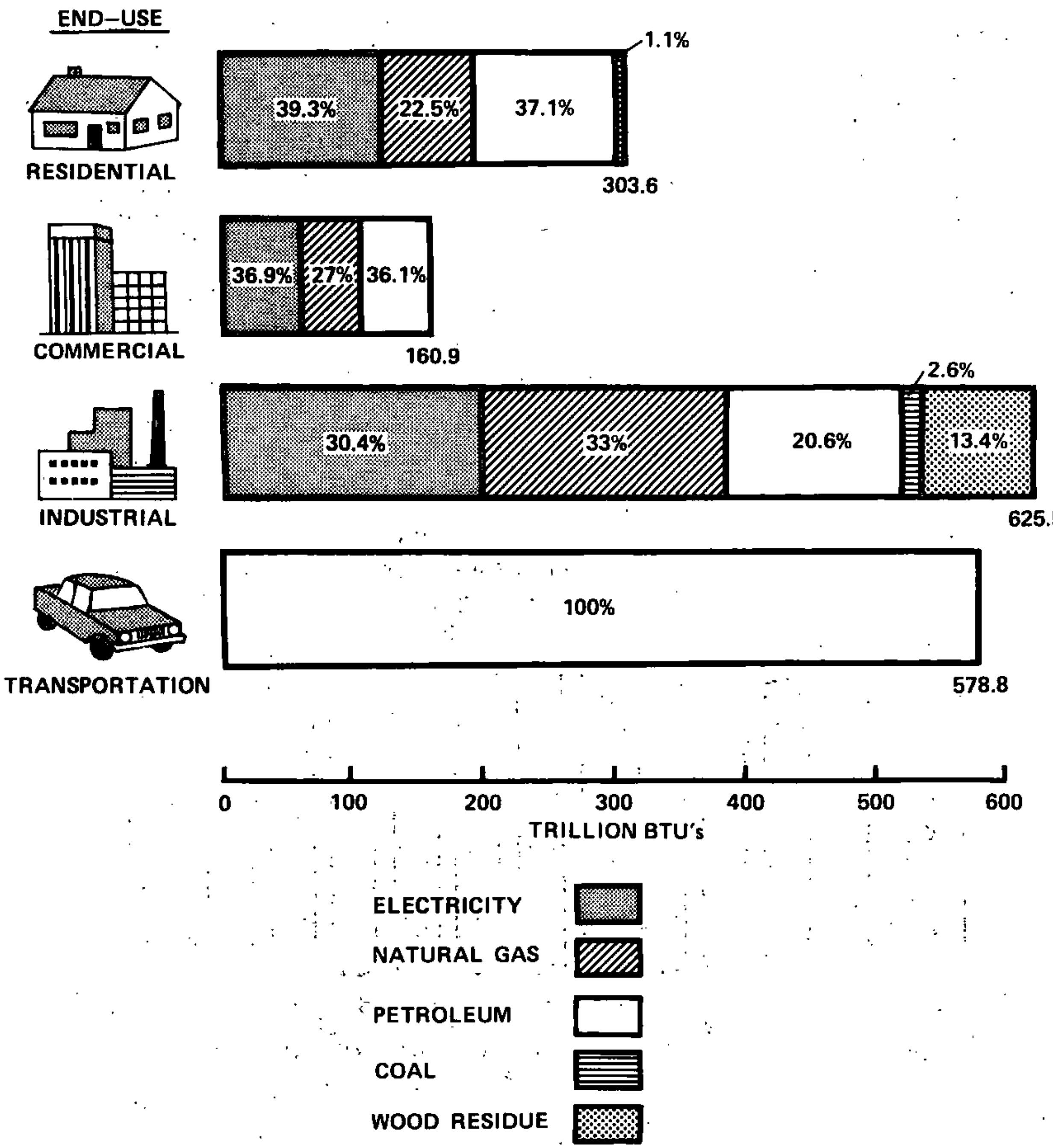
In 1974 about one-third of the Pacific Northwest region's total residential, commercial, and industrial energy consumption was supplied by electricity. As figure 2.2 shows electricity is an important source of energy for all major end uses except transportation. The region also relies on imported natural gas, coal, and petroleum and on regional coal and wood residues to supply its energy. Natural gas, petroleum, and wood residues are used directly for heating, transportation, and industrial processes, while most coal is used to generate electricity.

Electric power rates in the Pacific Northwest are the lowest in the Nation, as figure 2.3 indicates. Figure 2.4 shows that these low rates have resulted in a higher average consumption of electricity.

Low power rates in the Pacific Northwest have also resulted in consumption patterns that differ from those in the rest of the country. For example, electric residential space heating is much more common than in other regions. In 1974, 45 percent of homes in central and western Washington utilized electricity for this purpose compared with 8 percent nationwide. Figure 2.5 illustrates how the region uses its electricity.

Figure 2.2

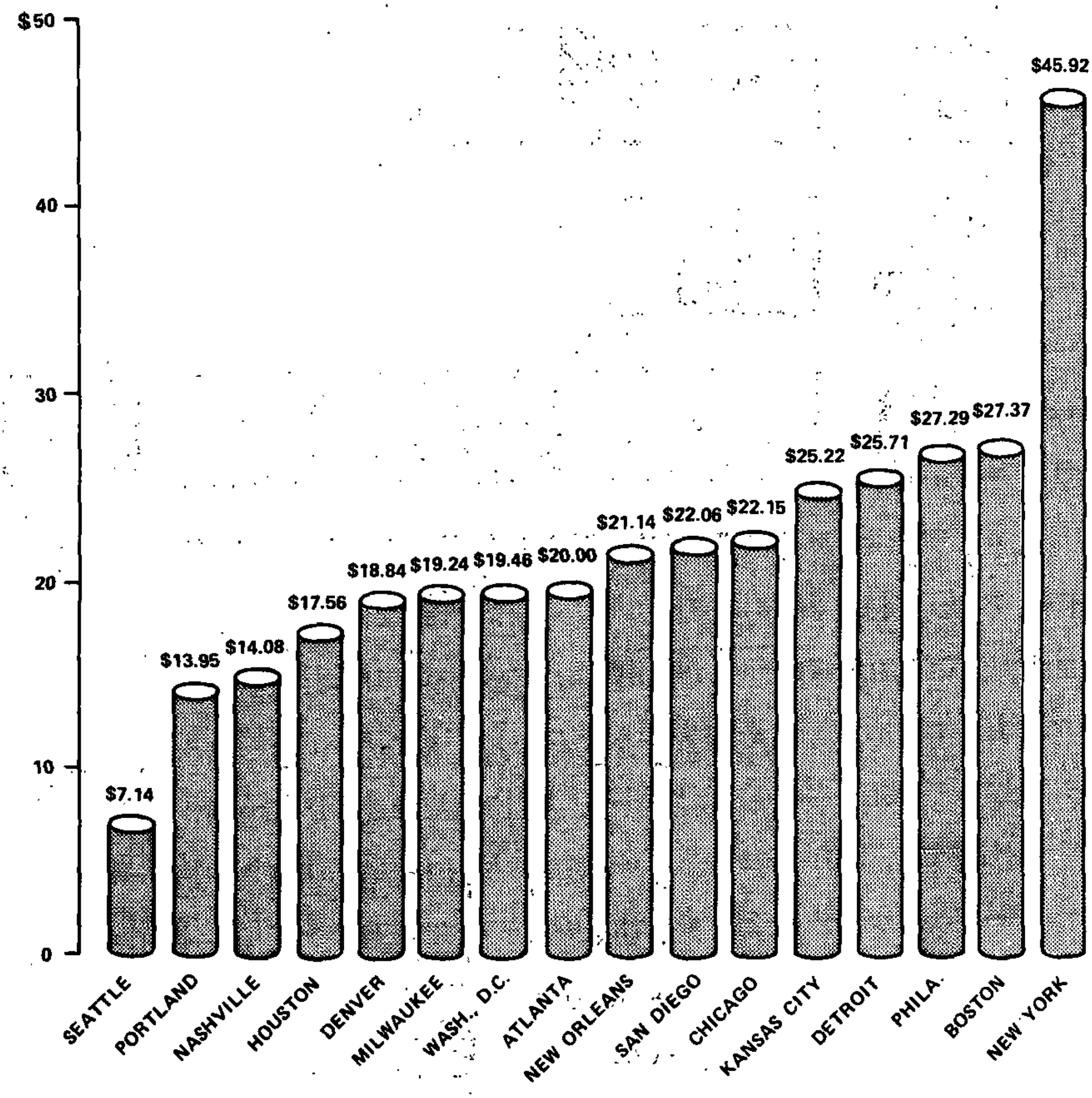
SOURCES OF PACIFIC NORTHWEST[a] ENERGY SUPPLIED TO MAJOR END–USES, CALENDAR YEAR 1974



[a] Excludes Western Montana

Source: Energy Demand Modeling and Forecasting, NEPP Module II, pp. 129– 35

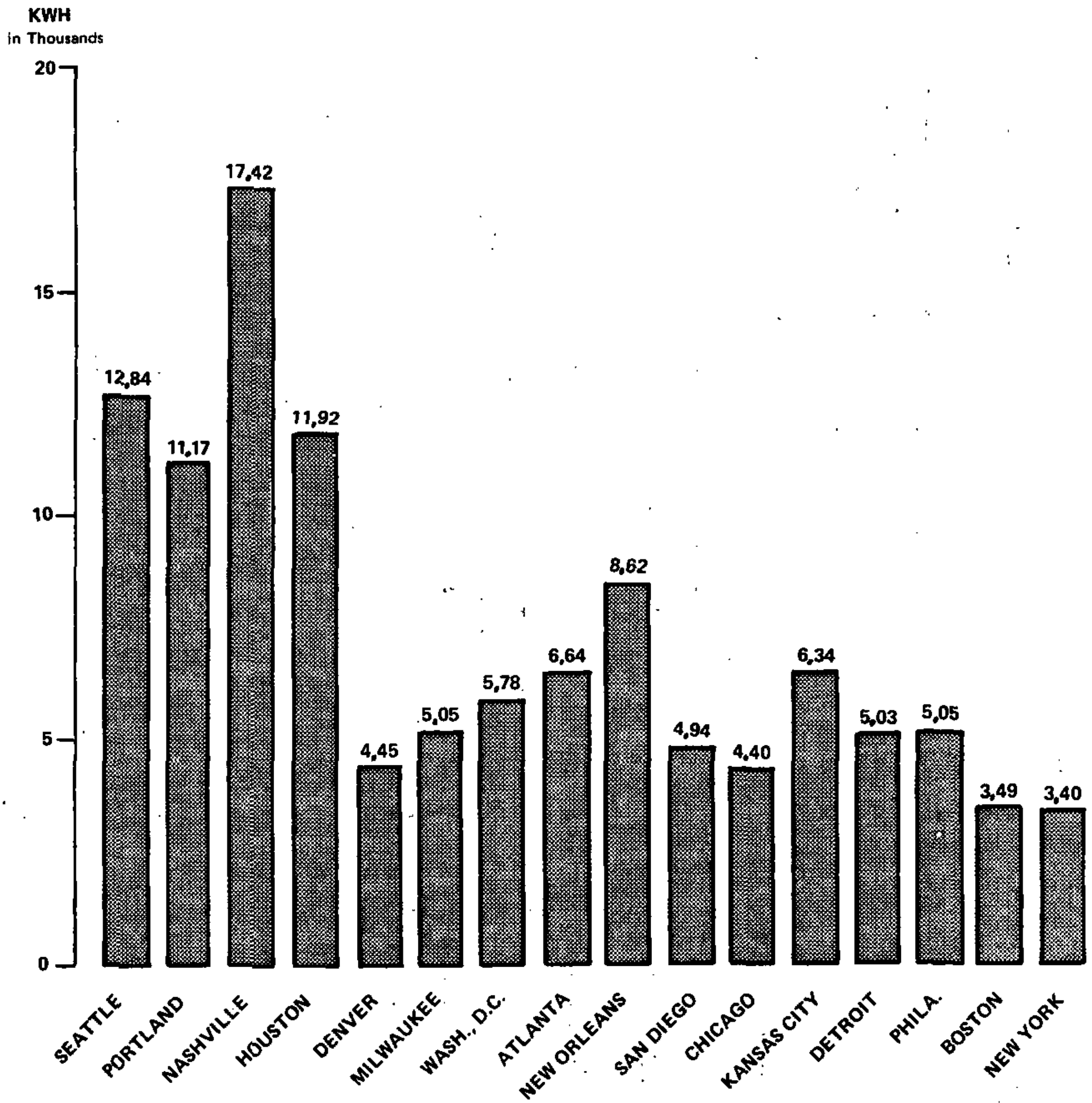
Figure 2.3
COMPARATIVE ELECTRIC BILLS FOR SELECTED CITIES
(JANUARY 1977 BILL FOR 500 Kwh RESIDENTIAL USAGE – TAXES INCLUDED)



Source: TVA

Figure 2.4

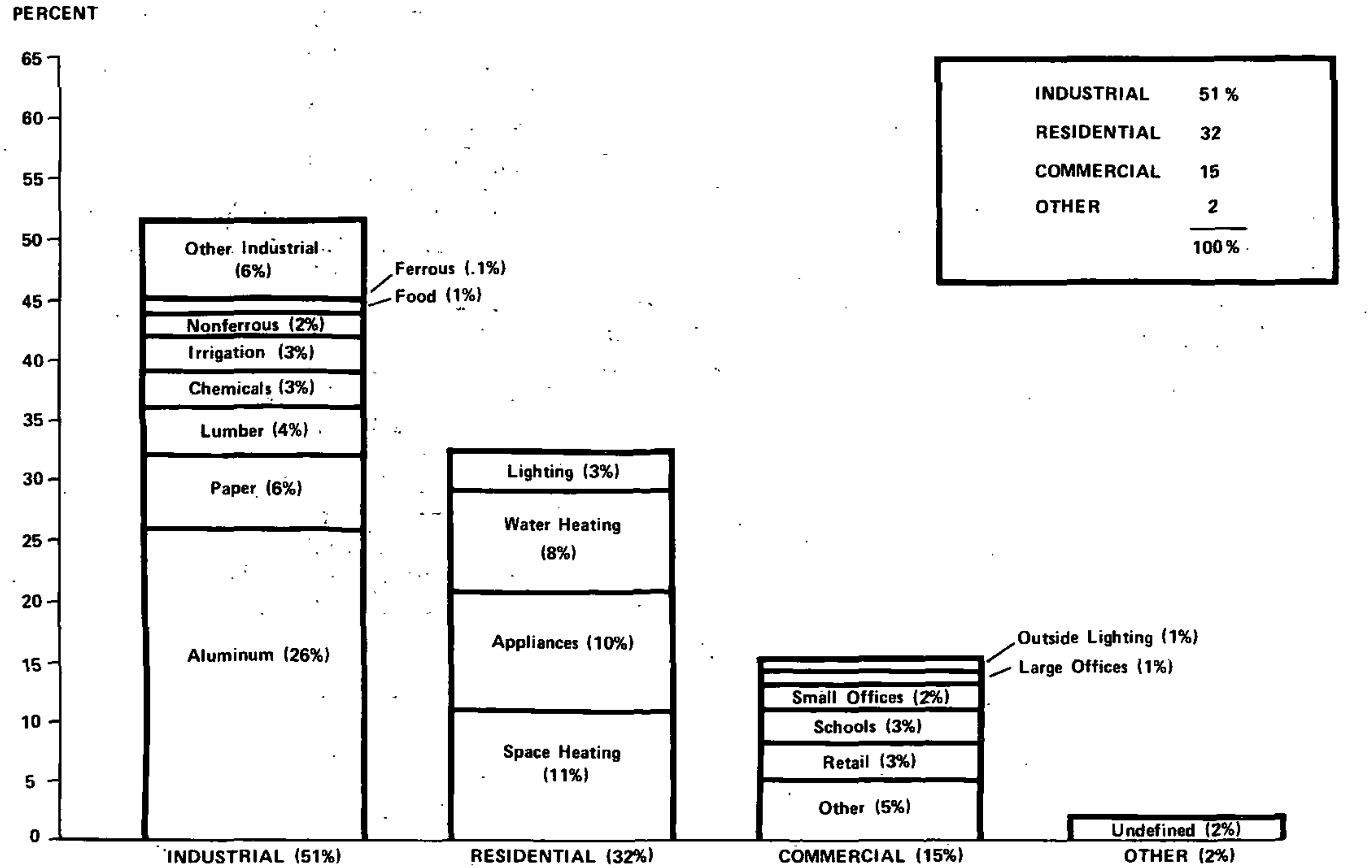
COMPARATIVE AVERAGE ANNUAL ELECTRICAL CONSUMPTION FOR C.Y. 1976 - RESIDENTIAL USAGE



SOURCE: FEDERAL POWER COMMISSION

Figure 2.5

USE OF ELECTRIC ENERGY IN THE PACIFIC NORTHWEST



Source: 1974 Power Requirements – BPA   Skidmore, Owings, and Merrill – July 1976

100% = 103.3 KwH (10^9)

CHAPTER 3

THE EVOLUTION OF ELECTRIC POWER DEVELOPMENT

The Pacific Northwest possesses more than 40 percent of the Nation's hydroelectric potential and has the most highly developed hydroelectric system in the world. Eighty percent of the region's electric generating capacity is provided by a combined system of more than 150 federally, publicly, and investor-owned hydroelectric projects.

Low cost hydropower has attracted many energy intensive industries and played a vital role in the region's economic development. Six major aluminum companies operate 12 plants within the region which produce over 30 percent of the Nation's aluminum. Other energy intensive industries producing paper products, refined metals, and chemicals have also located in the Pacific Northwest.

Although an abundant supply of inexpensive electricity has promoted the region's economic development, there is uncertainty over future energy supplies. The region's continued population growth, the energy intensiveness of its industries, and the scarcity of additional large hydro sites have raised concern about the future. For the first time in its history, the region is faced with hard choices on how to manage its electrical energy resources.

THE FEDERAL ROLE

The Federal role in constructing and operating power generation and transmission facilities has been significant. Over 50 percent of the electricity generated in the region is furnished by Federal dams built, operated, and maintained by the Bureau of Reclamation and the U.S. Army Corps of Engineers. The power generated at these dams is marketed and transmitted throughout the region by BPA.

Construction of generating facilities

The first Federal dams on the main stream of the Columbia River--Grand Coulee Dam and Bonneville Dam--were constructed in the 1930s. These 2 dams became the cornerstones for the world's largest hydroelectric power system, which now includes 29 major Federal dams and 124 other Federal and non-Federal hydroelectric projects.

The region's Federal dams were authorized as multi-purpose projects to provide flood control, irrigation, improved navigation, and public recreation, as well as power generation. The dams' large storage reservoirs, in conjunction with storage in Canadian reservoirs, enable them to capture spring runoff and control flooding. In summer, fall, and winter, the projects release water and provide sustained levels of power generation and irrigation when natural streamflows are low. While these features have greatly benefited the region, they have also caused some problems, such as reduction of valuable salmon runs.

The construction of dams in the region has not been strictly a Federal function. Construction of non-Federal dams was stimulated in the 1950s when Federal policy shifted toward reduced participation in such projects. Of further significance was the integration of non-Federal dams into the regional transmission network. This was made possible in 1957 when the Congress authorized BPA to transmit electricity generated at non-Federal dams over the Federal transmission system and thereby eliminated the need for the utilities to duplicate BPA's transmission facilities. In fiscal year 1976 almost 6 percent of BPA's revenues came from transmission services to non-Federal users.

Dam construction on the Columbia River system continued at a relatively constant pace after the first Federal dams were constructed in the 1930s. By 1975 nearly all the major damsites in the region had been developed or were considered unfeasible because of environmental and/or economic constraints.

Power transmission and marketing

The Bonneville Project Act of 1937 created BPA and authorized it to market power generated at the first Federal dams. The act authorized BPA to (1) sell electricity at wholesale to public bodies and cooperatives and to private agencies and persons, (2) construct, operate, and maintain a transmission system, (3) interconnect the Bonneville Dam with other Federal projects and publicly owned power systems, (4) encourage the widespread use of all the electricity generated, prevent monopolization by limited groups, and give preference to publicly owned distribution systems, and (5) set rates to recover the cost of generation and transmission. By virtue of this act and subsequent legislation, BPA now applies these provisions in selling Federal power to various customers throughout the region.

To a great extent, BPA represents the Federal presence in energy policymaking for the region. BPA markets half the region's electricity and owns and operates 80 percent of the region's high-voltage transmission lines. The Pacific Northwest is served by more than 120 electric distributors--investor-owned utilities, municipal systems, rural electric cooperatives, and public utility districts. All but one of these distributors buy some power from BPA. Only 27 of the distributors have their own generating plants. Nearly all those without generating facilities depend exclusively on BPA for their power supplies.

BPA has very successfully promoted the interconnection of Federal and non-Federal power systems. As of March 1977, BPA's transmission network included 12,300 circuit miles of line in service. These transmission lines act as a common carrier for all the region's utilities. BPA's extensive research and development work has made it a world authority on transmission system design and operation.

Types of customers

BPA has four major customer classes: (1) publicly owned utilities, (2) Federal agencies, (3) investor-owned utilities, and (4) direct service industries. One of the Bonneville Act's stated purposes is to give preference to publicly owned distribution systems. This provision, or preference clause as it is commonly known, requires BPA to give publicly owned utilities and Federal agencies first call on the Federal energy it markets. As shown in table 3.1, these preference customers account for the largest bloc of BPA power sales.

TABLE 3.1

BPA Sales of Electric Energy
Fiscal Year 1976

	kWh (000 omitted)	Percent
Preference customers:		
Publicly owned utilities and cooperatives	30,817,200	40
Federal agencies	636,959	1
Investor-owned utilities	7,660,263	10
Direct service industries:		
Aluminum	22,683,994	29
Other	2,378,600	3
Customers outside the region	13,294,075	17
Total	77,471,091	100

BPA owns and operates the northern segments of three transmission lines between the region and the Pacific Southwest, in addition to its regional facilities. In recent years, because of the seasonal nature of energy demands and streamflows in the region, surplus power has been available for transfer over these lines during certain months. Sales of the region's surplus energy have been a boon to buyers in California. The Stanford Research Institute estimated that in 1975 California utilities saved $167 million and reduced air pollution by displacing more expensive oil-fired generation with the surplus energy from the Pacific Northwest.

Rate setting

In determining rates to charge its customers, BPA must adhere to mandates of three principal acts: the Bonneville Project Act of 1937, the Flood Control Act of 1944, and the Federal Columbia River Transmission System Act of 1974. All three acts require BPA to produce sufficient revenue to recover costs to the Government of producing and transmitting electric energy, including amortization of capital investments. BPA must also obtain approval of its rates from a Federal regulatory agency. The Federal Power Commission reviewed BPA rate proposals until 1977, but this function was delegated on October 1, 1977, by the Secretary of Energy to the Economic Regulatory Administration.

BPA uses average cost pricing to establish its power rates at levels which recover the total costs of operations, maintenance, interest, and capital. Under this approach the high costs associated with new power supplies are averaged with the lower costs of older supply sources. As a result, the price of new power to BPA customers does not reflect the true replacement cost of the energy as advocated in the National Energy Plan. (See table 1.1.) BPA is currently considering alternatives, such as marginal or long run incremental cost pricing, which would raise rates on new power supplies to correspond to the actual costs of providing the electricity. However, implementation of such pricing policies would require legislative authorization.

Development of the region's major hydro sites, coupled with BPA's adherence to the Flood Control Act and that act's goal of marketing electric energy for widespread use at the lowest possible price consistent with sound business principles, has produced the region's unique energy environment: the Nation's lowest priced electricity and a per capita electricity consumption rate nearly twice the national average.

NON-FEDERAL GENERATION AND MARKETING

Investor-owned and publicly owned utilities together control 42 percent of the region's hydro capacity and 100 percent of the region's thermal capacity. (See table 3.2 and fig. 3.1 for a detailed presentation of the region's capacity and fig. 3.2 for location of generating plants.) These utilities are also building and/or planning to build large thermal generating plants to meet the region's future needs in coordination with the Federal hydro system.

TABLE 3.2

Pacific Northwest Region
Existing Electric Power Generating Capacity
at March 2, 1977

	Number of facilities	Nameplate rating (MW)	Percent of regional capacity
Hydro:			
Federal	29	14,235	58
Publicly owned utilities	36	6,029	24
Investor-owned utilities	88	4,421	18
Total	153	24,685	100
Thermal:			
Federal	-	-	-
Publicly owned utilities	16	1,810	29
Investor-owned utilities	29	4,533	71
Total	45	6,343	100

Source: BPA statistics.

The ratio of power sales of investor-owned utilities to those of publicly owned utilities varies greatly among States in the region. In Idaho and Oregon the investor-owned utilities sell by far the most electricity, 92 percent and 72 percent of statewide sales, respectively. In Washington, which has a large number of publicly owned utilities, only 20 percent of the electricity is sold by investor-owned utilities.

Different proportions of publicly owned and investor-owned utilities exist within these States because of differing State laws. Beginning in the 1930s Washington State enacted statutes to promote formation of publicly owned utilities. These statutes allow voters in one election to both organize and fund a public utility district (PUD). Oregon voters turned down similar proposals in the 1930s and 1940s and current Oregon law requires one

FIGURE 3.1

PACIFIC NORTHWEST REGION
EXISTING ELECTRIC POWER GENERATING CAPACITY

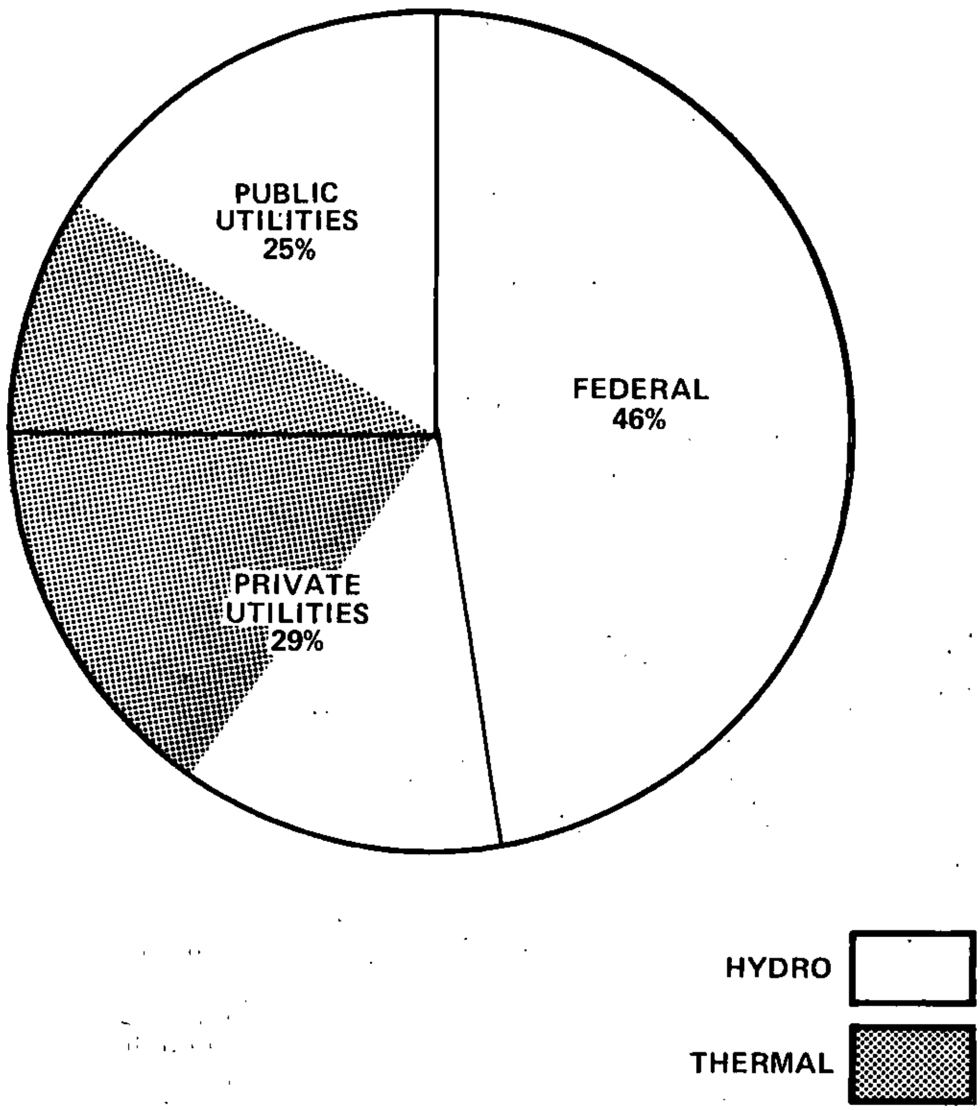
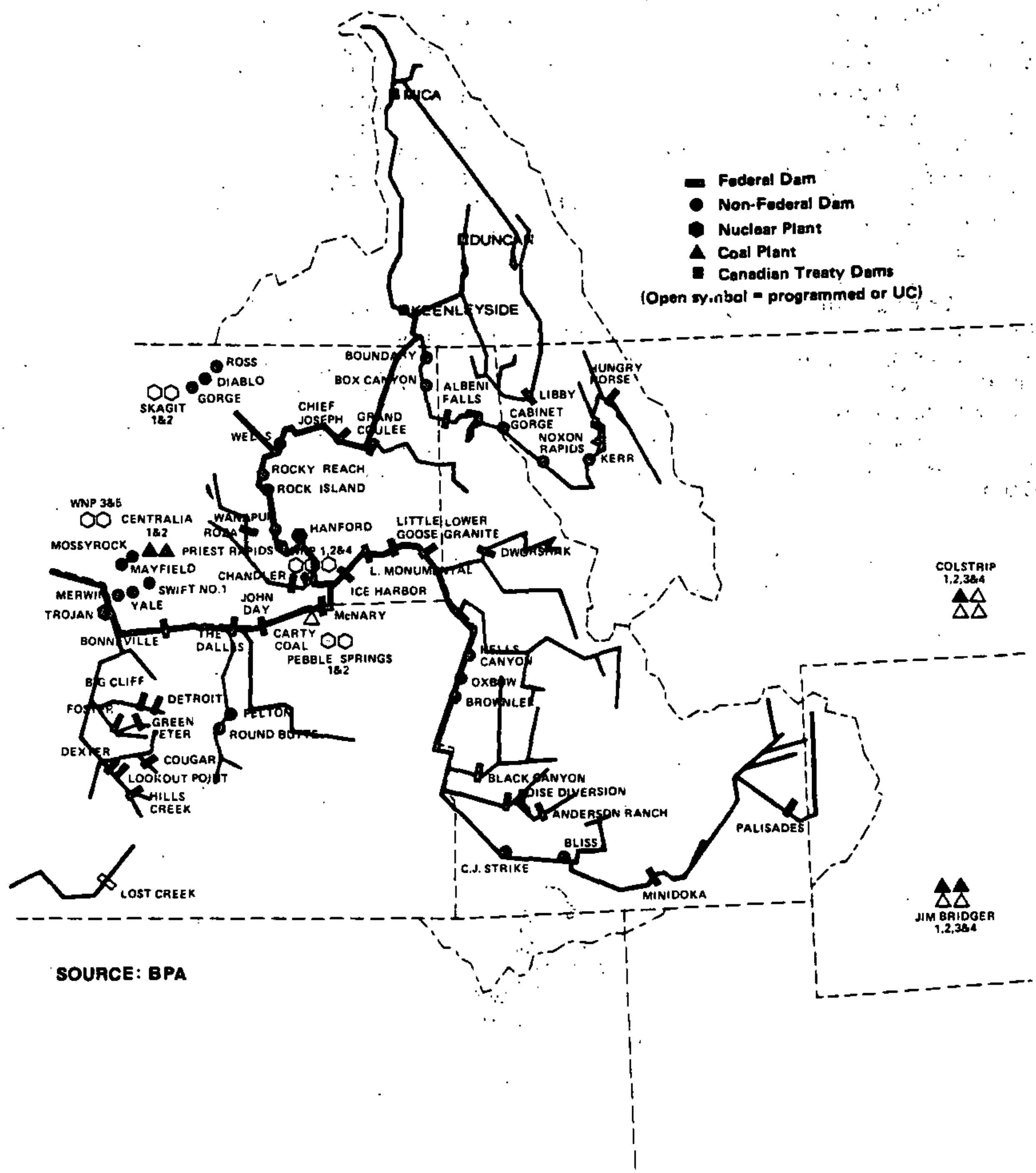


Figure 3.2

MAJOR GENERATING PLANTS IN THE PACIFIC NORTHWEST



election to authorize a PUD and a second election to fund it. Idaho law does not directly provide for the formation of PUDs, and thus investor-owned utilities account for almost all electricity sold in Idaho.

POWER PLANNING

The diverse patterns of regional power developments over the past 40 years have given rise to a myriad of power-planning institutions representing a variety of perspectives and constituencies. An NEPP study identified more than 20 institutions which participate directly in regional power planning, including Federal agencies, State bodies, and utility associations. A number of other organizations were identified as being in a position to constrain, regulate, or influence the region's planning and policymaking. (See table 3.3.)

Until the 1970s, power planning was largely conducted by Federal agencies and the region's electric utilities, which cooperated in proposing and carrying out power development efforts in the region. These entities formed various organizations to facilitate their joint planning efforts, including the Pacific Northwest Utilities Conference Committee, the Joint Power Planning Council, and the Public Power Council.

TABLE 3.3

Electric Power Planning in the Pacific Northwest

Participating institutions:
- Bureau of Reclamation
- BPA
- Bonneville Regional Advisory Council
- Canadian Government and British Columbia
- Corps of Engineers, U.S. Army
- Department of the Interior
- Joint Power Planning Council
- Northwest Power Pool
- Northwest Public Power Association
- Pacific Northwest River Basins Commission
- Public Power Council
- State agencies
- State Governors' offices
- State legislatures
- U.S. Congress
- Washington PUD Association and other public associations
- Western Systems Coordinating Council
- State siting councils
- Pacific Northwest Utilities Conference Committee

Constraining, regulating, and influencing organizations:
- International Joint Commission
- U.S. Congress
- Federal Power Commission
- Rural Electrification Administration
- State agencies
- Environmental Protection Agency/Council on Environmental Quality Coordination Agreement
- Internal Revenue Service
- Environmental and citizen groups
- Washington Environmental Council
- Sierra Club
- National Resources Defense Council

Source: NEPP study, 1977.

Private business investment and operating decisions have also played a major role in energy planning because of their impacts on energy requirements. The decisions corporations make on where to locate their plants, for example, can significantly affect the economies of counties and municipalities and are based in part on energy availability and pricing. In this way priorities of major industrial firms have influenced the shape of regional energy policies.

In recent years, with increasing public concern over energy supplies and pricing and the environmental consequences of new powerplants, State governments and citizens generally have sought a more active role in energy policymaking. Idaho, Oregon, and Washington have all established State energy offices within the last 2 years. Although the strength and influence of these offices vary from State to State, each incorporates independent energy analysis as a counterbalance to the utilities and BPA. The State of Oregon has, for example, developed its own model to forecast energy demand and recently published its second annual report on Oregon's energy future and policy options available to the State government.

While the States have increased their activity in regional energy planning and policymaking, public involvement in these functions is minimal despite increased public interest in energy-related issues. Most regional planning processes provide only limited opportunities for individual citizens or citizen groups to actively participate. As observed in the NEPP study "* * * public awareness of the long-run commitments being made on their behalf by politically insulated technocrats, both public and private, remains low."

THE MOVE TO THERMAL POWER

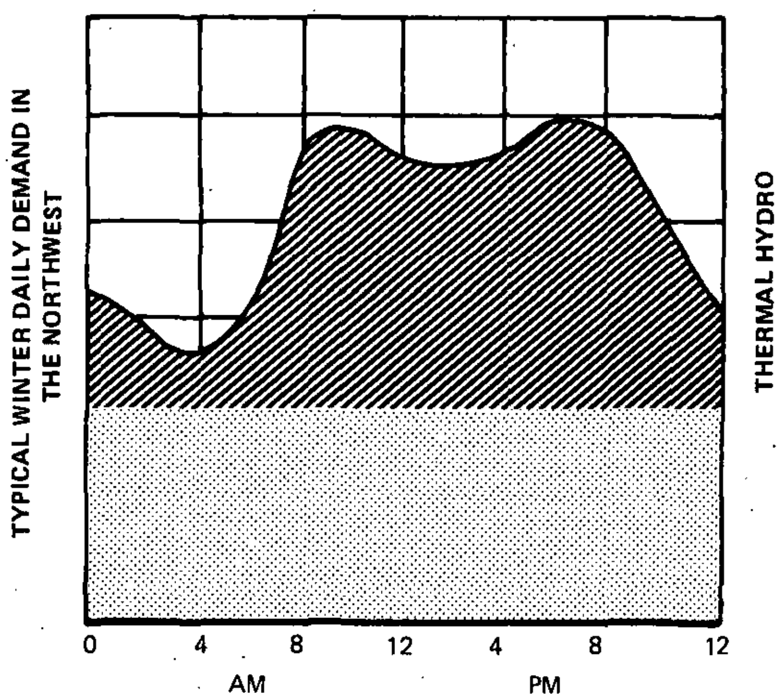
In the late 1960s regional energy planners determined that future load growth could not be met by the region's hydroelectric resources. BPA and regional utilities forecast electrical demand to triple between 1970 and 1990 and concluded that the region needed to supplement its hydro capacity with new forms of generation.

The Hydro-Thermal Power Program--Phase I

The Hydro-Thermal Power Program was devised by BPA and the region's utilities to meet forecast electrical demand by incorporating new coal-fired and nuclear generating plants into the existing hydroelectric network.

Under Phase I, the utilities were to build thermal plants and low-voltage transmission facilities while the Federal Government was to construct the additional high-voltage transmission system and provide hydro backup to meet contingencies and varying load requirements. The thermal plants were to provide the more constant levels of generation. (See fig. 3.3.) This mode of operation--thermal base with hydro for peaking--enables thermal plants to operate more efficiently at a steady output and capitalizes on the ability to turn hydro generating units off between peaks without appreciable loss of energy.

FIGURE 3.3
HYDRO-THERMAL GENERATION TO MEET NORTHWEST LOADS



WHILE THERMAL PLANTS SUSTAIN THEIR LEVEL OF GENERATION, HYDRO PLANTS "FOLLOW" THE REGIONAL PEAKS.

The initial activities of Phase I, which began in 1969, involved construction of seven large thermal plants (five nuclear, two coal fired) in the region, expansion of the generating capacity at hydroelectric projects, and further development of the Federal transmission system. BPA agreed to participate in paying for the publicly owned portions of thermal plants constructed in Phase I through an arrangement with its preference customers called net billing. Under net billing, preference customers participating in development of new thermal plants assign their share of the plants' power production to BPA. BPA pays for the power by crediting its customers' accounts for the amounts the customers are paying for their share of plant costs. As a result of net billing, more costly thermal power is integrated into the Federal system, increasing the average power rates for all BPA's customers. Net billing also shifts the financial risks associated with thermal plants from the preference customers to the Federal Government through BPA. This occurs because BPA agrees to pay for its preference customers' share of plant capability, even if the plants never produce electricity.

Currently Phase I plans to build seven thermal plants by 1981 are far behind schedule. As of October 1977, only three plants (two coal fired, one nuclear) had come on line, and completion of all seven plants is not expected until 1985. Various reasons are given for the delays, including adverse weather conditions, insufficient time allowances for licensing by Federal and State agencies, lack of skilled labor, and late delivery of construction materials. While construction has been delayed, the cost of an optimum-sized nuclear powerplant has escalated by nearly 500 percent from the $230 million projected in the late 1960s.

Delays have also slowed installation of new generating units at the region's Federal hydro projects. These delays have increased the estimated cost of new facilities at nine hydro projects by 54 percent from the 1969 level of $1.76 billion to $2.70 billion in 1975.

The Hydro-Thermal Power Program--Phase II

On December 14, 1973, BPA and regional utilities agreed to Phase II of the program, which was designed to provide power supplies into the 1990s. The program called for construction of seven coal-fired or nuclear generating plants in the region in addition to the seven plants scheduled under Phase I. However, BPA would not buy the output of Phase II plants.

Phase II called for the renegotiation of BPA's contracts with its industrial customers. BPA planned to write new contracts for the 1980s to 1990s and beyond and to put additional curtailment provisions into the contract.

Execution of the power sales contracts to implement Phase II was delayed in early 1975. Judgment by the Oregon Federal District Court in a lawsuit against BPA suspended the implementation of any new industrial contracts. The court ruled that BPA could not sign any industrial contracts until it had prepared an environmental impact statement (EIS) on a power sales contract for a new aluminum plant and also evaluated Phase II as it related to the contract. BPA decided to comply with the court order by preparing an expanded EIS covering regional energy options and BPA's role in power planning. A draft of the "Role EIS" was completed in August 1977 after a 2-year effort. It summarizes the evolution of BPA's policies and programs and analyzes several alternative roles which BPA could assume in regional power planning. These alternatives provide a variety of options ranging from a reduction in BPA's current role to an expansion which would authorize BPA to implement national energy policy within the region in coordination with the region's States. BPA has allowed 90 days for public review and comment on the draft statement and has scheduled a series of information workshops and public response meetings in cities across the Pacific Northwest. The final Role EIS is expected to be published late in the summer of 1978.

Until BPA finalizes its Role EIS and resolves its legal difficulties, the region will continue to operate with considerable uncertainty as to the Federal role in energy management. Because regional planning is based on cooperation between all utilities, BPA's temporary inability to participate makes planning and policymaking difficult, if not impossible. BPA's Administrator stated in March 1976 that Phase II of the Hydro-Thermal Power Program was in a shambles and that controversy over load forecasts and predicted shortages, delays in developing new resources, and the lack of a regional plan to meet future energy requirements had intensified concerns over the long-range power situation in the Pacific Northwest.

Because of forecast deficits in the 1980s, BPA has notified its preference customers that it cannot assure power to meet their load growth requirement after July 1, 1983. It has also advised its direct service industrial customers that their power sales contracts will probably not be renewed when they expire in the 1980s.

PLANNING UNCERTAINTIES

While BPA was developing its Role EIS, further uncertainties enveloped regional energy planning. Many of the uncertainties relate to two important questions prominent in regional debates:

--Can the region, which has relied for so long on renewable hydropower, also hope to meet its future energy needs with renewable resources?

--How realistic are energy demand forecasts prepared by regional utilities?

BPA power planning has emphasized its belief in the need for thermal generation, noting that thermal plants must account for 99 percent of the region's new energy supplies between 1977 and 1997. In a May 1976 publication, BPA detailed the need for thermal generation as follows:

"Because few undeveloped, economically feasible, and socially acceptable hydro sites remain, extensive building of thermal generation has been programmed for the Northwest. This program calls for the completion of a total of 11 nuclear units and 3 coal units (plus 8 coal units just outside the region) by the end of the 1980s."

Such an aggressive move to thermal generation represents an abrupt and significant departure from the region's historic reliance on renewable hydropower. Perhaps for that reason, coupled with the high costs and potential environmental impacts of thermal plants, many in the region are questioning the need for such a strong commitment to thermal generation and citing energy conservation and renewable energy sources as likely alternatives. Although some regional studies have been made to assess the alternatives to thermal powerplants, much remains to be done. Chapter 4 of this report summarizes the evidence compiled to date and highlights some of the questions which need to be addressed in future studies.

Regional uncertainties about thermal power developments are compounded by disagreements over how much energy will be needed in future years. Utility forecasts showing that energy requirements will nearly triple by the year 2000 are disputed by many. The potential roles of energy conservation and renewable energy sources are much debated, as are certain issues relating to the allocation of Federal hydropower and the financing of new powerplants. A discussion of these conflicts and their impacts on the region is presented in chapter 5.

CHAPTER 4

THE ALTERNATIVES TO THERMAL GENERATING PLANTS

Utility plans to construct numerous thermal generating plants, together with highly publicized national efforts to solve our country's energy problems, have stimulated regional interest in energy conservation and renewable energy sources as alternative means of meeting future power needs.

Groups concerned about the high costs and potential environmental impacts of nuclear and coal-fired plants are asking whether conservation measures, together with development of renewable energy sources, could reduce the need for such thermal facilities. Research data on the potential contributions these alternatives could make are, for the most part, fragmented and inconclusive. However, it is recognized by many that important decisions on future power supplies will be shaped by the emphasis energy policy-makers place on conservation opportunities and development of renewable energy sources.

CONSERVATION POTENTIALS IN THE PACIFIC NORTHWEST

Energy conservation, as defined in this report, includes not only improving the efficiency of energy use, but also making some modest lifestyle adjustments, such as lowering thermostats and turning off lights when not needed. Energy-conserving actions make homes, businesses, and industrial processes more energy efficient by using less energy to achieve essentially the same results. Typical actions include improving residential insulation and weatherization, using more energy-efficient appliances, lowering thermostats, modernizing production facilities, recycling materials, and using waste heat from industrial processes. Reduction of wasted energy through conservation constitutes, according to BPA, the least costly, most flexible, and most environmentally acceptable energy resource available.

Although recent studies of regional potentials for conserving electricity show widely varying results, there is little doubt that a significant potential exists. Electricity users in the region enjoy the lowest power rates in the Nation and use electricity for space heating much more than other regions. It is likely that relatively simple conservation measures, such as improved thermal efficiency of homes and commercial buildings, could yield significant savings. Similarly the region's industrial base includes many older aluminum plants and other electroprocess facilities which could realize energy savings.

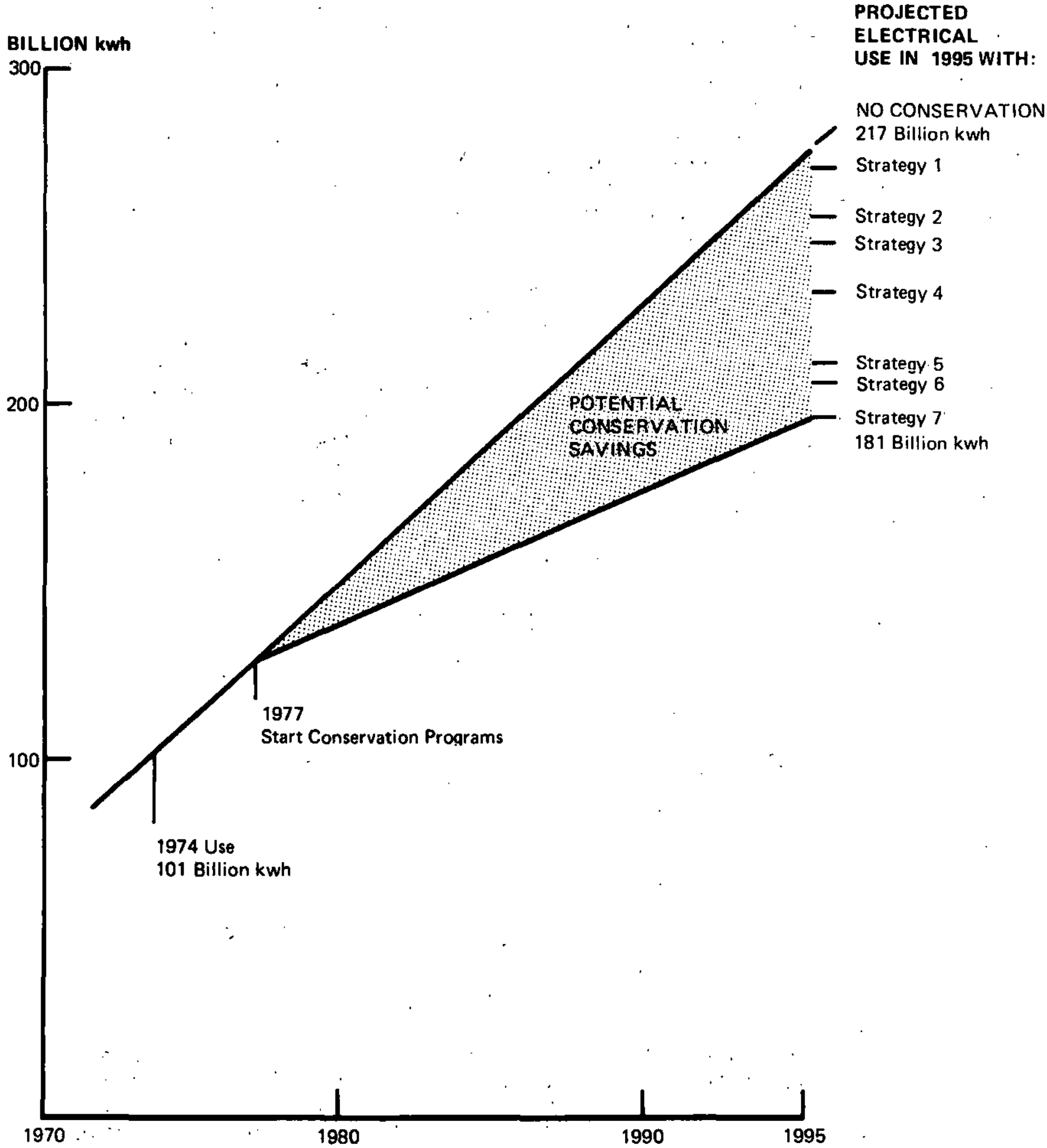
Federal agencies, State governments, and regional utilities have thus far taken only limited steps to encourage energy conservation, although there is a definite trend in this direction. With the exception of tax incentives for certain conservation investments and some conservation-oriented Federal and State building codes, most regional conservation efforts have relied on public education programs. Recently, however, BPA proposed a residential insulation program which would cost $287 million for all single-family electrically heated homes, including $137 million for those served by BPA preference customers. BPA estimates that this program, although limited in coverage, could yield annual energy savings approximating one-half the output of a large nuclear powerplant, with cost savings of about one-half billion dollars.

The region's heavy use of inexpensive hydroelectric power and the limited role of government-sponsored conservation efforts indicate a very significant potential for conserving electricity. Recent studies 1/ of this potential show that conservation could save the region as much as one-half of the energy growth forecast by regional utilities between 1974 and 1995. Figure 4.1 illustrates the results of one such study chartered by BPA to analyze a series of conservation strategies.

1/Skidmore, Owings and Merrill Electric Energy Conservation Study performed for BPA, July 1976 and "Choosing an Electrical Energy Future for the Pacific Northwest: An Alternative Scenario," National Resources Defense Council, Inc., January 1977.

FIGURE 4.1

POTENTIAL FOR CONSERVING ELECTRICITY IN THE PACIFIC NORTHWEST



SOURCE: Skidmore, Owings, and Merrill Electric Energy Conservation Study performed for BPA, July 1976.

RENEWABLE ENERGY POTENTIALS IN THE PACIFIC NORTHWEST

Renewable energy sources are those which are not diminished by use. In their basic forms, we know them as solar energy--heat from the sun--and geothermal energy--heat from the earth. 1/ Both solar energy and geothermal energy take many secondary forms. Solar energy striking the earth and its atmosphere produces rain and wind, which we tap by building hydro projects and windmills. We also release solar energy stored in plants by burning wood and other biomass to provide heat or generate electricity. Geothermal energy appears in three forms--as dry steam; hot water and wet steam; and hot, dry rocks--all of which can be used under varying conditions to meet our energy needs.

Solar energy and geothermal energy are unique in many important ways. First, and most important, is their availability. They are present in virtually unlimited supplies and are distributed in varying forms and amounts throughout the world. The capture and use of solar energy and some applications of geothermal energy generally entail less serious impacts on the environment and human health than more conventional coal and nuclear powerplants. Many renewable energy applications, such as windmills, wood fuels, watermills, and solar water heaters, were widely used in the past. Over the last 40 years, they were largely replaced by electric utility services, as well as by the growth of extensive distribution systems for oil and natural gas.

The Pacific Northwest is rich in various renewable energy sources which could be developed to meet future power needs. Some renewable energy applications, such as small hydroelectric projects and wind turbines, could be used to generate additional electricity. Other applications, such as the use of windpower for pumping water or the use of solar radiation for water heating, could partially displace electricity from those functions and, thereby, free power for other uses.

Within the region utilities and power-planning organizations have taken little action to develop renewable resources. For the most part, research data on regional potentials for developing solar and geothermal energy is still fragmented and inconclusive. Available evidence

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1/Renewable energy is also present in the oceans; it appears in the form of tides, currents, wave action, and temperature differences.

suggests, however, that important potentials may exist for (1) four types of solar energy--hydroelectric, wind, biomass, and solar radiation--and (2) geothermal energy in nonelectric applications. It is also clear that better information is needed to accurately assess and capitalize on many of these renewable sources.

Hydroelectric potentials

As mentioned in chapter 3, most large hydroelectric sites in the Columbia River system have already been developed. However, a significant untapped hydro resource may still remain in the form of numerous smaller or less desirable sites. In a January 1976 report the Federal Power Commission 1/ concluded that the region accounted for about one-third of the Nation's total undeveloped conventional hydroelectric capacity. The report showed that 63.5 percent of the region's potential generating capacity was undeveloped and that only 164 of 682 hydroelectric sites had been developed. The report excluded 21 undeveloped sites in the region which had been precluded from hydroelectric development by the Wild and Scenic Rivers Act or other special acts.

Regional studies have concluded that hydropower cannot be expected to supply much additional energy in the future. This conclusion is supported by arguments that (1) many promising hydro sites are covered by legislation preserving wild and scenic rivers and are ineligible for development, (2) strong opposition can be expected to any dam which would further impact the region's salmon and steelhead fisheries, and (3) the region's undeveloped hydro sites are many in number but represent little energy potential individually. While these factors may indeed preclude the development of many hydro sites, we doubt that they are sufficient grounds for assuming that additional hydropower will play only a minor role in the region's energy future. A thorough study is needed to analyze the region's untapped hydro potentials in the light of new energy-related technologies and new economic realities. Such a study could show that hydropower development can play a major role in meeting future energy needs.

1/Now the Federal Energy Regulatory Commission. Functions of the Federal Power Commission were transferred to the Department of Energy, Federal Energy Regulatory Commission, effective October 1, 1977.

Hydropower represents a relatively benign, efficient, and readily available technology. In light of its extensive and longstanding use, it appears to be acceptable to most regional citizens. We think it would be premature and unwise for regional policymakers to assume that the region's untapped hydro potentials are largely inappropriate for development. Many of the region's potential hydro sites may prove desirable in times of rising energy prices and increasing concerns about the environmental impacts of thermal powerplants.

Technological advances also argue against a hurried judgment on the potentials for additional hydropower development. A number of recent developments could impact favorably on the region's future use of hydropower:

--Tubular hydro turbines for low-head sites, widely used outside the United States, are being used in the Central and Eastern United States and studied for possible use in the States of Washington and Idaho. Special survey efforts will be needed to fully assess the potential contributions of such turbines.

--Pumped storage hydroelectric plants, which generate during peakload periods using water pumped from a lower reservoir to an upper reservoir during off-peak periods, are drawing increased attention. A recent Corps of Engineers study identified more than 500 potential pumped storage sites in the Pacific Northwest.

--The low cost and flexible energy storage capacity of hydro projects is being recognized as a unique regional resource, especially as it relates to development of windpower and solar applications. Such storage capacity is vital to wind and solar radiation systems which depend on intermittent energy sources and need storage buffers to help match fluctuating generation with consumers' energy needs.

--Recent improvements in the technologies and economics of aquaculture may encourage further hydroelectric development by mitigating the adverse impacts of dams on the region's salmon catch. The development of new salmon runs for commercial harvesting is gaining acceptance in the region. "Ocean farming" operations have been started at private hatcheries on coastal streams where mature salmon are harvested as they return from the sea to their artificial spawning grounds. If aquaculture projects of this type are successful, the region may be able to increase its supply of salmon while simultaneously capitalizing on its undeveloped hydroelectric capacities.

Wind energy potentials

Wind energy potentials in the region are among the best in the Nation. Research indicates that wind-powered generation of electricity is feasible along the Oregon and Washington coasts, in the Columbia River gorge, and in open areas east of the Cascade Mountains. Wind is particularly appealing because it peaks in the winter months and could supply substantial generation during periods of heavy demand for electric heating. The Energy Research and Development Administration (ERDA) 1/ selected two northwest sites for possible installation of large-scale wind generators. An NEPP analysis indicates that wind energy might ultimately be used to generate 500 to 2,000 2/ megawatts of electricity within the region.

More research is needed to fully assess potentials for wind-generated electricity. Because wind characteristics vary greatly from location to location, much more wind data collection and evaluation is needed. Demonstration programs are also needed to develop the required technology and to integrate wind-generated electricity into existing electrical systems.

In addition, windpower can be employed in direct mechanical uses which displace electricity and thereby release it for other uses. Pumping water for agricultural irrigation is an example of such mechanical use. It has been suggested that wind energy be used at pumped storage hydro projects to pump water from lower reservoirs to higher reservoirs for use during peakload periods.

Biomass potentials

The conversion of waste biomass materials--principally wood residues from lumber and papermills--into electricity or electricity replacements already plays an important role

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1/The functions of ERDA were transferred to the Department of Energy with its creation effective October 1, 1977.

2/Compared with the average size of nuclear powerplants of 1,000 megawatts.

in the region. Recent developments indicate that a near-term expansion of that role may be likely.

In 1974 wood residues accounted for about 13 percent of industrial energy consumption in the region and about 5 percent of the total energy consumed. Wood residues are used by regional forest products companies to meet many of their needs for process heat and electricity. Several northwest municipalities purchase surplus electricity from such operations.

Regional interest in biomass utilization has been increased by development of a commercial process for converting wood residues into high-density pellets having a high energy content and the burning characteristics of coal. According to the manufacturer, the pellets burn more efficiently than coal, generate fewer pollutants, and may be made from almost any organic material. Pellet-manufacturing plants are under construction in Oregon and California, and additional plants are being considered for Washington State and several foreign countries. In April 1977 a Washington State hospital began using the wood pellets to replace coal for heating. The hospital expected to save $60,000 in heating costs in 1977 and to avoid expenditure of $200,000 for new air pollution control equipment.

Despite the region's extensive and growing use of wood residues for generating or displacing electricity, an NEPP study indicates that the long-term use of wood for energy production may decline as the demand for wood increases. The study predicts that competition will lead to increased recovery of wood residues for use in wood products.

Other potential applications of biomass waste for energy production include the use of municipal solid wastes as fuels and the development of biomass plantations to grow fuels for energy production. NEPP research indicates that while there is considerable interest in these applications, there is little near-term potential for their development in the region.

<u>Solar radiation potentials</u>

Solar radiation can be used to generate electricity or to displace electricity in uses such as space and water heating, crop drying, and food processing. Electrical generation can be accomplished through (1) solar cells which produce an electric current and (2) conventional steam-electric generating plants which use concentrated solar heat to produce steam. Both forms of generation are still very costly and are undergoing extensive research and development in government and industry.

Displacement of electricity by solar energy is usually achieved through solar collectors, which use sunlight to heat air or water. The heated air or water is then transferred from the collector and used for a variety of residential or industrial processes. Good quality solar heat collectors for residential use are commercially available.

The Pacific Northwest region has considerable potential for direct use of solar energy, although that potential varies widely throughout the region due to diverse weather conditions. The region's sun belt east of the Cascade Mountains receives sun radiant energy comparable with that of large portions of the Midwest and includes some desert areas which receive about 80 percent as much solar radiation as deserts in the Southwestern United States. While cloud covers are more prevalent west of the Cascades, solar energy can still be collected at reduced levels under moderately cloudy conditions.

Within the region there is widespread public interest in practical applications of solar energy. A number of residences are using solar water and/or space heating. Many of these residences are being monitored for results by local utilities. Public information programs and workshops on solar energy are being held.

Estimates of how much energy the region can expect from solar applications vary widely. An NEPP report shows that direct generation of electricity is unlikely before 1990 due to the high costs and technological uncertainties involved. With respect to electricity displacement, NEPP's high-growth scenario assumes that 10 percent of all homes and businesses in the region could use solar collectors in their heating systems by the year 2000. NEPP estimated that these collectors would supply an average of 40 percent of the space heat required by each dwelling or business. The average of 40 percent was selected to allow for projections of higher solar heat contributions in new construction and lower contributions in systems added to existing homes.

In May 1977 the coordinator of Battelle Laboratories' solar research program in the Pacific Northwest estimated that the region could meet 25 to 35 percent of its energy needs with solar energy using on-the-shelf technology. He indicated that solar energy could replace a large part of electrical heating in houses and commercial buildings, heat water, and supply low-grade industrial process heat. He said the cost of some of these applications would be competitive with the region's low electric rates, while other applications might cost three to four times as much. The coordinator emphasized that these solar applications were possible now--without long-range technological breakthroughs.

Geothermal potentials

There is significant geothermal potential in the region. Geothermal energy has been used for several years for space heating in Boise, Idaho, and Klamath Falls, Oregon. In Idaho an ERDA contractor is developing a geothermal powerplant to produce electricity.

A 1975 assessment of geothermal resources published by the U.S. Geological Survey showed a broad distribution of geothermal sources throughout the region. (See fig. 4.2.) Most of the identified sources have been found at temperatures which, with present technology, are unsuitable for electrical generation. Many, however, may be suitable for use in applications which can reduce regional demands for electricity, such as geothermal-based space heating, air-conditioning, refrigeration, and industrial processes.

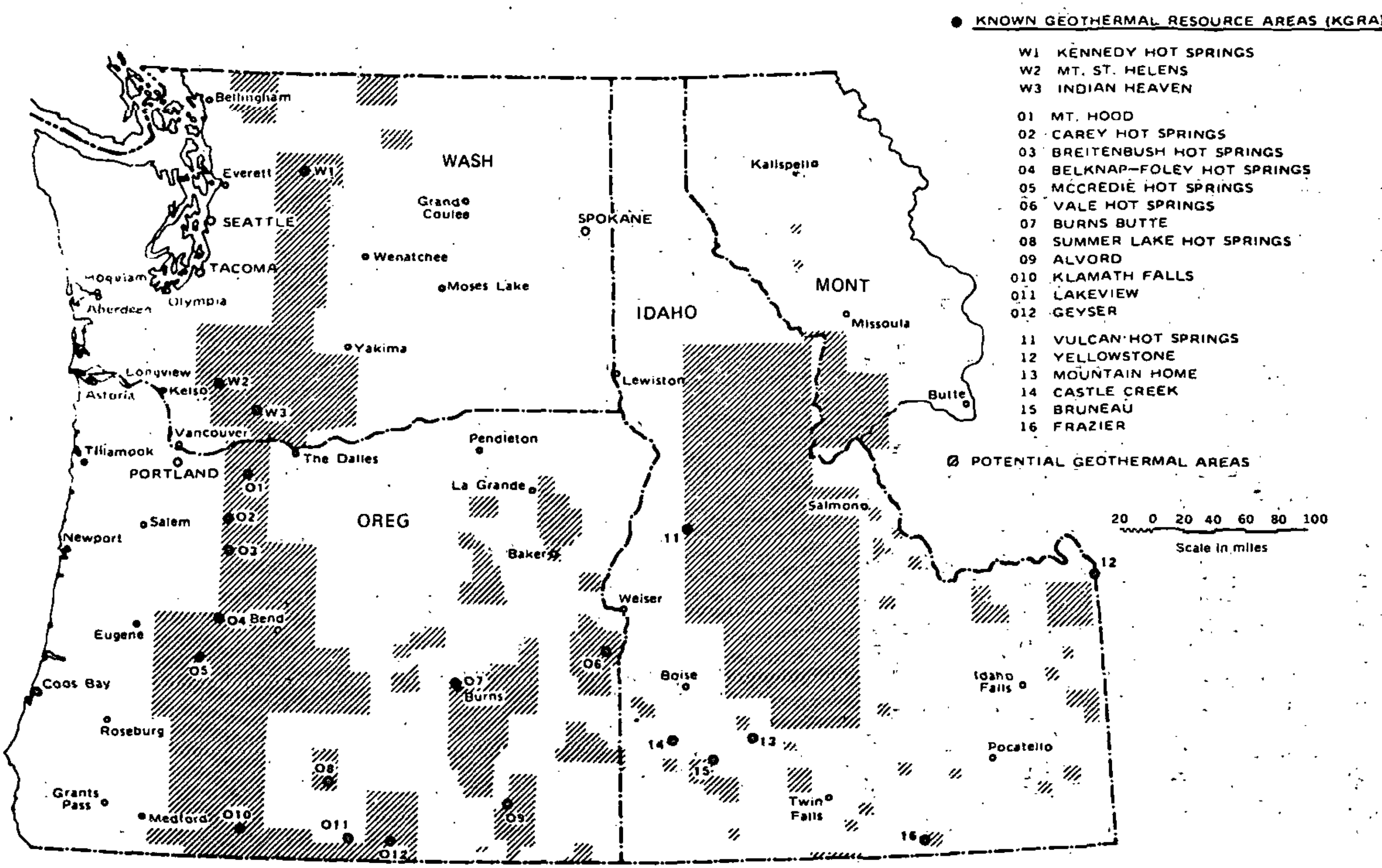
Development of the region's geothermal potential is continuing and will likely be stimulated if certain demonstration projects prove successful. Plans are presently underway to supply geothermal heating to many State office buildings in Boise. The possibility of developing a geothermal field in the Portland area is also being investigated. Successful completion of these projects could stimulate additional projects, especially if power rates in the region rise to accommodate the costs of expensive new generating plants. NEPP's study states that the most serious impediment to geothermal development is the small number of geothermal projects underway.

Other renewable potentials

Several other renewable energy sources exist which regional researchers have judged inappropriate for development under present conditions. These include animal wastes; sewage sludge; and ocean tides, currents, waves, and temperature differences. Because of their high costs or small energy impacts, these sources have received only limited analysis. While this may be appropriate for the time being, the changing patterns of energy economics and technologies will necessitate periodic reappraisals of these and most other renewable energy sources.

FIGURE 4.2

KNOWN AND POTENTIAL GEOTHERMAL RESOURCE AREAS IN THE PACIFIC NORTHWEST



IMPEDIMENTS TO CONSERVATION AND DEVELOPMENT OF RENEWABLE RESOURCES

Conservation opportunities and renewable energy sources are found in varying degrees everywhere. Every factory, office, and home has some potential for energy conservation. Many can use renewable energy sources through applications such as wood furnaces, solar hot water systems, windmills, or geothermal space heaters.

Because they are so widely available, conservation and renewable energy sources can greatly reduce customer dependence on external energy supplies. For example, if a homeowner thoroughly insulated and weatherized his home, he would need less energy from his local utility. If he put solar collectors on his roof to capture radiant energy for hot water and space heating, he would need still less. Should he ultimately develop an independent source of electricity--perhaps through a system combining a wind generator with storage batteries--he would approach total independence from the utility network. He might at times even have surplus energy to "sell" to his utility.

The potential independence which energy conservation and use of renewable energy sources offer may explain why utility officials have hesitated to advocate these methods of meeting demand growth. As customers become more independent of central supply sources, utility revenues may decline and rate increases may be necessary to meet costs. This particularly concerns investor-owned utilities, which must cover costs and account to their stockholders for earnings stability and growth. As one consulting firm which studies solar energy opportunities in the State of Florida reported:

> "The utility stance is to avoid, and even possibly discourage, solar energy development out of apprehension that the only result can be a reduction in utility revenues.
>
> "Solar energy is viewed essentially as a threat which the utilities have not yet determined how to turn into a benefit."

Further, since the earnings of an investor-owned utility are regulated on the basis of a percentage of its capital investments, the larger its investment in generation and transmission facilities the larger its potential profits. Use of decentralized renewable technologies, even if it failed to reduce current revenues, could limit future investment and restrict profit growth of investor-owned utilities.

BPA has also been hesitant to aggressively promote energy conservation and nonconventional energy sources in light of its mission to promote widespread use of all electricity generated at Federal hydro projects. As discussed in the next chapter, BPA has only recently become involved in proposals for energy conservation which would go beyond public information efforts.

Although BPA and the regional utilities have taken only limited steps to encourage energy conservation and use of renewable energy sources, these options represent major objectives in the National Energy Plan. Furthermore, there is considerable interest in these alternatives within the region. Concern about the planned move to thermal generation has heightened this interest and led to conflict over energy supply options. This conflict, along with other issues confronting the region, is discussed in the next chapter.

CHAPTER 5

CONFLICTS AND OUTDATED INSTITUTIONAL CHARTERS

ARE DELAYING ACTION ON NEW ENERGY PRIORITIES

The Pacific Northwest faces many important and difficult decisions in electricity management during the transition from dependence on hydro resources to increased use of other energy options. Difficult tradeoffs must be dealt with to establish an effective system of regional electricity management. In the absence of strong and unified leadership, energy management objectives have not been established and regional institutions are in disagreement over key policy issues. Conflicts have also developed over the right to Federal hydropower, Federal assistance in financing new powerplants, and the lack of broad-based participation in regional power planning. This has prevented the cooperation needed to develop a regional electricity plan and program.

POLICY ISSUES AT CONFLICT

Policy issues are at the heart of the regional conflicts. There is serious disagreement over how much electric energy the region will need and how that energy should be supplied. The principal issues can be summarized in four questions:

--What methods and assumptions should be used to forecast electrical energy demand between now and 2000?

--Can energy conservation make a substantial contribution to the region's energy future?

--What mix of supply options--nuclear plants, coal-fired plants, and renewable energy technologies--should be used to meet growing electricity demand?

--Who should participate in electric power planning and policymaking?

Forecasting methods and assumptions

Important policy issues have been raised regarding the methods and assumptions used to forecast the region's electricity demand. These issues involve whether or not: (1) those who prepare and/or have input to regional forecasts use the most accurate and current data available, (2) the latest, most sophisticated forecasting techniques are used, and (3) the most reasonable assumptions about social and economic factors are made. Conflict over recent forecasts demonstrates a lack of agreement on forecasting methods and assumptions.

A number of forecasts have been developed which project vastly different growth rates for regional electricity demand. Forecasts of average annual growth ranging as high as 4.5 percent and as low as 0.47 percent have been prepared by the Pacific Northwest Utilities Conferences Committee, the Northwest Energy Policy Project, and the National Resources Defense Council. (See fig. 5.1.) These projections differ mainly because of differences in forecasting methods and in the assumptions made about factors such as population growth, industrial growth, conservation efforts, and employment levels. While the forecasts differ, they do agree that the growth in electricity demand will be much less than the 6.9-percent annual growth rate experienced in the region between 1950 and 1974.

The PNUCC, or "high side," forecast, 1/ is the official regional forecast used by the utilities to schedule new powerplant construction. It is essentially an aggregation of forecasts made by its member utilities' using a variety of forecasting models and assumptions. A study 2/ commissioned by BPA revealed the diversity of forecasting methods and assumptions used by the region's utilities. The study shows that while one utility may use an elaborate model to forecast demand, another utility may simply extrapolate historic demand patterns.

At the low end of the spectrum, the NRDC forecast, released in 1977, predicts only a 0.47-percent annual average demand growth. This rate is keyed to a number of assumed conservation actions, such as establishment of energy-efficient building codes and performance standards for industry, aggressive technical assistance and loan programs by utilities, and tax incentives.

The BPA-commissioned study of energy forecasting practices indicated that some efforts are underway to design new forecasting models for the region. The newest--developed for NEPP--is a detailed econometric model with numerous variables, including policy variables, price variables,

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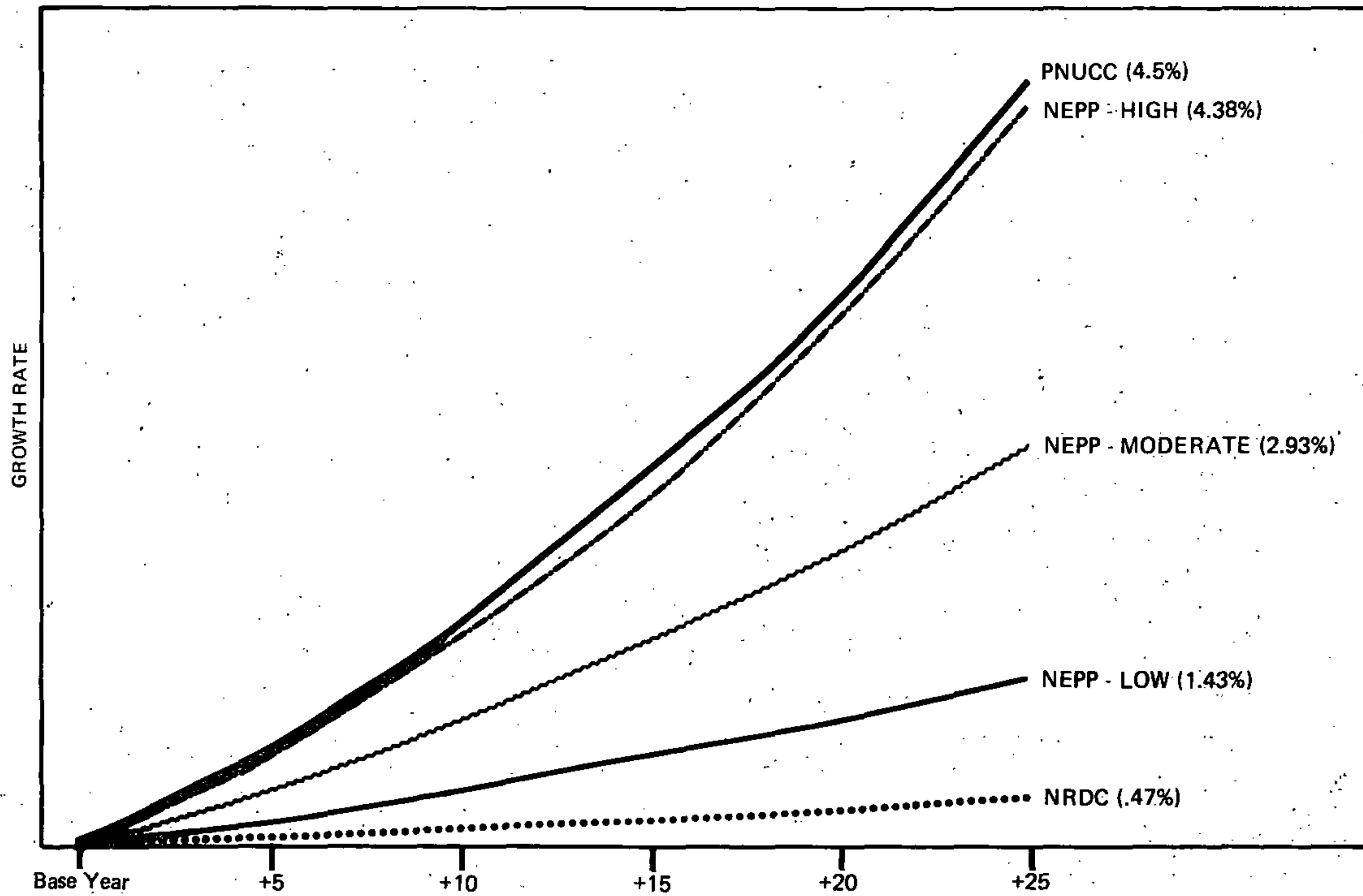
1/February 17, 1977, forecast. A more recent forecast by PNUCC, West Group, was made March 1, 1978, which reflects a 4.4-percent average annual growth.

2/Review of Energy Forecasting Methodologies and Assumptions, Enrst and Ernst, June 1976.

FIGURE 5.1

PACIFIC NORTHWEST FORECASTED ANNUAL AVERAGE ELECTRICAL GROWTH RATES



and end-use variables. The Oregon Department of Energy has also developed a detailed econometric model for the State which is similar to the NEPP model.

Despite recent interest in better forecasting, the region still lacks agreement on forecasting methods and assumptions needed to develop a generally accepted demand forecasting model. Until such a model is operable, forecasts developed by any regional entity will be challenged by those who advocate different forecasting methods and assumptions.

The following incidents are illustrative of why conflicts persist about forecasts and forecasting:

--Commenting on PNUCC's projected tenfold increase in energy requirements for the manufacturing subsector called other industrial, a consulting firm 1/ noted that "* * * the magnitude of this overestimation may be more than twice the 1975 usage of the [region's] primary aluminum industry."

--The Oregon Department of Energy reported that: "The simplistic assertion that utilities overforecast is not an accurate one. In general, though, the investor-owned utilities' forecasts are higher than others. It is clear that more appropriate forecasting techniques are available which are not being used in their facility planning."

--Concerning a September 1977 hearing on a utility's proposed rate increase, an Oregon Public Utility Commissioner stated that: "For the first time, we will have competent forecasting as well as [the utility's] testimony. That is the most important thing * * * the place where the decision is made about future rates is in the forecast."

Forecasting is an issue that will continue to polarize regional opinion until a more widely accepted process and institutional setting is devised. The absence of an objective regional approach to forecasting electricity demand continues to hinder planning and policymaking.

1/"Evaluation of Electrical Power Alternatives for the Pacific Northwest," prepared for ERDA by TRW.

Conservation potential

While the potential for energy conservation is only one of many factors involved in forecasting demand, conflicts over its role in the region's electrical energy picture have made it a major policy issue worthy of separate consideration. When electricity was plentiful, BPA worked with regional utilities to encourage its widest possible use. Today, faced with potential shortages, there is general agreement that efforts are needed to conserve electricity through more efficient use.

BPA and the utilities are initiating and promoting energy conservation programs, but these programs are largely voluntary and dependent upon consumer response to pleas for conservation. Few aggressive actions have been taken by BPA or the region's utilities to stimulate conservation through rate changes or financial participation in conservation projects. In 1977, however, the region's utilities submitted a bill to the Congress requesting the establishment of a fund, not to exceed $300 million, for conservation programs which may provide for grants or loans to the ultimate consumers. This fund would be administered by BPA, but details of the conservation programs are yet to be developed. Among proposals which BPA has prepared for public review and comment are a residential insulation program and a program involving rewards and penalties for those utilities that conserve or fail to conserve.

There is no agreement within the region on how much electrical energy can be saved by conservation. Regional utilities believe that conservation opportunities are limited, while opposing groups envision a vast conservation potential. Further, there is disagreement about the impact of conservation on the region's economy.

Conflicts over the potentials of energy conservation were vividly illustrated by the controversy which followed release of a consulting report on conservation commissioned by BPA. The 1976 report outlined energy savings and impacts using seven different conservation strategies of increasing strength. The report became controversial largely because of the energy savings it projected. Under its most stringent conservaton strategy, the study estimated that the energy savings would equal 53 percent of the energy growth forecast by the local utilities between 1974 and 1995 and thereby displace at least 11 thermal generating plants. The study concluded that these savings could be achieved <u>without</u> new technologies or significant institutional or lifestyle changes and would be six times less expensive than investing in new thermal plants. The study also concluded that conservation would create at least as many jobs--particularly for the unskilled--as would thermal plant construction.

Even though BPA commissioned the study, it stated that it could not totally endorse the study findings because:

> "* * * a higher level of conservation is currently being practiced in the region than was assumed [in the study] * * *," and "* * * the probability of all the [conservation] programs being implemented is not great due to: (1) the controversial nature of some * * *, and (2) the government procedures which would be required to implement them."

Another study, conducted by NRDC in 1977, not only supports BPA's consulting study but considers the conservation potential to be underestimated. A third study, conducted by NEPP, estimates that, with the maximum adoption of the conservation policies studied, electricity savings would be 40 percent by the year 2000, although full adoption was considered unlikely. NEPP estimates savings of 22 percent by the year 2000 under what it considers to be a more probable scenario involving information programs, incentives, and regulatory policies.

The existence of a substantial energy conservation potential has been confirmed in three studies, although each study arrived at a different estimate of its magnitude. Efforts to realize this potential have been impeded by the hesitancy of BPA and the utilities to actively promote energy conservation, as discussed in chapter 4, and by legal constraints impeding these institutions. Aggressive promotion and leadership by these institutions will be needed if energy conservation programs are to assume the "cornerstone" role envisioned in the National Energy Plan.

Supply options

To the extent that growth in regional electricity demand exceeds the potential to conserve energy through more efficient use, new energy supplies will be needed. In the past Federal agencies and regional utilities met increased demands for electricity primarily by building or expanding hydroelectric projects along the Columbia River system. As acceptable sites for large hydro projects have become scarce, utility officials have generally planned to construct large thermal generating plants to meet future growth in electricity demand.

The utilities' planned thermal plants are the subject of much discussion within the region. Opposition to large-scale use of thermal generation has centered on the high cost of thermal power; the adverse environmental effects associated with coal-fired plants; and the hazards involved with building, operating, and decommissioning nuclear plants.

Some within the region believe that BPA and the utilities have not adequately considered or promoted development of the renewable energy sources discussed in chapter 4. BPA has made limited efforts in this regard by cooperating with ERDA in a proposal to locate a prototype wind turbine generator on a BPA site in southwestern Washington and with Oregon State University researchers to install wind-measuring devices at a number of sites throughout the region.

The use of renewable sources, such as wind, solar radiation, geothermal, or biomass conversion, would help meet electricity demand without many of the environmental impacts associated with thermal plants. The region's potential for harnessing these sources was reviewed in a study conducted for NEPP by the University of Idaho in 1977. The report concluded that the region has many opportunities for development of these sources and estimated that by the year 2000, they could account for as much as 9.1 percent of consumption in space heat, process heat, and steam applications and could provide up to 8.3 percent of the region's electrical generating capacity. However, the report's conclusions have been criticized by regional experts, some claiming the potential for use of unconventional sources was overly pessimistic and others that it was overly optimistic. Their comments, according to the report:

> "reveal the controversial nature of forecasting future utilization of unconventional energy sources and reinforce the [report's] conclusion drawn about the high degree of uncertainty that characterize the estimates themselves."

Regional uncertainties about selecting energy supply options for the future were dramatically evidenced in Seattle. In 1975 the city of Seattle was considering limited participation in two nuclear plants as a means of meeting future energy demands. A controversy arose over city energy policies, future energy needs, and projected impacts on the rate payers. Consequently, a study entitled "Energy 1990" was undertaken to evaluate demand reduction and supply options for the city. The study involved the municipal utility, consultants, and city officials and provided a unique opportunity for broad public participation through a citizens' review committee. On the basis of the study findings, the Seattle City Council voted against participation in the proposed nuclear plants.

Nuclear power costs were cited as a principal factor in the council's decision. The council chose instead to rely on a comprehensive energy conservation program, including such features as (1) revision of city building codes to provide maximum cost-effective energy conservation, (2) review of utility rates to encourage conservation, and (3) consumer information and technical assistance programs. The council also commissioned studies to further investigate the alternatives for generating additional electricity in the future, with primary emphasis on hydro and coal-fired alternatives.

<u>Participation in planning and policymaking</u>

In the past there was general agreement within the region that hydropower projects were appropriate to spur growth of the region's economy. As a result electricity planning in the region has dealt largely with technical programs involving development of hydroelectric sites, integration of utility operations, and design and construction of larger and more efficient transmission networks. Most of these programs were designed and directed by technical experts employed by BPA and the electric utilities. The entire power-planning and development process was conducted with little public participation and somewhat in isolation from public view.

A predominantly technical approach to electricity planning no longer seems appropriate in light of the socioeconomic and environmental issues now facing the region. While these issues are of vital concern to all regional citizens, existing institutions for power planning and development generally do not represent the broad spectrum of regional interests. Many factions, including State and city governments, environmentalists, and conservationists, feel that energy planning is dominated by the utilities and BPA's large industrial customers and offers little opportunity for public participation. These factions want to play more active roles in shaping the region's energy future, and their inability to participate has made them question the competency and objectivity of the power planners' forecasts and analyses of supply options. Lack of public participation appears to be a major cause of the many lawsuits which have been filed to prevent or modify implementation of regional power programs. The closed-door nature of power planning has intensified regional conflicts and made it more difficult to develop a comprehensive and forward-looking plan for electrical development.

Today's power-planning issues are important to citizens concerned about economic stability and environmental quality, as well as to a Nation confronted with serious shortfalls in its domestic supplies of energy. Unlike hydroelectric power, some of the energy supply sources now being considered are neither indigenous to the region nor relatively benign in nature. They include coal-fired and nuclear plants whose environmental impacts could be far greater than the hydro projects of the past 40 years. Compounding the debates over energy demand forecasts and future supply sources are volatile equity issues concerning the allocation of Federal hydropower and the appropriateness of Federal assistance to utilities financing new powerplants.

Under these conditions it is not surprising that public and private interests, largely silent in the past, are now questioning utility planning practices and clamoring for opportunities to help shape regional energy policies. Their concerns are thoroughly documented in the regional media, as shown by the following excerpts:

--"* * *[Oregon] has been frustrated in the past in its attempt to become a more equal partner in the Northwest power planning, and * * * the public systems--most of which are in other States--are lining up to grab the remaining Federal hydro-power." 1/

--"Public participation was not provided for in the original Project Act, most likely because no one thought about it then * * *. It seems obvious that this should be remedied, especially when one considers the far-reaching consequences for the Pacific Northwest of the decisions made by the officials of the BPA. * * * The doors to Bonneville's system should be opened to allow input from citizens of the Northwest, those most directly affected by these decisions." 2/

1/"Northwest Electrical Power Needs," Senator Mark O. Hatfield, March 1977.

2/"Bonneville Power Administration: Northwest Power Broker," Environmental Law, The Lewis and Clark Law School, Spring 1976.

--"* * * there has been little public input during the formulation of BPA's policies or plans. Bonneville * * * recently stated that it is only responsible to the Federal Government. The State legislatures, the governors, and even the public utilities have no power to set or control its policies or activities nor does the interested general public." 1/

--"Unfortunately, BPA has chosen to work exclusively with utilities and aluminum companies to develop amendments to the BPA legislation. These discussions are being held in closed door sessions. Environmental and other citizen groups, as well as representatives of Oregon's Public Utilities Commission, have been barred from attending these sessions. * * * In addition, * * * any documents or other materials discussed at the meetings will not be available for public review under the Freedom of Information Act." 2/

--"Critics of the utilities find one thing particularly frustrating. It is difficult for the public to challenge the utility industry or to influence its policies, they say, because no effective mechanism exists for public involvement in the electricity decisionmaking process. In a practical sense, the utilities are our policymakers." 3/

The concerns and frustrations illustrated above are responsible to a large degree for defensive actions which have been taken by State legislatures, city governments, and citizen groups, as described in the next section. Until more representative decisionmaking processes are established, conflicts and mistrust will continue to prevent the cooperative energy planning needed to deal with the problems of transition. It seems clear that a more participative and broad-based approach to regional power planning is needed, one which redefines and integrates the roles of Federal and State Government and opens the door to increased public involvement.

1/"Bonneville Power--Entering Its Fifth Decade," Earthwatch Oregon, February 1977.

2/"An Alternative Energy Scenario," Earthwatch Oregon, March 1977.

3/"Washington's Low-Profile Power Planners," Pacific Search, February 1977.

EQUITY ISSUES AT CONFLICT

The prospects of power shortages and sharply higher electricity rates have greatly increased public concern over future energy supplies. Institutional conflicts center around which utilities should have access to inexpensive Federal hydropower and how the utilities should finance the new plants needed to expand the region's generating capacity. Both of these questions are perceived as equity issues. They are so important to regional interests that answers must be found to break the planning deadlock which presently exists.

Access to Federal hydropower-- the preference customer concept

The Bonneville Project Act of 1937 requires BPA to first supply the needs of the cooperatives and public bodies, giving these preference customers first call on the region's inexpensive Federal hydroelectric energy. The act states,

> "In order to ensure that the facilities for the generation of electric energy at the Bonneville project shall be operated for the benefit of the general public, and particularly of domestic and rural consumers, the administrator shall at all times, in disposing of electric energy generated at said project, give preference and priority to public bodies and cooperatives."

In the past the region's investor-owned utilities also purchased firm power from BPA to supplement their own generation facilities. These purchases of Federal hydropower allowed the investor-owned utilities to keep their rates within the range charged by the publicly owned utilities. In 1973 Federal firm power ceased to be available to investor-owned utilities in Idaho, Oregon, and Washington, forcing them to develop more costly supply sources and to raise their power rates far above those of publicly owned utilities. This disparity can be illustrated by comparing the power rates in Portland with those of its neighboring city across the Columbia River, Vancouver, Washington.

Electric power customers in Portland are served by the Portland General Electric Company and the Pacific Power and Light Company, both investor-owned utilities, whereas customers in Vancouver are served by the Clark County PUD, a publicly owned utility and a BPA preference customer. Portland customers' electricity rates have increased substantially over the past several years and are now more than twice those of Vancouver customers. (See table 5.1.)

TABLE 5.1

Residential Bills for Power Provided by Selected Regional Utilities, as of August 1977 (Based on 1,000-kWh usage)

Investor-owned utilities:	
Portland General Electric	$25.15
Pacific Power and Light	23.50
Puget Sound Power and Light	18.45
Idaho Power	20.95
Washington Water Power	a/13.20
Publicly owned utilities:	
Clark County PUD	b/11.10
Eugene Water and Electric Board	14.85
Seattle City Light	11.74
Snohomish PUD	9.50
Cowlitz County PUD	8.75

a/Spokane County only.

b/Effective September 1977.

Source: BPA.

Rate disparities, such as those in table 5.1, and the possibility of greater disparities in the future have caused a public outcry. A further outcry resulted from recent disclosure that some publicly owned utilities use BPA preference power wholly or largely to serve industrial users. (See table 5.2.) While this practice does not violate the preference clause, it may conflict with its intent. It can be argued that the preference clause is intended to provide power from Federal facilities for the direct benefit of the people, not for selected individuals or companies. The conditions illustrated in tables 5.1 and 5.2 demonstrate what some feel is an inequitable and arbitrary distribution of the Federal hydroelectric energy produced in the region.

TABLE 5.2

Publicly Owned Utilities With
Industrial Power Sales Exceeding Half of Total Sales
Calendar Year 1975

Utility	Industrial sales (MWh)	Industrial sales as percent of total sales
Whatcom County PUD	119,199	100.0
Clatskanie PUD	623,112	88.9
Heyburn, city of	45,055	76.8
Cowlitz County	1,548,739	64.0
Port Angeles, city of	252,184	55.9
Blachly-Lane County Cooperative	46,980	55.4
Douglas County PUD	233,837	53.6
Central Lincoln PUD	485,241	52.9

Source: BPA.

The conflict over access to Federal hydropower has resulted in several defensive actions. In March 1977 the city of Portland applied to BPA asking to be classified as a preference customer, but was refused. In November 1977, in response to the refusal, the city brought suit against BPA asking that all BPA's power sales contracts, extension and renewal agreements, and net billing agreements entered into by BPA since January 1, 1970, be declared null and void. The suit asks that environmental impact statements be prepared for each of the agreements cited and for any future agreements of that nature. The States of Idaho and Oregon have expressed interest in joining Portland in the suit.

In June 1977 the State of Oregon enacted legislation to create a Domestic and Rural Power Authority to obtain the benefits of Federal power for customers of Oregon's investor-owned utilities. The authority would buy power from BPA and other sources and sell it to domestic and rural consumers. This bill, coupled with other energy-related legislation in Oregon, such as a bill to ease formation of PUDs, could reduce the amount of energy otherwise available for BPA's existing preference customers.

Oregon's Domestic and Rural Power Authority is scheduled to begin operations on March 1, 1979, unless the 95th Congress enacts a regional power bill which the Oregon Governor judges adequate to assure equitable costs of power to all Oregon consumers.

Financing new powerplants

In the past the region's utilities met their load growth through expansion of the hydroelectric system. Because the region can no longer depend solely on hydroelectric resources, additional energy supplies must ultimately be added to the system. BPA, the utilities, and direct service industrial customers have planned to add these supplies by constructing thermal generating plants. However, since BPA is not authorized to develop its own thermal powerplants, the utilities must meet future load growth by constructing their own thermal plants.

A major issue facing the region's utilities, both publicly owned and investor-owned, is how to finance construction of power-generating facilities. The utilities have purchased substantial amounts of power--in many cases all their power--from the Federal Government. As a result, according to BPA's former power manager, their equity bases are smaller than those of utilities in other areas, making it difficult for them to attract capital to finance new power facilities. The former power manager argued that since their power purchases helped repay the Federal investment in the region's power system, the utilities should obtain some benefit from the Federal equity they helped to build.

To obtain the benefits of the Federal equity, the utilities have sponsored legislation which would allow BPA to underwrite the financing of their new powerplants by agreeing to purchase the energy they produce. Conservationists and other critics of this proposal contend that policymakers should carefully review the idea before introducing it into the region. Some critics contend that if the power is really needed and the market demand is really there, the capital should be attracted without Federal backing. A 1976 study commissioned by BPA noted that the bond issues of the region's utilities have been highly regarded in the national market and concluded that as long as these utilities remain financially sound, they should continue to find favor with investors.

CONFLICTS AND OUTDATED INSTITUTIONAL CHARTERS HAVE DELAYED ACTION ON NEW ENERGY PRIORITIES

Conflicts over policy and equity issues, coupled with outdated institutional charters, have delayed regional initiatives on new energy priorities, such as energy conservation and development of renewable energy sources.

Although several studies have concluded that regional conservation programs could yield significant energy savings, BPA and the utilities have made only limited efforts to promote energy conservation but have been limited by institutional constraints. BPA has stated that energy conservation programs--whether voluntary, with incentives, or mandatory--can be an integral part of its efforts to assure adequate power for the region. It is awaiting public input on its Role EIS and proposed conservation programs before its future policies and role are established. Historically, the primary responsibility of the region's utilities has been to supply power, not conserve it. The president of a Washington State power supply group has explained to the press that, in his opinion, utilities are not the proper agencies to set standards for conservation. He stated also that his group is not intended to formulate policies or implement programs affecting conservation.

Similarly neither BPA nor the region's utilities have taken the initiative to expedite development of the region's renewable resource potentials. Although research efforts have indicated that the region has important wind, geothermal, direct solar, and biomass potentials, BPA and the utilities have for the most part assumed that these and other unconventional sources will make no significant energy contributions during the remainder of this century. Without more aggressive and innovative leadership from its energy institutions, the region will continue to lag in responding to the problems of transition and to the Nation's new energy priorities.

Within the region it is generally recognized that the time has come for a new, forward-looking approach to energy planning and policymaking. No agreement can be reached, however, on a workable approach. The intensity of intraregional conflicts demonstrates the need for a well-defined, comprehensive, and updated approach to managing the region's electrical resources. However, regional infighting over the allocation of Federal hydropower and the proposed Federal role in financing new powerplants has become so divisive that without congressional assistance there is little hope of agreement on how the region should plan its energy future.

CHAPTER 6

ANALYSIS OF THREE ALTERNATIVE

ELECTRICAL ENERGY POLICY SETS

To assist the committees of the Congress and regional policymakers in making informed choices about the region's electrical energy future, we employed a team of energy consultants to describe and analyze three alternative electrical energy policies for electricity management. This format allows us to focus directly on major policy questions and their potential effects on the region. By making each policy set consistent in assumptions, baseline data, and technical procedures, the resulting differences are due solely to the difference in policy considerations. The three policy sets are not intended to represent the way the future is going to be, but do represent the best informed future estimate of application of the particular policies being studied.

We asked our consultants to explore the economic, environmental, and social impacts of each policy set through the year 2000. The consultants used two forecasts in analyzing the alternative policy sets. One forecast, referred to as the high-growth projection, represents the predictions of regional utilities that electrical energy demand will grow at an annual rate of about 4.8 percent. 1/ This compares with the historical growth rate for the Northwest of 7.2 percent through 1973. The other forecast used is a moderate-growth projection of 2.7 percent 1/ based on the energy use model developed by NEPP for the region's State Governors. Several forecasts have been made for the Pacific Northwest. They range from the PNUCC forecast to three

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1/The growth rates used in our study were based on preliminary demand forecasts. Both forecasts were subsequently adjusted: the utilities' forecast to 4.5 percent and the NEPP moderate growth to 2.93 percent, as shown in figure 5.1.

projections made by NEPP (high, moderate, low growth) to a zero-growth projection made by NRDC. 1/

It is very difficult to foresee which rates of growth will, in fact, most accurately predict the growth that actually occurs. The difficulty arises because actual energy demand results from a complicated aggregation of many different components and determinants, most of which are themselves subject to somewhat unpredictable variation over time. For example, population levels and appliance use per household are both important determinants of future electricity use levels, but no one knows for sure what population or lifestyles will be 15 or 20 years from now. Recognizing this, we chose these two forecasts to reflect the utilities' expectations and the rate the NEPP considered the most likely to occur. These are not the most extreme forecasts that can be proposed and defended as having some likelihood of realization, but they do bracket a range that includes several points of view on Pacific Northwest future growth. It is not the intent of the policy sets to depict either forecast as the most likely to occur. (See app. X for further discussion of regional forecasts.)

This chapter is based on work documented in technical appendixes I through X, which were prepared by the consultants. The conclusions drawn from this work are GAO conclusions.

POLICY SETS SELECTED FOR ANALYSIS

The three sets of alternative electrical energy policies selected for analysis cover a broad spectrum of energy policy options. Their principal characteristics are summarized in the paragraphs below.

1/One reason for variances in the region's load growth rates is the amount of conservation expected. The load growth forecasts for the region "back out" conservation in arriving at a load growth rate. Our policy sets were designed to meet the same total regional demands for electricity with conservation treated as a nongenerating means of meeting demand. For example, if the NEPP moderate-growth demand were reduced by the conservation potential shown in our intermediate policy set and renewable/transition policy set, the growth rates would be about 1.6 percent and 0.92 percent, respectively. The 1.6 percent approximates the NEPP low-growth demand rate of 1.43 percent.

Thermal/traditional policy set

Thermal power development would characterize the thermal/traditional policy set. These policies embody an extension through the year 2000 of energy management policies used in the region's hydrothermal power program in the late 1960s. Under this policy set, there would be total reliance on thermal generation to meet load growth which could not be met by hydropower additions. This policy set would put minimal policy emphasis on conservation and development of alternative renewable energy sources. Commitments to conservation programs or renewable energy projects would be left to private initiative on the basis of existing market conditions and associated economic benefits and costs, without government assistance or encouragement. Average cost pricing policies now in force would be continued. The high costs of new thermal plants would be melded with the low costs of older hydro projects to develop average cost prices. Electrical load growth would be met by equal increments of nuclear and coal-fired generation after the completion of powerplants already approved for construction.

Intermediate policy set

The intermediate policy set would be characterized by mild government and utility policies to encourage conservation and development of renewable energy sources. These policies would include a broad public information program, tax credits, loans, grants, and other incentives designed to induce people to conserve electricity and to develop renewable energy sources. Renewable energy technologies would be implemented after they had been proven economically feasible. Average cost pricing would be continued, with new customers paying less than the true costs of new power supplies. Large industrial customers would be provided inexpensive power priced at averaged costs, but only in quantities sufficient to operate highly efficient plants. For power needs exceeding these levels, actual costs of new power would be charged.

Requirements for additional generating capacity beyond what is now scheduled for construction would be supplied first by conservation programs, then by development of renewable energy sources, and finally--if necessary--by thermal generation divided equally between coal-fired and nuclear plants.

Renewable/transition policy set

Aggressive government and utility policies to achieve energy conservation and develop renewable energy sources would characterize the renewable/transition policy set. This policy set would employ, in more aggressive forms, most of the incentives provided in the intermediate policy set, plus strict building codes, retrofit insulation programs, and a surcharge on electricity to achieve replacement cost pricing.

To maximize conservation, government institutions and utilities would expand public information programs to reach more people. Financial incentives would include government-financed demonstration projects, basic research programs, extensive tax credits, and loans or grants for conservation and renewable resource development. State and local government cooperation would be obtained to strengthen building codes and insulation standards.

Replacement cost pricing of electricity would be used to reduce energy waste and stimulate conservation and renewable energy investments. As energy prices increased, people would tend to value electricity more and waste it less, thus recapturing wasted electricity for use in meeting increased demand. Furthermore, with higher electricity prices more conservation projects would become economically attractive and renewable technologies would become competitive. The surcharge on electricity proposed in the renewable/transition policy set would be used to establish a grant and loan fund to help finance energy conservation programs and renewable energy projects.

The renewable/transition policy set would not wait for alternative technologies to be proven economically feasible. Conservation and renewable energy projects would be started when the technologies appeared likely to become economically feasible so that their contributions could be realized as early as possible. In this respect, the policy set would anticipate economic feasibility. However, alternative energy sources would be added to the system only as needed to supply growth in electric demand.

COMPARISON OF ALTERNATIVE POLICY SET IMPACTS

The sections below summarize how the three policy sets compare in certain economic, environmental, and social aspects. Comparisons were made so that alternative energy policies could be evaluated in terms of

--demand loads,

--supply sources,

--costs of generating and conserving energy,

--capital requirements,

--environmental effects,

--equity considerations,

--economic impacts and employment conditions, and

--likelihood of power shortages.

Evaluation of policy set impacts in these areas led us to many of the conclusions expressed on pages 7.2 to 7.5 The material which follows is documented in technical appendixes I through X, which were prepared by the consultants. All dollar figures presented are in constant 1976 dollars.

Demand loads

All three policy sets were designed to meet the same total regional demands for electricity. However, because conservation is an offsetting or a nongenerating means of meeting demand, each policy set requires a different amount of net generation, as shown below in table 6.1. As a result, the intermediate and renewable policy sets derive new load growth rates. Table 6.2 shows what the load growth rates would be as modified by the intermediate and renewable policy sets.

TABLE 6.1

Options for Meeting Electric Load Estimates--Year 2000

	Total electric energy requirements	Method of meeting electric load estimate	
		Conservation	Generation (note a)
	(MWy)		
High-load growth (4.8 percent):			
Thermal policy set	44,930	-	44,930
Intermediate policy set	44,930	10,270	34,660
Renewable/transition policy set	44,930	14,540	30,390
Moderate-load growth (2.7 percent):			
Thermal policy set	28,060	-	28,060
Intermediate policy set	28,060	6,210	21,850
Renewable/transition policy set	28,060	9,350	18,710

a/In 1977 the total regional electrical energy requirement was 15,160 MWy.

The conservation figures in table 6.1 represent electricity saved by investing in more energy-efficient facilities to eliminate energy waste. The renewable/transition policy set would conserve the greatest amount of electric energy and thus would rely the least on electrical grid generation.

TABLE 6.2

Load Growths

	Modified-load growth
High-load growth (4.8 percent):	
Thermal policy set	4.80
Intermediate policy set	3.66
Renewable policy set	3.07
Moderate-load growth (2.7 percent):	
Thermal policy set	2.70
Intermediate policy set	1.60
Renewable policy set	0.92

The principal measures used to encourage conservation in each policy set are listed below.

Policy set	Policy measures to encourage conservation (note a)
Thermal/traditional	Policies generally used by the region from 1963 to 1973 with reliance on thermal generation to meet the load that could not be met by hydro generation and no policy emphasis on conservation
Intermediate	Limitations on quantities of inexpensive power provided to industrial customers Information programs Building codes and insulation standards Tax credits and low-interest loans Energy efficiency research grants Demonstration programs

Renewable/transition	Replacement cost pricing to discourage waste and to establish a loan and grant fund for conservation and renewable energy projects Required home insulation retrofit standards More stringent building codes Extensive tax credits Mandatory appliance labeling Technical assistance through energy extension service

a/For more details see the discussions of conservation programs in each policy set description.

Energy supply sources

Policies for each policy set would lead to a mix of conservation and generating facilities required to meet energy requirement forecasts. In the year 2000, the supply mix for the three policy sets would be as shown in table 6.3 and figures 6.1 and 6.2.

FIGURE 6.1

HIGH DEMAND GROWTH MET BY THERMAL GENERATION, CONSERVATION, AND RENEWABLE RESOURCES THROUGH 2000

(In Thousands Of MegaWatt Years)

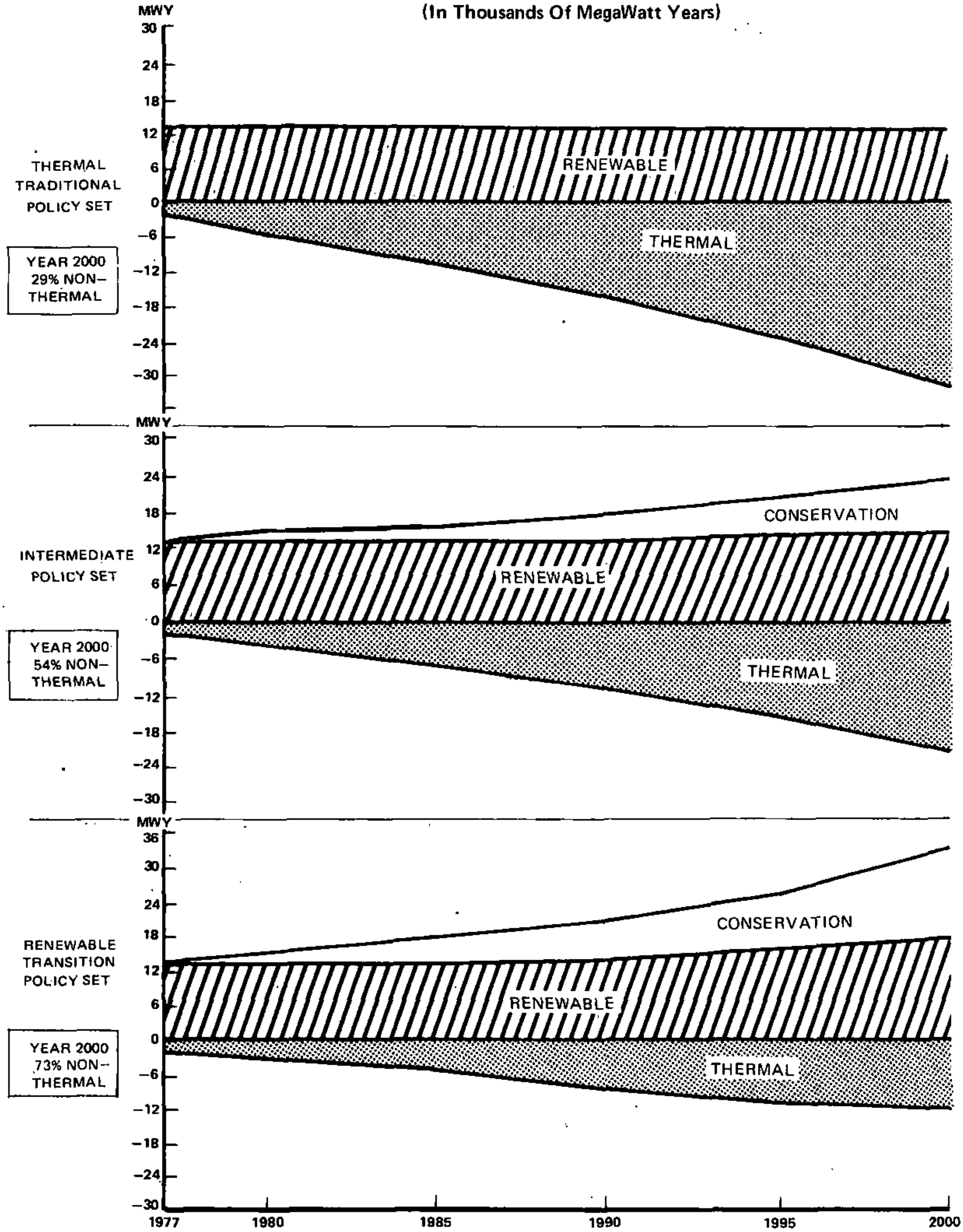

FIGURE 6.2

MODERATE DEMAND GROWTH MET BY THERMAL GENERATION, CONSERVATION AND RENEWABLE RESOURCES THROUGH 2000

(In Thousands Of Mega Watt Years)

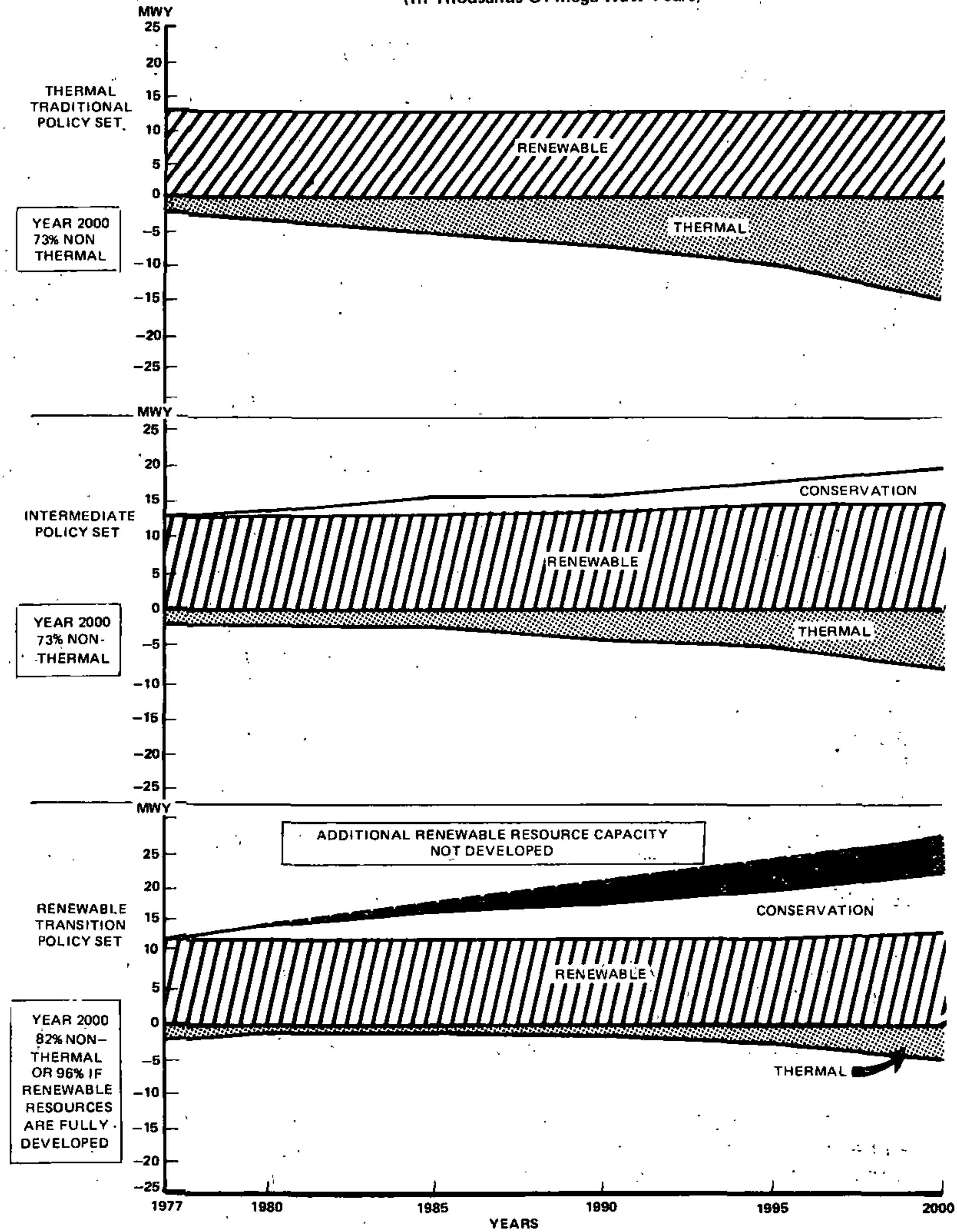

TABLE 6.3

Electrical Energy Forecasts and Supply Sources

High-load growth (4.8 percent)	Actual 1977	In the year 2000 (note a) Thermal/ traditional alternative	Intermediate alternative	Renewable transition alternative
	(MWy)			
Thermal	2,230	31,870	20,520	12,230
Conservation	-	-	10,270	14,540
Hydro	12,930	13,060	13,460	14,160
Solar	-	-	300	1,900
Wind	-	-	80	1,500
Biomass	(b)	-	300	600
Total	15,160	44,930	44,930	44,930

Moderate-load growth (2.7 percent)	Actual 1977	In the year 2000 (note a) Thermal/ traditional alternative	Intermediate alternative	Renewable transition alternative (note c)
	(MWy)			
Thermal	2,230	15,000	7,710	4,950
Conservation	-		6,210	9,350
Hydro	12,930	13,060	13,460	13,760
Solar	-	-	300	-
Wind	-	-	80	-
Biomass	(b)	-	300	
Total	15,160	28,060	28,060	28,060

a/For a critical water year, excluding reserve capacity.

b/It is estimated that an additional 5 percent, or approximately 760 equivalents, are presently being produced by burning wood wastes.

c/Renewable resource capacity not developed because not needed.

Table 6.3 and figures 6.1 and 6.2 show that the alternatives differ substantially in their reliance on convervation and their use of renewable and nonrenewable generation. Under moderate-demand growth, the renewable/transition policy set would meet 82 percent of forecast through conservation and renewable generation by the year 2000, while in the thermal/traditional policy set, only 47 percent of the forecast would be met by these supply sources. The intermediate policy set, with a less rigorous approach to conservation and more cautious development of renewable resources, would nonetheless rely on these sources to meet 72 percent of forecast in the year 2000.

The region presently meets over 80 percent of its power needs with renewable energy, principally from hydropower and wood wastes. This level of self-sufficiency might be maintained or improved if conservation and renewable resources development were emphasized in the future. If thermal power developments were emphasized, by the year 2000 the contributions of renewable energies would likely slip to less than half of total generation. Although diminished, this profile would still represent a greater percentage of renewable generation than that found in any other region of the country.

The renewable/transition policy set is the only one which would maintain or improve the region's renewable resource posture under moderate-demand growth. If high-demand growth occurred, as predicted by the regional utilities, even the renewable/transition alternative would call for the equivalent of 27 new thermal plants 1/ and a further decline in the region's self-sufficiency.

Under the renewable/transition policy set with moderate-demand growth, the region could approach electric self-sufficiency by the year 2000. To do so would require intensive conservation programs, construction of all feasible renewable energy projects, and a phasing-out of thermal plants no longer needed. This would be a rigorous and challenging task for the region, but if successfully executed could demonstrate to the Nation that regional energy independence could be achieved through conservation and full development of domestic energy resources.

Costs of production and conservation

The policy set results illustrate that energy conservation would be a less costly means of meeting forecasts than

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1/Assuming production were equally divided between coal and nuclear generation, 6 nuclear (1,250 MW) and 13 coal units (500 MW) would be required by the year 2000.

construction of new thermal powerplants. In the intermediate and renewable/transition policy sets, the average systemwide costs of electricity would generally be below the costs projected for the thermal/traditional policy set. However, the level of demand growth would also be of critical importance. If demand growth exceeded energy conserved, regional utilities would be forced to invest in expensive new powerplants, thereby raising the average cost of electricity. Table 6.4 and figure 6.3 show average costs for each policy set through the year 2000.

TABLE 6.4

Average Costs of Meeting Regional Forecasts for Electricity

	Average cost (note a) of electricity plus conservation in			
	1977	1980	1990	2000
	(in mills per kWh of energy used plus energy conserved (note b))			
High-demand growth (4.8 percent):				
Thermal/traditional policy set	12.5	14.2	23.9	29.8
Intermediate policy set	12.5	13.1	18.8	22.0
Renewable/transition policy set	12.5	13.1	16.6	18.7
Moderate-demand growth (2.7 percent):				
Thermal/traditional policy set	12.5	13.1	17.2	23.7
Intermediate policy set	12.5	12.7	14.9	16.2
Renewable/transition policy set (note c)	12.5	12.2	14.6	13.1

a/Amounts spent for conservation investments are added to other system costs for determining average costs per kWh of energy used plus energy conserved.

b/All costs expressed in 1976 dollars.

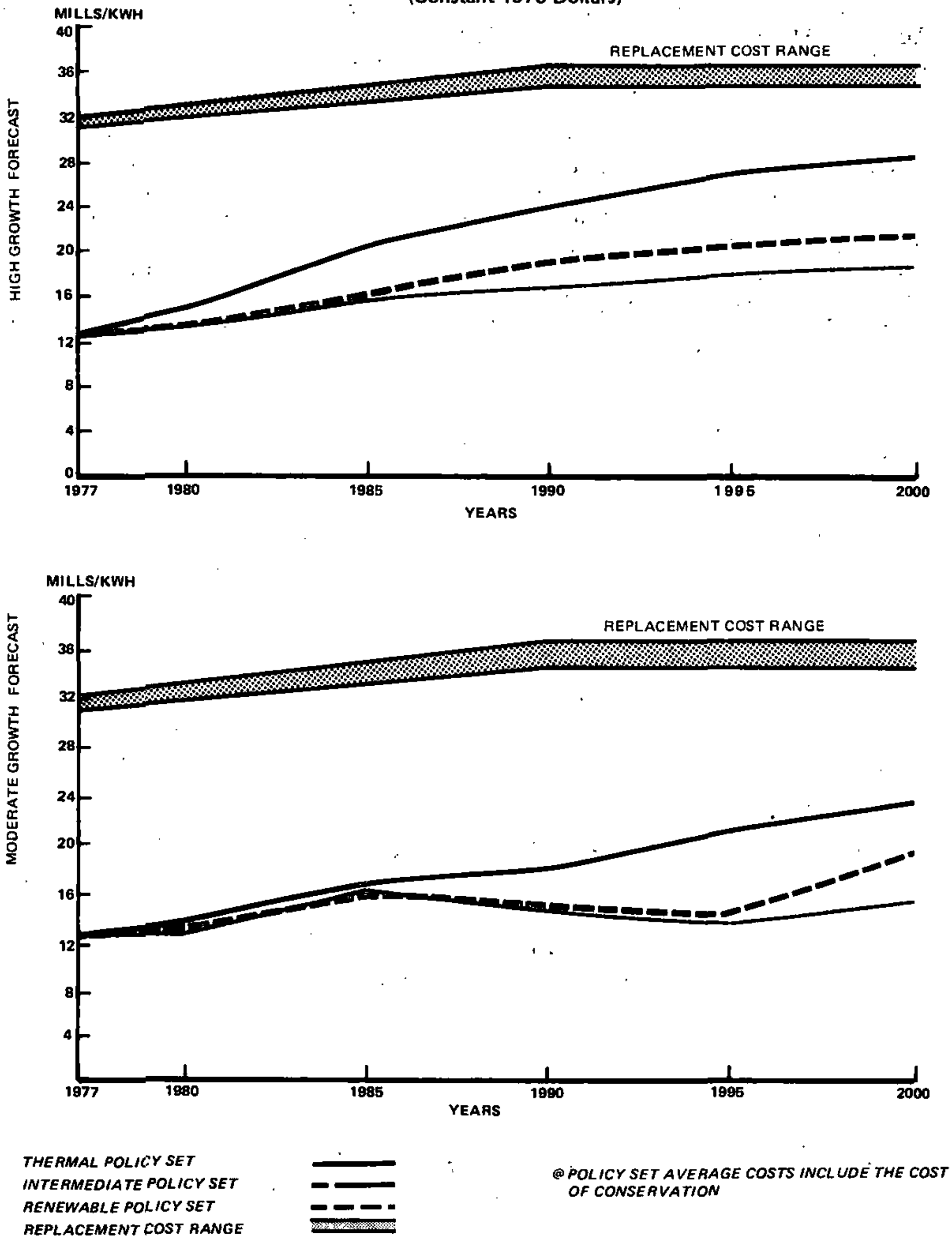
c/Includes minimal costs for development of renewable resources because conservation and thermal plants scheduled for completion by 1985 would meet most load requirements through 2000.

Table 6.4 shows that the renewable/transition policy set, with its heavy emphasis on conservation, would provide the least expensive means of meeting regional power forecasts. The intermediate policy set is also shown to be far less costly than the thermal/traditional policy set. The table also shows that high-demand growth would always lead to higher electricity costs.

The renewable/transition policy set would encourage the most conservation because, by use of a surcharge on electricity, it would price electricity at or near the replacement cost of thermal energy rather than at the average costs shown above. The extra funds collected via the surcharge would be used in a grant and loan fund for conservation programs and renewable energy projects. Cost-wise the entire power system would benefit if regional needs could be met with fewer new generating plants.

FIGURE 6.3

POLICY SET AVERAGE COSTS AND REPLACEMENT COSTS@ —1977 THROUGH 2000 (Constant 1976 Dollars)



The table shows that thermal power developments would result in substantially greater capital investments than approaches emphasizing conservation. The financing of coal and nuclear plants, with their high capital costs and extended construction periods, could strain the region's financial abilities far more than aggressive conservation programs and, as shown in table 6.4, would result in higher average costs.

Environmental effects

The generation of more electricity will produce side effects which are damaging, or at least offensive, to many people; the specific effects in the region will depend on the mix of generating sources used to meet electrical demand. As discussed below, the thermal/traditional policy set could be expected to have greater environmental risks from coal and nuclear plants while the renewable/transition policy set would lead to different environmental effects from increased use of hydropower and solar, wind, and biomass sources. The intermediate policy set would entail a mix of the risks present in the other two alternatives. The environmental impacts described for each policy set would be limited to those associated with central station powerplants--thermal or renewable. Decentralized systems, such as residential conservation, solar heaters, or small windmills, were not included because the acquisition of such units would be voluntary to the user and the impacts would probably be small and widely dispersed.

The renewable/transition policy set would have the least potential for catastrophic nuclear disaster but could have the greatest visual impact because of large and very visible wind and solar generating plants. Ultimately, the renewable alternative could use 4 to 8 square miles of land for central station solar generation and a like amount of land for wind generation. However, much of the area needed for wind generation could be used for other purposes, such as farming. Under the renewable/transition policy set, most renewable powerplants would be constructed after 1990 because thermal plants already approved for construction could meet load growth up to that time.

The thermal/traditional policy set would meet most load growth by construction of thermal plants. By the year 2000, with high-demand growth, this could require as many as 17 new nuclear units and 38 new coal units. For this policy set, the nuclear threat could be the most devastating environmental effect. With fuel reprocessing and plutonium separation, nuclear terrorism, extortion, and theft of weapons grade nuclear materials would be possibilities but could not readily be assigned a probability of occurrence. The operational characteristics of nuclear power also pose important problems involving fuel storage, disposal of nuclear wastes, and powerplant decommissioning. Concern about nuclear generation as a long-term solution is growing in the region as it has been elsewhere in the Nation. The environmental impacts of more than a dozen nuclear powerplants could possibly become a major environmental concern if the thermal/traditional alternative policy set materialized.

By the year 2000, there could be more than 40 coal-fired units operating under the thermal policy set. Given the new requirements for coal "scrubbers," the selection of remote plant sites, and the availability of low-sulfur coal, it appears that air contamination would be reduced. At times, there would be noticeable particulate and sulfur emissions in areas near plant sites, but these would dissipate quickly and not affect any large population centers. As pointed at in our report on U.S. coal development, 1/ scrubbers may help reduce air pollution, but they will give rise to a new pollutant--coal sludge--which could create serious disposal problems. Also some air quality problems are not so simply resolved. Our coal report notes that coal combustion releases over 50 dangerous trace elements, including mercury, lead, beryllium, arsenic, and fluorine. As with the renewable energy technologies, many environmental questions about thermal generation have yet to be answered. Obviously the environmental problems associated with coal and nuclear plants would be much more prevalent in the thermal/traditional alternative policy set than in the renewable/transition policy set.

The intermediate policy set would combine thermal generation, conservation, and small amounts of solar and wind generation to meet regional load growth. Like the renewable/transition policy set, it would rely quite heavily on conservation measures to reduce the need for additional generation plants. If high-load growth occurs, however, this policy set would rely on thermal generation to meet about half the new loads. From an environmental perspective, the intermediate policy set would offer many of the advantages present in the renewable policy set, but with less assurance that the adverse effects of thermal generation would largely be avoided.

1/U.S. Coal Development--Promises and Uncertainties, EMD-77-43, Sept. 22, 1977.

Equity considerations

Equity, or the ability to treat individuals and groups with fairness, is an important consideration in determining energy policies. If certain groups or individuals are treated unfairly--or are perceived to be--there will be inadequate public support for even the best decisions of energy policymakers.

The renewable/transition policy set earned high rates for equity. By using a surcharge it would price electricity at its true replacement cost. This would put an end to average cost pricing, which tends to favor new customers at the expense of existing customers. The surcharge would be used to establish a loan and grant fund to finance conservation, renewable energy projects, modernization, and tax relief in the same economic sectors paying the surcharge.

Replacement cost pricing could also be used to increase the incentive for all customers, old and new, to eliminate energy waste by imposing a low power rate for base usage and higher rates for heavy or excessive usage. This pricing approach could be used to avoid increases in electricity bills for customers who are practicing energy efficiency or are limited by their income to low levels of energy conservation.

The thermal/traditional policy set would not seek to price energy at its true replacement cost. By continuing with average cost pricing, it would benefit new power users at the expense of existing customers. The average cost pricing structure, typical of this policy set and the intermediate policy set, would have the effect of raising the energy prices paid by all customers, including those who had restricted their demands, and charging rates for increased or new consumption which were insufficient to cover the costs of new plants.

The intermediate policy set would emphasize conservation programs but not employ replacement cost pricing. As a result, there would be some inequities in the price paid by old and new customers, just as in the thermal/traditional policy set. In addition, some people would continue to use electricity inefficiently because its average price would not appear to justify conservation investments.

Energy pricing is clearly one of the most important factors for policymakers to consider in charting the region's energy future. Various pricing strategies could be employed within any of the policy sets to advance prices beyond average cost and move them toward replacement cost. Figure 6.3 shows the relationship of average cost of energy used and conserved to replacement cost for energy used.

Regional economy and employment conditions

Each alternative policy set was designed to furnish the electricity necessary to maintain financial stability and continued economic growth. Consequently, energy demand, the general state of the regional economy, and employment conditions would be generally the same under each alternative policy set. There are, however, some differences worth noting.

The renewable/transition policy set, by investing more in conservation and renewable technologies, would tend to employ more local business and semiskilled workers. The thermal/traditional policy would employ more skilled labor and more engineers and scientists. It would also generate employment in east coast manufacturing facilities which produce components for central station thermal powerplants. Because conservation costs less than powerplant construction, the renewable policy set might provide a lower but more widely distributed direct input to the regional payroll during construction periods than the thermal policy set. In the long term, however, the renewable/transition policy set's lower cost of meeting energy demands would mean that more money would be left for other activities, which would contribute more to the region's overall economy and employment picture.

The replacement cost pricing policy of the renewable policy set would mean much higher power costs for industry and would impact especially on energy intensive industries. Under the renewable/transition policy set, BPA's industrial customers would produce about the same quality of aluminum and other products as they do now, but higher energy prices would require them to adopt more efficient production methods. In addition, the higher prices would support a grant and loan fund to assist industry in financing conservation projects, eliminating waste, and reducing energy demands. Without this kind of pricing policy, industrial customers would delay making conservation investments until constrained by price increases from the introduction of numerous expensive thermal generating plants.

Overall the price of electricity does not appear to be a major determinant in regional economics, because electricity constitutes such a small percentage of total business costs. Table 6.5 shows that even for the energy intensive industries, such as primary metals, electricity costs are only 6.3 cents per dollar of value added. The low cost of electricity contributes to industry's tendency to overlook opportunities for energy conservation, concentrating instead on savings in larger cost categories, such as labor costs.

TABLE 6.5

Electricity Costs Per Dollar of Value Added for Various Industries

Standard industrial classification code	Sector	Purchased electricity costs per dollar of value added
20	Food and kindred products	2.6 cents
24	Lumber and wood products	1.2 cents
26	Paper	3.0 cents
28	Chemicals	4.8 cents
33	Aluminum	6.3 cents

A special consulting study conducted at our request showed that if electrical energy for Pacific Northwest aluminum companies were increased from the present 3 mills/kilowatt-hour to 25 mills/kilowatt-hour, the two most inefficient plants in the region might cease operations. The other eight would likely be modernized, take on more workers, and produce more aluminum without increasing their consumption of energy.

If energy prices were gradually raised to levels existing elsewhere in the Nation, most regional industries would remain competitive. Although replacement cost pricing might substantially increase power rates, energy prices in the Pacific Northwest would still be competitive with those paid by many people elsewhere in the Nation.

Likelihood of energy shortages

The likelihood of shortage varies with the adequacy of the electric energy control system established to deal with such problems. A typical system includes demand control measures ranging from requests for voluntary actions, such as turning down thermostats, to mandatory curtailments, such as industry shutdowns and rotational blackouts. As an impending shortage is perceived, load-shedding measures to promptly reduce demand and longer term measures to increase supply can be put into effect. Before the situation requires that new generating facilities be built under emergency conditions to prevent substantial mandatory curtailments, the system will probably have repetitive early warnings through frequent minor shortages. The subsequent response to correct the problem should take far less time than normal to correct if all levels of government, the utilities, and industry work together to reduce construction leadtimes.

While the risk of shortage would be equal in each policy set, each would have certain characteristics which would tend to affect the risk of electricity shortfall and the ease of its correction.

Ability to finance construction of capacity

The thermal/traditional policy set's reliance on capital intensive thermal plants could result in power shortages due to underbuilding capacity because of lack of capital or prohibitive cost overruns. There would be an equal likelihood that serious cost overruns on central station solar and wind generators could also result in underbuilding under the renewable/transition policy set. Capital shortages, however, would be less likely in the renewable/transition and intermediate policy sets because of reliance on low-cost conservation.

Diversity of energy sources--generation/conservation

The thermal/traditional policy set would concentrate generation in a sizable number of large coal and nuclear installations, which could be susceptible to sabotage or technological weaknesses. The renewable/transition alternative would rely on more conservation and less generation, which would reduce the number of generating plants susceptible to sabotage but might make the results of a successful attack more acute. Under the thermal/traditional policy set's intensive development of coal and nuclear generation, the region could become increasingly dependent on thermal technology and less technical experience would be available for developing and integrating renewable technologies into the system.

Analysis of the risks inherent in centralized and decentralized generating facilities is not addressed in the policy sets. Under all three policy sets, there would be near total reliance on centralized generation of electricity through the year 2000. Within the scope of the analysis, the alternative policies cannot be differentiated with respect to risk of shortfall based on the mix of centralized and decentralized generating facilities.

Reliability and responsiveness to change

There would be considerably varied risks in all three policy sets. The thermal policy set would use known technology which would require a long and difficult planning and construction period. The renewable policy set's technology is in the development stage, but would probably permit use of small generating units which might be easier to construct quickly when additional capacity is needed. The intermediate policy set with a combination of thermal and renewable energy sources, would incorporate a portion of the benefits and problems associated with the other two policy sets.

RESULTS OF ALTERNATIVE POLICY SET ANALYSIS

The work of our consultants in describing these alternative energy options enabled us to evaluate the policy sets in terms of (1) the administration's national energy principles and (2) the policy sets' feasibility and financial implications. Our evaluations yielded the following results.

Compliance with national energy principles

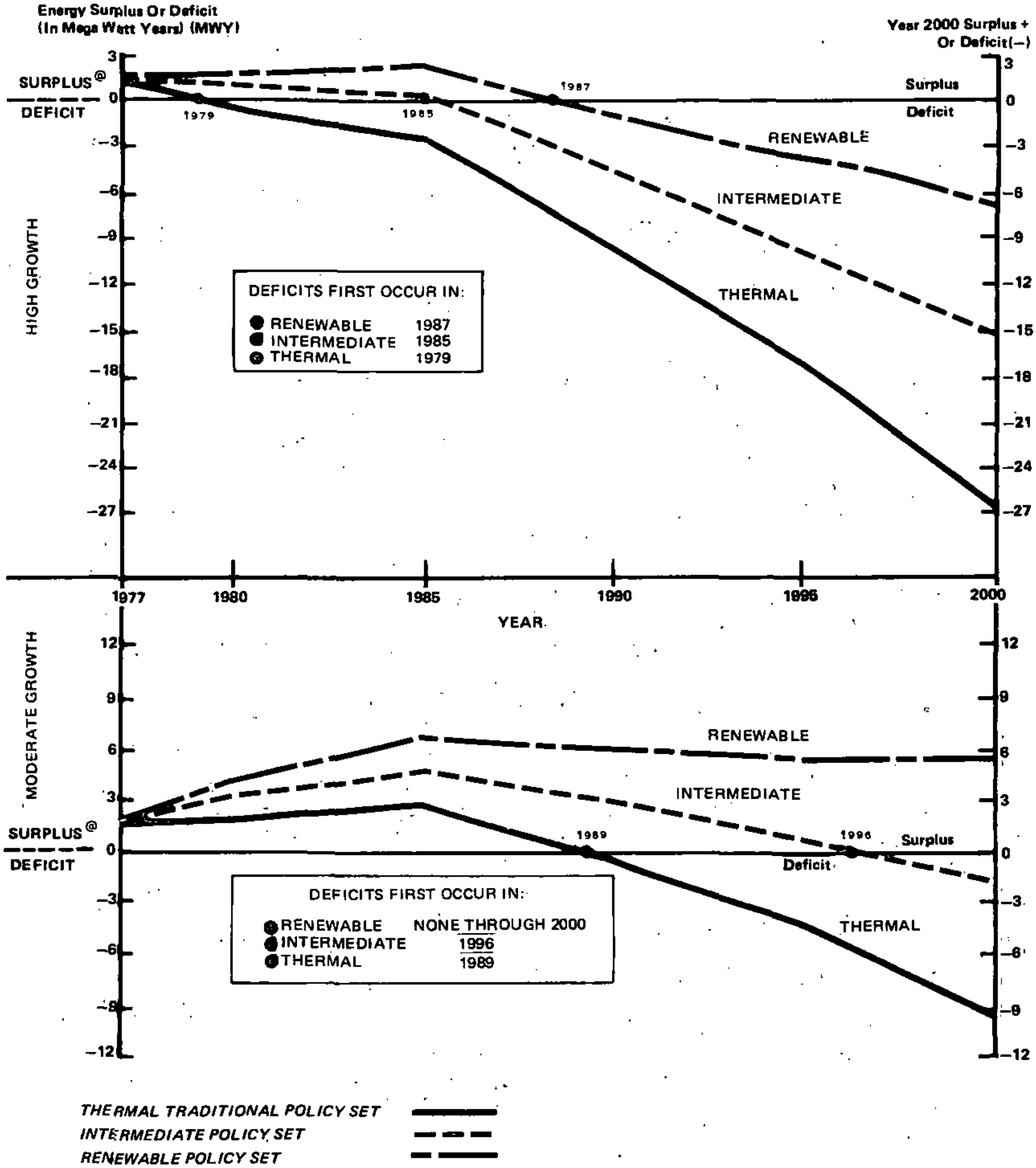
--In terms of consistency with several of the administration's national energy principles, the renewable/transition policy set received top marks. With its surcharge to discourage energy waste and to finance investments in conservation and renewable technologies, this policy set would minimize the region's dependence on nonrenewable energy sources and avoid many of their environmental consequences. This policy set's heavy emphasis on energy conservation would minimize capital requirements and total system energy costs by the year 2000. It would also enable the region to develop very rapidly a substantial knowledge of renewable resource technologies and how to apply them. With moderate growth in energy demands, the region would need no thermal plants beyond those licensed and under construction. In fact, by the year 2000, the region could achieve 96 percent electrical generation from renewable energy sources. Figure 6.4 shows when more generating capacity would be needed for each policy set. However, the acceptability of the renewable/transition policy set may be in doubt because of the stringent policies it would employ to maximize energy conservation. The acceptability of policies such as replacement cost pricing 1/ and mandatory insulation programs is dependent upon (1) increased public understanding of the electricity supply demand situation and (2) strong Federal leadership dedicated to implementation of the national energy principles.

--The intermediate policy set ranked second in compliance with the national energy principles. It would enable the region to realize about 70 percent of the conservation savings predicted for the renewable/transition policy set and would do so mostly through incentive programs, without the use of a surcharge on electricity. Because it would conserve less energy, the intermediate policy set would rely more heavily on development of new thermal powerplants. With respect to renewable energy sources the intermediate policy set would fall behind the renewable/transition policy set under high-demand growth, providing only about 23 percent as much new energy from these sources by the year 2000. In terms of total energy costs for the system in the year 2000, the intermediate policy set would slightly exceed--by a little more than 3 mills/kilowatt-hour--the low levels set by the renewable/transition policy set. With respect to system capital requirements, the intermediate policy set would require only 13 percent more capital than the renewable/transition policy set if predictions of high demand growth were realized. If moderate growth occurred, however, capital requirements for the intermediate policy set would exceed the renewable policy set's capital requirements by nearly 40 percent because of greater reliance on new plant construction.

1/The success of introducing replacement cost pricing into a region accustomed to inexpensive hydropower is especially suspect. Whereas BPA sells its power at wholesale for about 3.7 mills/kilowatt-hour, our analysis showed that replacement costs for new power supplies would range from 31 to 37 mills/kilowatt-hour, between 1977 and 2000.

FIGURE 6.4

NEW ENERGY GENERATION REQUIRED THROUGH 2000 FOR EACH POLICY SET



NOTE @: READINGS ABOVE THE ZERO LINE MEAN THAT NO NEW GENERATING PLANTS ARE REQUIRED BEYOND THOSE LICENSED AND UNDER CONSTRUCTION. FIGURES BELOW LINE REPRESENT THE ADDITIONAL ENERGY NEEDED..

A question exists whether the intermediate policy set's substantial conservation benefits could be realized by mild incentive programs as predicted, with no departure from average cost pricing which tends to conceal the costs of new power supplies.

--The thermal/traditional policy set with its passive approach to conservation and minimal development of renewable energy resources, ranked third in terms of consistency with the national energy principles. This alternative would develop nonconventional renewable resources only after they had been proven feasible and had been commercially financed. As a result, nonconventional resources would not be developed under this policy set. By the year 2000, its intensive development of coal-fired and nuclear generating facilities would (1) reduce the region's reliance on renewable energy sources from the present 85 percent to 47 percent or less, (2) subject the region to all the environmental consequences and uncertainties of large thermal powerplants, and (3) burden the region with capital requirements more than double those of the renewable/transition policy set under moderate load growth. If high-demand growth occurred, capital requirements for the thermal/traditional policy set would exceed the renewable/transition requirements by more than 50 percent. Total system costs for electricity under the thermal/traditional policy set in the year 2000 would exceed total costs for the renewable/transition policy set by more than 50 percent. The thermal/traditional policy set's continuance of average cost pricing would inhibit full development of the region's conservation opportunities.

The thermal/traditional policy set can also be challenged for its credibility. Under the high-growth forecast, if production were equally divided between coal and nuclear generation, 17 nuclear and 38 coal units would be required by the year 2000. 1/ Is it realistic to anticipate that the region's population would require or allow the construction of as many as 55 coal and nuclear units in the next 23 years?

1/Assuming all coal units have a 500-megawatt complete capacity and operate at 70 percent of capacity while nuclear units have a 1,250-megawatt capacity and operate at 64 percent of capacity. It is customary for a coal plant to have one to four units and nuclear to have one to two units.

Options available for carrying out conservation/renewable program

The renewable/transition policy set is the most consistent with national energy principles to carry out conservation practices, develop renewable resources, and charge replacement prices. It is clear, as shown in chapter 5, that maintaining the status quo would not get the renewable/transition policy set carried out. Further, it seems clear that the region would desire a self-sufficiency position by aggressively capitalizing on conservation and renewable resources. Another factor which the region would have to address is a practical solution to eliminate the rate disparities.

Although the renewable/transition policy set is most consistent with national energy principles, it contains certain policies, such as replacement cost pricing, that might not be practical to implement. Resistance to large, abrupt price increases could be expected. The intermediate policy set, however, would avoid taking potentially unpopular actions, but it would have three principal shortcomings.

--Its conservation levels would be less than would be achieved through replacement cost pricing.

--It would not aggressively seek the development of renewable supply sources.

--It would provide no mechanism for financing the billions of dollars needed for financing nonconventional energy programs.

To meet the costs and carry out a conservation and renewable energy program whose costs are illustrated in table 6-6, we considered the following alternatives:

1. Federal appropriated money.

2. Surcharge on Federal hydropower.

3. Surcharge on all electricity distributed in the region.

TABLE 6-6

Total Costs of Conservation and Renewable Energy Supplies 1977 Through 2000

	High-demand growth		Moderate-demand growth	
	Intermediate	Renewable	Intermediate	Renewable
	(billions)			
Conservation programs	$6.6	$11.1	$4.2	$9.0
Renewable energy supplies	1.6	7.4	1.6	a/ 0.3
Total	$8.2	$18.5	$5.8	$9.3

a/Conservation would be sufficient under the renewable policy set to meet energy needs without fully developing renewable capacities available.

Federal appropriated money

This alternative would use Federal appropriated money to carry out a conservation and renewable program. This alternative would spread the cost over the entire United States and act as a demonstration to the rest of the country to show the viability of such a program. This approach would recognize the need for the conservation and renewable energy program but believes the region's consumers would resist any surcharge. The Northwest consumers, especially those supplied with inexpensive Federal power by publicly owned utilities, are accustomed to low-cost electricity. Resistance to price increases could be expected.

This approach would (1) eliminate the problems surrounding surcharges, (2) carry out the principles of the National Energy Plan through the Federal presence in the region--BPA, and (3) specifically demonstrate to the rest of the country a viable conservation and renewable energy program.

There would be certain disadvantages and problems, however, to the Federal appropriations approach. The appropriation process would offer no assurance of providing the needed money because of changing priorities, national pressures, and the need for annual approval. In addition, any actions to perpetuate low prices for Federal hydropower at the expense of the national public or to pledge Federal assistance would be viewed as regionalized energy subsidies. As such, they could be sought--on the basis of equity--by all regions. Under this alternative, the current regional rate disparity would continue and rates would remain low, which would not make the public energy conscious. Therefore, we feel some means of regional financing through rate adjustments would be better than appropriated money to carry out the conservation and renewable programs.

It is argued by many that increased electricity prices are needed to stimulate conservation investments and reduce energy waste. Creation of a loan and grant program funded by a surcharge on electricity could greatly help individuals, businesses, and utilities finance the cost of conservation programs and renewable energy projects. This strategy--the use of a surcharge in combination with a loan and grant fund--would (1) make more certain the conservation benefits projected for the intermediate policy set, (2) raise the level of renewable energy development in the intermediate policy set, and (3) enable the region to finance much of its own energy future.

While the benefits of this strategy would be numerous, it is not at all clear whether a surcharge on electricity would be acceptable. The people of the region, especially those supplied with inexpensive Federal power by publicly owned utilities, are accustomed to the lowest electricity prices in the Nation. Resistance to price increases could be expected and especially strong resistance to abrupt or major price increases. Under these conditions two important questions become central to policymaking:

--How large a surcharge would be required to provide the needed financing?

--Would the appropriate surcharge be tolerable to regional electricity users?

Surcharge on Federal hydropower

A surcharge levied on Federal hydropower sales would be totally within Federal control, would tend to reduce the rate disparities which presently exist between customers of publicly owned utilities and customers of investor owned utilities, and would enable the region to finance much of its own energy future. It can be argued that no power consumers should have a preferential right to benefit from low-cost Federal hydropower. A surcharge on these consumers would be the most appropriate one to help finance the region's future energy investments. Under this approach, however, surcharge revenues collected from consumers of Federal hydropower would be used in a loan and grant fund to benefit all regional consumers, many of whom might be contributing nothing to the fund. Furthermore, by applying the surcharge only to Federal hydropower, the base over which the surcharge could be spread would be limited.

We found that the cost of conservation and renewable energy developments illustrated in table 6-6 could be financed by adding each year a surcharge of not more than nine-tenths of 1 mill per killowatt-hour to the price of Federal hydropower. By using a graduated annual surcharge of this type, surcharge revenues produced by Federal hydropower sales through the year 2000 would be sufficient to pay for all the costs associated with conservation programs and renewable energy developments envisioned in the intermediate and renewable transition policy sets. Table 6-7 below illustrates what the cumulative surcharge would be for the years between 1980 and 2000 for these alternative policy sets.

TABLE 6-7

Graduated Surcharge on Federal Hydropower

	Annual surcharge increase (note a)	Cumulative surcharge in 1980	1985	1990	1995	2000
	(mills/kWh)					
High-demand growth (4.8 percent):						
Intermediate policy set	.41	1.2	3.3	5.3	7.4	9.4
Renewable/transition policy set	.90	2.7	7.2	11.7	16.2	20.7
Moderate-demand growth (2.7 percent):						
Intermediate policy set	.29	.9	2.3	3.8	5.2	6.7
Renewable/transition policy set	.47	1.4	3.7	6.1	8.4	10.8

a/In comparison with these surcharges, the annual increase to the region under the thermal/traditional policy set (high demand growth) would be about 0.7 mills/kWh.

Table 6-7 shows that by the year 2000 Federal hydropwer would be carrying a surcharge of between 6.7 and 20.7 mills/kilowatt-hour. This would be sufficient to fund regional energy programs and, at the same time, substantially reduce the disparity between public power rates and those of investor-owned utilities.

Although the graduated surcharge would provide electric utilities and consumers with a predictable and consistent annual price increase, under our alternative policy sets it would not match year-by-year the requirements for grants and loans to support regional conservation programs and renewable energy projects. Likewise, as the region developed and modified its goals for conservation and renewable resource development, there would undoubtedly be years when working capital would have to be advanced to the grant and loan fund so that energy programs and projects could proceed on schedule. However, by no later than the year 2000, revenues collected through the graduated surcharge on Federal hydropower should be sufficient to repay any working capital advanced to the regional grant and loan fund.

An additional means of securing money to support the energy loan and grant fund would be to establish a share-the-savings rate for surplus Federal hydropower which BPA markets to customers outside the region. This pricing policy would evenly divide the customers' savings between the customers and BPA. If BPA had used a share-the-savings rate in 1975, it might have realized more than $80 million in additional revenues from California utilities. Proceeds from BPA sales of surplus Federal hydropower could be dedicated to the loan and grant fund and could reduce surcharge rates within the region.

Regional electricity surcharge

Another financing approach considered would use a smaller surcharge on all electricity distributed within the region, which would enable the region to finance much of its own energy future. A regional surcharge would be more difficult to implement because of the various institutional structures which would have to be changed within the region. It would offer, however, an equitable and relatively low-impact means of financing the region's energy future. However, the current disparity in regional rates would continue.

The region could finance the costs of conservation and renewable energy developments illustrated in table 6-6 by adding each year a surcharge increase of less than four-tenths of 1 mill/kilowatt-hour to the price of all electricity distributed in the region. By using such a graduated annual surcharge, the region could, by the year 2000, pay for all the costs associated with the conservation program and renewable energy developments envisioned in the intermediate and renewable/transition policy sets. Table 6-8 below illustrates what the cumulative surcharges would be from the year 1980 through the year 2000 for these policy sets.

TABLE 6-8

Graduated Surcharge on All Electricity Distributed

	Annual surcharge increase (note a)	Cumulative surcharge in				
		1980	1985	1990	1995	2000
	(mills/kWh)					
High-demand growth (4.8 percent):						
Intermediate policy set	0.14	0.4	1.2	1.9	2.7	3.4
Renewable/transition policy set	.39	1.2	3.1	5.0	6.9	8.9
Moderate-demand growth (2.7 percent):						
Intermediate policy set	.17	.5	1.3	2.2	3.0	3.9
Renewable/transition policy set	.31	.9	2.5	4.1	5.7	7.3

a/In comparison to these surcharges, the annual increase to the region under the thermal/traditional policy set (high demand growth) would be about 0.7 mills/kWh.

As in the graduated surcharge on Federal hydropower, this surcharge would provide energy producers and consumers with a predictable and consistent annual price increase but would not, under our alternative policy sets, be matched to the loan and grants required each year to support regional conservation programs and renewable energy projects. Again working capital would have to be advanced to the loan and grant fund so that energy programs and projects could proceed on schedule. No later than by the year 2000, however, revenues collected via the graduated surcharge on electricity should be sufficient to repay any working capital advanced to the loan and grant fund.

CHAPTER 7

CONCLUSIONS AND RECOMMENDATIONS

The issues being debated in the Pacific Northwest--both policy issues and equity issues--are complex and volatile. For the most part, they are issues not previously faced by regional policymakers. Timely resolution of these issues is important but unlikely to occur without assistance from the Congress.

Intraregional conflicts over access to Federal hydropower and Federal financial assistance have obscured the need for an updated approach to managing the region's electrical resources. The absence of an agreed-upon electricity management program inhibits decisionmaking in all sectors. State planners, utility officials, industrial customers, and homeowners are all affected by uncertainties as to future energy policies. Until these uncertainties are removed, regional decisionmakers will be unable to conduct their work with confidence.

It seems clear that congressional action will be needed to recharter the Bonneville Power Administration and to resolve the conflicts which now deadlock regional planning and decisionmaking. This view is shared by various groups and interests within the region. BPA, in its Role EIS, describes several new roles in which the Congress might cast BPA, ranging from dissolution of the agency to establishment of BPA as the lead agency for implementing national energy policy in the Pacific Northwest. Two bills have already been introduced into the 95th Congress (H.R. 5862 and H.R. 9020/S. 2080) which would create new and differently chartered structures to oversee electricity management in the region.

In the following pages we have summarized conclusions and recommendations synthesized from our review work and from the work of our consultants. The recommendations have been shaped with two purposes in mind: (1) to provide the region with mechanisms for developing an agreed-upon and forward-looking energy management program and (2) to resolve the conflicts which have deadlocked regional power planning. The conclusions and recommendations which follow contain the principal features which, in our opinion, are essential to development of a cohesive and comprehensive electricity management program.

CONCLUSIONS

--To resolve regional conflicts, the Congress will have to end, directly or by appropriate instructions to the executive branch, counterproductive disputes over inexpensive Federal hydropower and Federal assistance in financing new powerplants. It will be necessary to resolve these issues in a manner that is equitable, not only in a regional sense, but also from a national perspective. We believe that the Congress should treat Federal hydropower as a national resource to be allocated and priced so as to further national energy goals without unnecessarily disrupting the region's economic growth. Any actions taken to perpetuate unrealistic pricing of Federal hydropower or to pledge Federal assistance in financing new powerplants will be viewed as regionalized energy subsidies. As such, they will be sought, on the basis of equity, by all regions.

--We believe more information is needed before the Federal Government makes any firm commitments to guarantee the financing of new thermal powerplants in the near future. First, it is unclear how much energy will actually be needed to meet future load growth. It is possible that the construction of new powerplants could be postponed for many years if the utilities turned increased attention to conservation and energy efficiency. The potential of conservation, combined with the numerous uncertainties present in regional load forecast, argues against a premature Federal commitment to participate in new generating plants. Further, it has not been demonstrated that regional utilities cannot secure the capital needed for new generating plants without Federal assistance.

--The Pacific Northwest region needs improved leadership in electric power planning and policymaking. No regional entity is responsible for spearheading the development of a coordinated electricity management program for the region. Although the individual States are taking steps to increase their oversight capabilities, many of the problems and opportunities inherent in this transitional period can be dealt with most effectively on a regional basis. A mandate for regionwide policymaking is required to put intra-regional conflicts in their proper perspective and to encourage power planners to proceed with the more important work of charting the region's energy future.

--Representative citizen involvement in power planning and policymaking is prerequisite to development of an acceptable electricity management program. Increased opportunities to participate in power planning must be provided to State and local governments, environmentalists, utility customers, and other interested citizens. Further, the opportunities for participation must be front-end opportunities involving the development of plans. Citizen involvement should not be limited to after-the-fact reviews of plans developed by officials of electric utilities and Federal agencies. In the absence of more open and representative planning, regional power programs will be increasingly disrupted by legal actions brought to protect citizen interests.

--Long-range energy demand forecasts are critical to planning and policy analysis and yet so inconsistent that decisionmakers must make every reasonable effort to assure the objectivity and validity of forecasts before accepting them for planning purposes. Even after they are accepted for use in planning and policymaking, demand forecasts should be closely monitored and periodically reevaluated in the light of actual demand experience, improvements in forecasting techniques, and load management goals.

--It would be unwise for regional policymakers to rush their decisions on when and where to build new thermal generating facilities. Some regional power planners contend that power shortages are imminent due to slippages in the hydro-thermal construction program. However, the uncertainties associated with utility load forecasts, together with the evidence of significant untapped conservation and renewable energy potentials, argue against hurried decisions to build additional thermal generating capacity. Our policy set analyses showed that if NEPP's moderate forecast proved more realistic than the high forecasts of regional utilities and moderate conservation incentives were adopted, the thermal generating plants already approved for construction would be sufficient to meet regional demand growth through 1995. Assuming a 10- to 15-year leadtime for developing thermal plants, this would enable regional policymakers to defer decisions on additional plants until the 1980-85 time period.

--The renewable/transition policy set would be most consistent with the national energy principles to carry out conservation programs, develop renewable resources, and charge replacement prices. We believe these principles are viable goals for the Northwest.

--The pricing of electrical energy at true replacement cost would result in greater consumer awareness and greater potential for voluntary conservation. Gradually increasing the rates for Federal hydropower would help accomplish this objective.

--Arguments that higher energy prices will automatically lead to economic disaster are not supported by the available facts. Generally, electricity constitutes such a small portion of the total costs experienced by commercial enterprises and industries that it rarely becomes critical to decisionmaking. Even for energy intensive industries, electric costs are not a major factor. In the aluminum industry electricity accounts for 6.3 cents per dollar of value added. In chemical manufacturing it declines to 4.8 cents and in paper production to 3.0 cents.

--Conservation and renewable energy technologies deserve thorough consideration as alternatives to thermal powerplants. These alternative energy sources can be added in smaller increments, require less capital and shorter construction schedules, and generally entail fewer serious environmental risks than nuclear and coal-fired plants. Conservation, because it reduces energy waste and frees existing generation for use elsewhere, is recognized as the least expensive source of electricity. Renewable technologies, often referred to as exotic energy sources, are in some cases off-the-shelf technologies which were widely used in the recent past and are still being used in more energy-conscious societies. The region may be able to capitalize on its extensive renewable energy potentials more quickly than many power planners predict.

--The energy supply alternatives available to regional power planners might be expanded considerably if more attention were given to small or decentralized applications. There may be a tendency for power planners to concentrate their attention on traditional supply systems in which large central station generating plants produce power for subsequent distribution to points of use. This tendency could obscure the potentials of decentralized applications, such as solar water heating, home insulation, and recovery of heat from industrial processes, many of which do not generate electricity but displace it at the point of use. Our analyses and review work suggest that the region might benefit if small or decentralized applications received more emphasis in power planning.

RECOMMENDATIONS

Updated and strengthened leadership is needed to help the Pacific Northwest develop a comprehensive regional plan and program for electricity management. Because of the resources, experience, and inplace expertise represented by BPA, we believe that the Congress should use BPA as a cornerstone in building an updated Federal presence in the region. Such a reconstituted Federal presence need not and should not preempt those institutions, both public and private, which have served the region so effectively over the past 40 years.

We believe that Federal leadership should build on the coordination and cooperation which have long characterized regional utility operations. Where changes in the behavior of institutions outside the Federal framework are necessary to help the region meet new energy priorities, they should be encouraged by new incentives which encourage initiative and self-direction. We are recommending that the Congress:

--Relieve BPA of its charter responsibility for encouraging the widest possible use of electricity and instead charge the agency with regionwide responsibility for (1) leading the development of electricity management plans and programs, (2) encouraging conservation and the most efficient use of energy, and (3) assuring adequate public involvement in energy planning and policymaking.

--Charge BPA with a long-term objective of working with the institutions and citizens of the Pacific Northwest to achieve electrical self-sufficiency through energy conservation and use of renewable energy resources--i.e., a return to the electrical self-sufficiency which existed in the region until the 1970s.

--Direct BPA to continue to market Federal hydropower to preference customers in accordance with existing legislation. It would be inequitable to abruptly discontinue deliveries of Federal power to preference customers who have become so dependent on this supply source. 1/

--Direct BPA, to develop and implement a plan for moving the region toward pricing at replacement cost, encouraging conservation, and reducing the disparties in regional power rates through the marketing of Federal hydro-power. As a first step an annual surcharge could be added to the price of Federal power in an amount sufficient to bring the total price of hydropower, prior to the year 2000, into parity with the average cost of power produced in the region. The revenues collected by BPA through this surcharge could be used to finance a loan and grant fund for regional conservation programs and renewable energy projects. The fund could be managed by BPA so as to return surcharge revenues, in the form of loans and grants, to the economic sectors paying the surcharge.

--Amend the Federal Columbia River Transmission System Act (16 U.S.C. 838) to permit BPA to use its bond authority to obtain money needed in the loan and grant fund for those early years when the surcharge is not adequate to meet demands on the fund contingent upon the surcharge on federal hydropower being sufficient to repay all advances made under this authority by no later than the year 2000.

--Until more information is available, avoid making firm commitments in the near future to help finance conventional thermal powerplants in the Pacific Northwest. However, were it to become clear, given more information, that load growth would be so high as to require additional thermal generation, the Congress could reconsider this issue.

1/The question of who should qualify as a preference customer is now being tested in the courts. The suit brought by the city of Portland against BPA (see p. 5.13) should help define who these customers will be.

--Direct the Secretary of Energy to take lead in establishing a representative regional power-planning board to exercise a regionwide perspective over electricity management and to advise the Secretary of Energy; the Administrator of BPA; and the Governors of Washington, Oregon, Idaho, and Montana on the development of regional power plans and policies. The regional power-planning board should include representatives of Federal agencies, State government, investor- and public-owned utilities, environmental groups, industry, and energy consumers generally, as well as presidential appointees, one of whom would serve as chairperson. At the board's request, BPA would conduct or contract for studies and reports needed to test and validate demand forecasts; review decisions involving the selection of new supply sources, including conservation; and determine the adequacy of public participation in energy planning and policymaking.

--Direct BPA, working in conjunction with State energy offices, regulatory bodies, and regional utilities and industries, to develop by 1980--and update every 5 years thereafter--a forward-looking and comprehensive electricity management plan for the region extending 25 years into the future and identifying potentially important developments possible within 50 years. Such a plan should include specific objectives, action plans, and target dates for enhancing (1) conservation of electricity, (2) development of renewable energy sources, (3) industrial efficiency in electrical use, (4) techniques for reducing or mitigating the environmental impacts of power plants and transmission facilities, and (5) public participation in energy planning and policymaking. The comprehensive electricity management plan should include contingency plans outlining early warning systems and practical regional responses to such potential risks as fuel supply interruptions, unscheduled plant outages, transmission line failures, or adverse conditions of water or weather. Electricity management plans prepared by BPA should be submitted to the regional power-planning board for advice and comment and to the Secretary of Energy for his concurrence.

--Direct BPA to conduct or participate with other Federal agencies in conducting the studies and tests needed to assess more accurately regional potentials for energy conservation and development of renewable energy sources. Such studies should include for both centralized and decentralized applications (1) more thorough identification of regional sites with high potential for wind energy development, (2) reassessment of the region's untapped hydroelectric potentials considering new hydro sites, improvements of existing sites, and nonconventional hydroelectric technologies, (3) evaluation of potential for solar radiation applications, and (4) more thorough assessment of geothermal development opportunities. At the conclusion of such tests and studies, recommendations for energy conservation or development programs should be made through the regional power-planning board to the Secretary of Energy.

--Require BPA to prepare and publish annual financial reports and to report annually to the people of the Pacific Northwest region, the Congress, and the President on progress and problems in implementing the regional electricity management plan.

AGENCY COMMENTS AND OUR EVALUATION

DOE states in its letter of May 11, 1978 (see app. XII), that our report does an excellent job of assembling a variety of data on the energy situation in the Pacific Northwest and should be useful to DOE, regional leaders, and the Congress in understanding the various energy options and developing those most appropriate to the region.

DOE believes, however, that the report should be limited to a discussion of the situation in the Pacific Northwest and our conclusions, with no recommendations to the Congress to recharter BPA. DOE believes it already has authority to carry out most of our recommendations under the broad energy mission given it through the passage of the Department of Energy Organization Act (Public Law 95-91).

We do not believe this is the case, however. BPA was transferred to DOE from the Department of the Interior to operate under the same legislative charter it had been operating under. Even if Public Law 95-91 in some way modified the BPA Act, no delegations have been made to the BPA Administrator to implement and carry out the scope of our recommendations nor are they being carried out. Further, we feel there are issues discussed in our report, such as Federal power allocations and pricing alternatives, which the DOE act could not resolve. Legislation has already been introduced that would impact on BPA's charter. Therefore, to make BPA's charter specifically clear, we feel a new BPA charter should be established by legislation along the lines we recommend.

Several of DOE's comments are addressed to the impacts of pricing electric energy at replacement prices. DOE believes the report understates the economic and social consequences of such a policy on low-income groups, direct service industries, and the region's economy.

Each of our policy sets was designed so that regional employment and regional economic output would not be disrupted, regardless of the pricing method. Each policy set gives a description of the anticipated regional economic picture under each set of policies. For example, the direct service industries, or aluminum companies, are considered by many as economically essential to the Pacific Northwest. For this reason we contracted with Charles River Associates, Inc., to study the impacts of electricity prices on this industry. CRA assumed electricity rates up to 25 mills per kilowatt-hour for the aluminum industry in the Pacific Northwest. On the basis of these rates, plant salvage values, transportation costs, and costs of electricity in other regions (domestically and foreign), CRA concluded the companies most likely would modernize, become more energy efficient, and remain in the Northwest. Because of this we assumed the aluminum industry would remain in the Northwest and make its anticipated contribution to the regional economy.

Concerning the impacts of replacement prices on low-income households, we agree that replacement prices can cause hardship if conservation programs are not implemented at the same time. The intermediate and renewable/transition policy sets, however, with emphasis on conservation, could reduce these hardships. As the intermediate policy set points out, subsidies or other inducements could be increased for low-income households, which could be very effective in gaining conservation participation and further the general public policy goal of improving the living level for this strata of society. This could be done through purchase and installation of items to increase thermal efficiency in low-income residences and publicly supported housing projects.

As we recognize in the report, an abrupt move to replacement cost pricing would be strongly resisted. For this reason, we recommend a gradual move to replacement pricing. As figure 6.3 shows, average cost would be very near the replacement cost range by the year 2000 if the thermal policy set were followed and a high growth occurred. There is no guarantee hardship or economic consequences would not occur under these circumstances also.

Another concern of DOE is that the policy options do not satisfactorily consider the importance of providing a reliable power supply sufficient to meet demand. It points out that analysis and selection of any strategy is influenced by (1) the availability of the technology to deliver power proposed by the strategy and (2) the reliability of the power source.

We agree that responsibility of providing a reliable power supply is important to strategy analysis and selection and that operating a power grid is made more complex by introducing new technologies or technologies not frequently used. Integrating new technologies into a reliable electric supply system is an area that will require planning and design. Questions will have to be answered from an engineering and economic point of view.

We see the Federal Columbia River Power System providing an excellent opportunity to blend new technologies into an existing system, and the most direct way to do this would be to expand BPA's charter as an electric demonstration agency to show the technical and economic feasibility of implementing new technologies.

Regardless of the policy option, questions arise concerning reliability. For this reason appendix IX offers a discussion of the risk and impact of shortfall or excess capacity under each policy option. For example, the thermal/traditional policy set raises questions about meeting demand, although it would use what is considered known technologies. This policy set would require more capital investment than the other policy sets and could pose a problem of capital availability through the financial markets. This policy set would also depend on thermal power as a major supply source. As the report points out, there are still uncertainties about nuclear power, such as disposal of radioactive materials, decommissioning, and concern over prevention of major accidents or those caused by sabotage, which have resulted in some public opposition. Such opposition could impact on the future limits to nuclear power in providing a reliable source of meeting demand.

Although the intermediate and renewable/transition policy sets would use alternative supply forms for meeting demand, these forms would not become a major factor until the 1990s. Conservation, along with plants now under construction and licensed which will come on line, will be the major source of new supply until then. Other sources coming on line in the 1980s are minimal but include mostly hydro/ and biomass/cogeneration which have proven technologies.

THE THERMAL/TRADITIONAL POLICY SET

INTRODUCTION

The objective of the thermal/traditional policy set is to examine the consequences of a continuation of past practices and traditional institutional arrangements for supplying electricity to consumers in the Pacific Northwest. Energy conservation brought about by deliberate policy, or even by voluntary adoption in the absence of new policy, is not included. Traditional energy resources (i.e., coal, uranium, hydropower, and oil- or gas-fired combustion turbines) are assumed to provide all the electricity used in the region.

The growth in population and income among people and businesses in the region is assumed to be basically the same in this policy set as it would be in the other two. Past practices of maintaining a favorable business climate for high electricity use (energy intensive) industries would be preserved, and these industries would grow substantially through the rest of the century. The traditional regional practice of averaging high-cost thermal electricity with low-cost hydropower to establish an average cost price for electricity would be continued. Coal-fired and nuclear generating units would be used to meet most demand growth.

The traditional policy set does not represent present trends in the electric utility industry in the Pacific Northwest. That is not its objective. It is a continuation of utility operations established during the 1950s and 1960s, when electricity was plentiful and cheap, into the present and future when supply conditions are greatly changed. Deviations from the conditions of the traditional policy set can be expected to occur as a result of changing public attitudes and Federal and State policies already active at the present time.

SUMMARY OF ADVANTAGES AND DISADVANTAGES

The principal advantage of the traditional policy set is that it would avoid experimentation with unproven technologies and institutions. Under this policy set electricity would be supplied to consumers through well-established institutions using conventional generating technologies. Coal and uranium are resources in plentiful supply domestically so that there would be no concern about electricity supply interruptions in the region either because of resource exhaustion or foreign embargoes. The current economic base or industrial mix of the region would be preserved to the maximum possible extent. Government intervention would be minimized, although some actions would be necessary to ensure equitable distribution of Federal hydropower.

The principal disadvantage of the traditional policy set is that it would fail in several respects to respond to the recent increases in electricity supply costs in the region. Under average cost pricing, the prices paid by consumers for new electricity supplies are below the cost of providing them. Furthermore, there are no efforts to bring to people's attention opportunities to save money as well as electricity through the adoption of energy conservation measures or to develop new sources of supply that can eventually supplant the current types of thermal plants with renewable sources that are environmentally more benign.

LOADS AND RESOURCES

The region's basic load in the traditional policy set is shown in figures I.1 and I.2 for the high-growth and moderate-growth cases, respectively. In the high-growth case, the load growth would average 4.8 percent annually during the 23-year period from 1977 to 2000 and the firm energy used would grow from 15.2 thousand to 44.9 thousand average annual megawatts. In the moderate-growth case, the average annual load growth would be only 2.7 percent and the firm energy used in the year 2000 would be 28.1 thousand average annual megawatts. In the moderate case, the load would be insufficient in the early years to absorb all the generation existing or under construction. These growth rates compare with the region's historical growth rate of 7.2 percent through 1973.

The electricity supply in the traditional policy set would come entirely from conventional hydroelectric, coal-fired, nuclear, combustion turbine, and miscellaneous small thermal plants. With high-load growth, all plants already scheduled for construction plus others not yet planned would be required. With moderate-load growth, completion of plants on schedule would produce surplus capability in 1985 and 1995 and some construction schedules could be delayed; however, additional thermal plants beyond those presently planned would be required by the year 2000.

FIGURE I.1

THERMAL/TRADITIONAL POLICY SET
HIGH GROWTH (4.8 PERCENT)

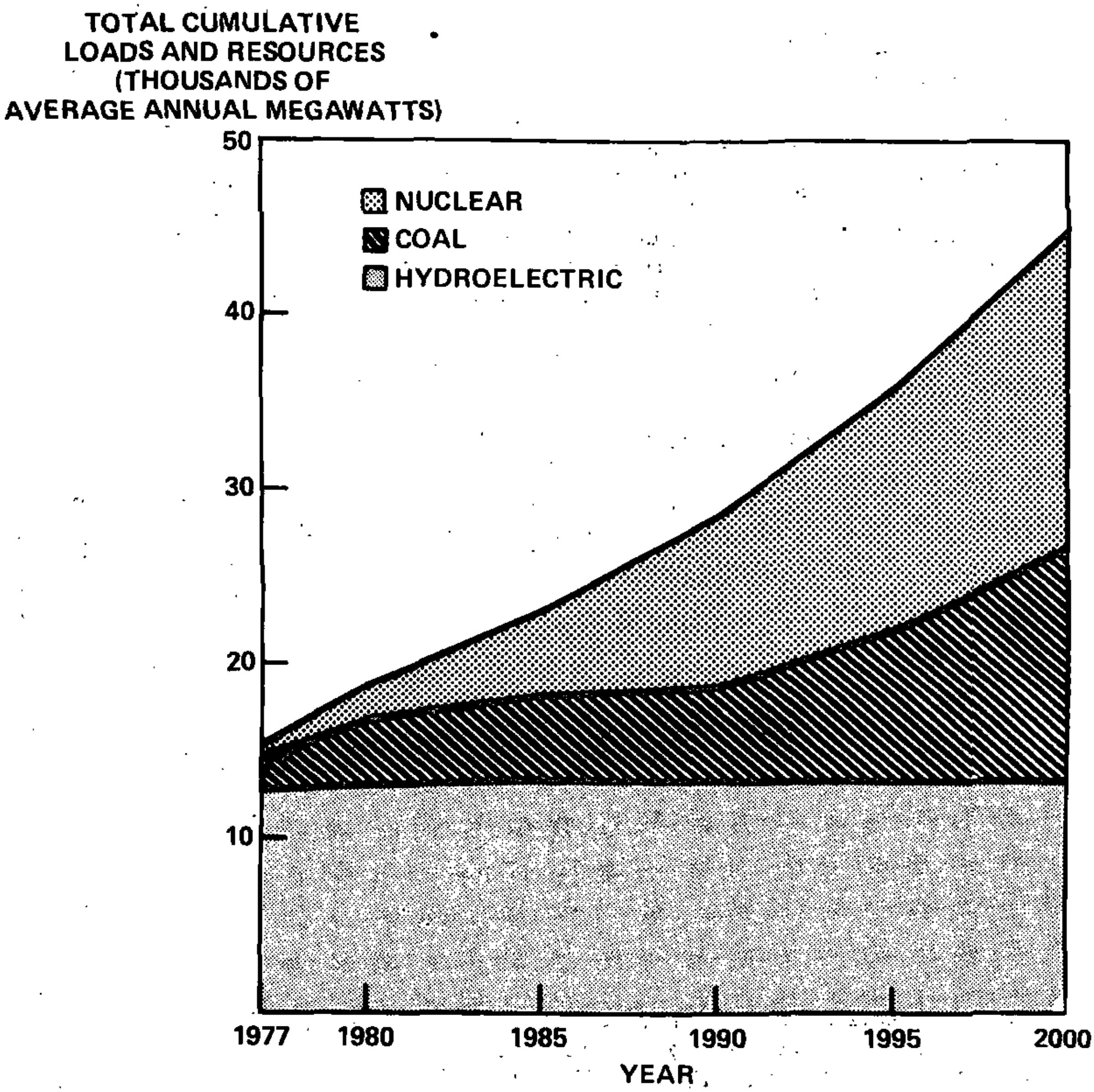
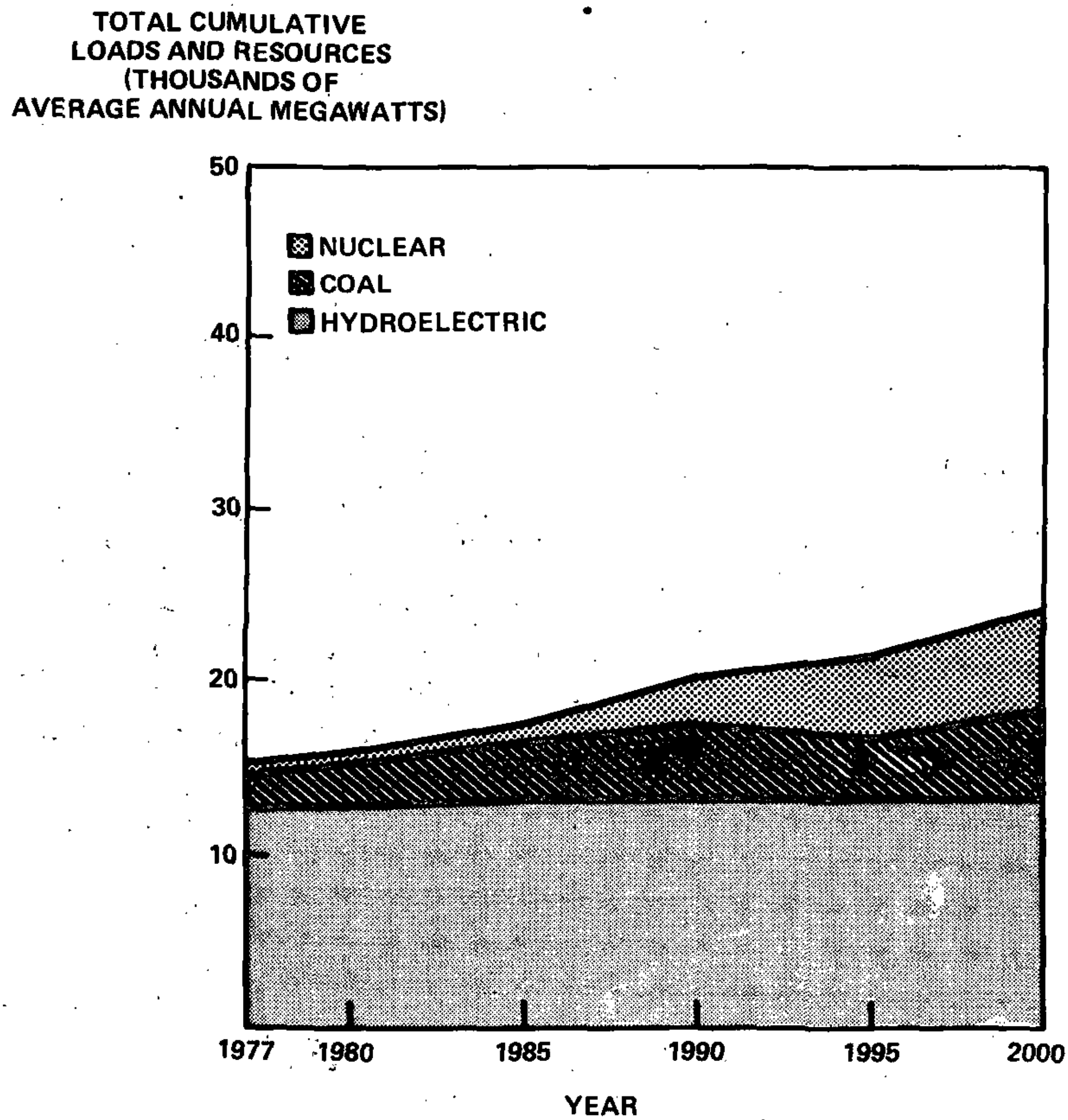


FIGURE I.2

THERMAL/TRADITIONAL POLICY SET
MODERATE GROWTH (2.7 PERCENT)



POLICY MECHANISMS AND INFRASTRUCTURE

The traditional policy set does not include new policies to encourage either energy conservation or renewable energy supply systems. New policies are limited to reallocation of the low-cost Federal hydropower among publicly owned utilities, privately owned utilities, and large industrial consumers.

The regionwide treatment of electric supply issues does not bring out distributional effects of unequal electricity prices in different areas within the region. The overall regional economy is primarily determined by regionwide average prices to different classes of customers and is affected little by geographical price differences. However, these price differences generate intense resentment among those who pay higher prices, and they are the subject of two bills before the Congress. These legislative proposals are basically concerned with questions of equity under conditions where there is no agreement on what is equitable. Proposals for resolving this problem are discussed in chapter 7 of this report.

LIFESTYLE UNDER THE TRADITIONAL POLICY SET

Regional perspective

The traditional policy set would continue regional growth patterns that are already well established. The region's natural resources, timber, farmland, hydropower, minerals, and recreation areas, have been the basic ingredients for resource industries and related service industries. Strategic location with respect to Asian markets and early establishment of certain high technology industries, notably the aircraft and metallurgical industries, have led to other growth situations.

Some resources, especially timber and hydropower, are now approaching their development limits, and this would have some effect on growth in related industries; but in other industries, growth would continue at rates at least equal to those of the recent past. The aluminum-smelting industry and other large electricity users would continue to take all the electrical energy made available to them because, under average cost pricing, it would still be a great bargain.

On the whole, employment and economic output would continue to grow in this policy set in almost the same way it would under either of the other two. Immigration would add to the natural population increase as outsiders moved in to take advantage of attractive living conditions and expanding employment opportunities.

Individual perspective

Lifestyles of Northwest residents living under the traditional policy set would be very similar to lifestyles under the other two policy sets. This similarity, which may seem surprising at first, arises from three circumstances assumed for our analyses. The first is that electricity would continue to be available in all three policy sets to consumers at costs that did not represent more than a very small percentage of their incomes. The second is that in all three policy sets, real incomes would rise dramatically through the rest of the century and future lifestyles would be determined primarily by the uses of the added income, which would not be closely related to electricity use. The third is that electricity production and use would have very minor impacts on the lives of most people so that, although the impacts might differ among policy sets, they would be small in all cases.

Nevertheless, there would be small differences in lifestyle among policy sets for most people and large differences for a few people. In terms of today's dollars, residential customers in the year 2000 would pay between 1.1 and 1.7 cents per kilowatt-hour more for electricity than they do today, an increase of 90 to 140 percent. As a result, electricity would cost a Northwest family from $100 to $500 more per year depending on usage. On the other hand, assuming that past trends continued, the average family would have about $10,000 more income per year (in 1976 dollars) to use for additional goods and services.

The traditional policy set would include some changes in people's perceptions about the safety, stability, and healthfulness of the environment in which they lived. Among the three policy sets, the traditional policy set would have the greatest commitment to nuclear power. By the year 2000, under the high-growth forecast, there could be between 15 and 20 nuclear power units 1/ operating in

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1/Assuming that coal-fired generating units would have a 500-megawatt capacity and operate at 70 percent of capacity, while nuclear units would have a 1,250-megawatt capacity and operate at 64 percent of capacity.

the region. The effects that these plants would have are very uncertain. If current fears about accidents, fuel storage, plant decommissioning, and nuclear blackmail proved to be correct, concern would be widespread. On the other hand, if the future record did not include major disasters and is, in fact, no worse than the national record of the past 20 years, tension about this technology might subside. At present, it does not concern most people.

The other major thermal plants in the region would be coal-fired plants. Under the traditional policy set by the year 2000, there could be as many at 40 coal-fired units 1/ serving the Northwest, some located in the region and others in the major Rocky Mountain coalfields. Each would produce air pollution that would be noticeable at times to people in the vicinity out to a distance of several miles. The damage done by coal plants in the traditional thermal policy set would be somewhat greater than the same type of damage in the other policy sets, especially with respect to the volumes of coal ash and sludge to be disposed of. The hydroelectric component of the regional electricity supply would produce fluctuations in river flows that would be increasing as hydropower was used more to meet load peaks. The changing flows would reduce the utilization of some portions of the rivers for recreational purposes and might have increasingly adverse effects on salmon runs. These effects would be shared by all policy sets, but they would be largest in the traditional policy set.

IMPACTS OF THE POLICY SET

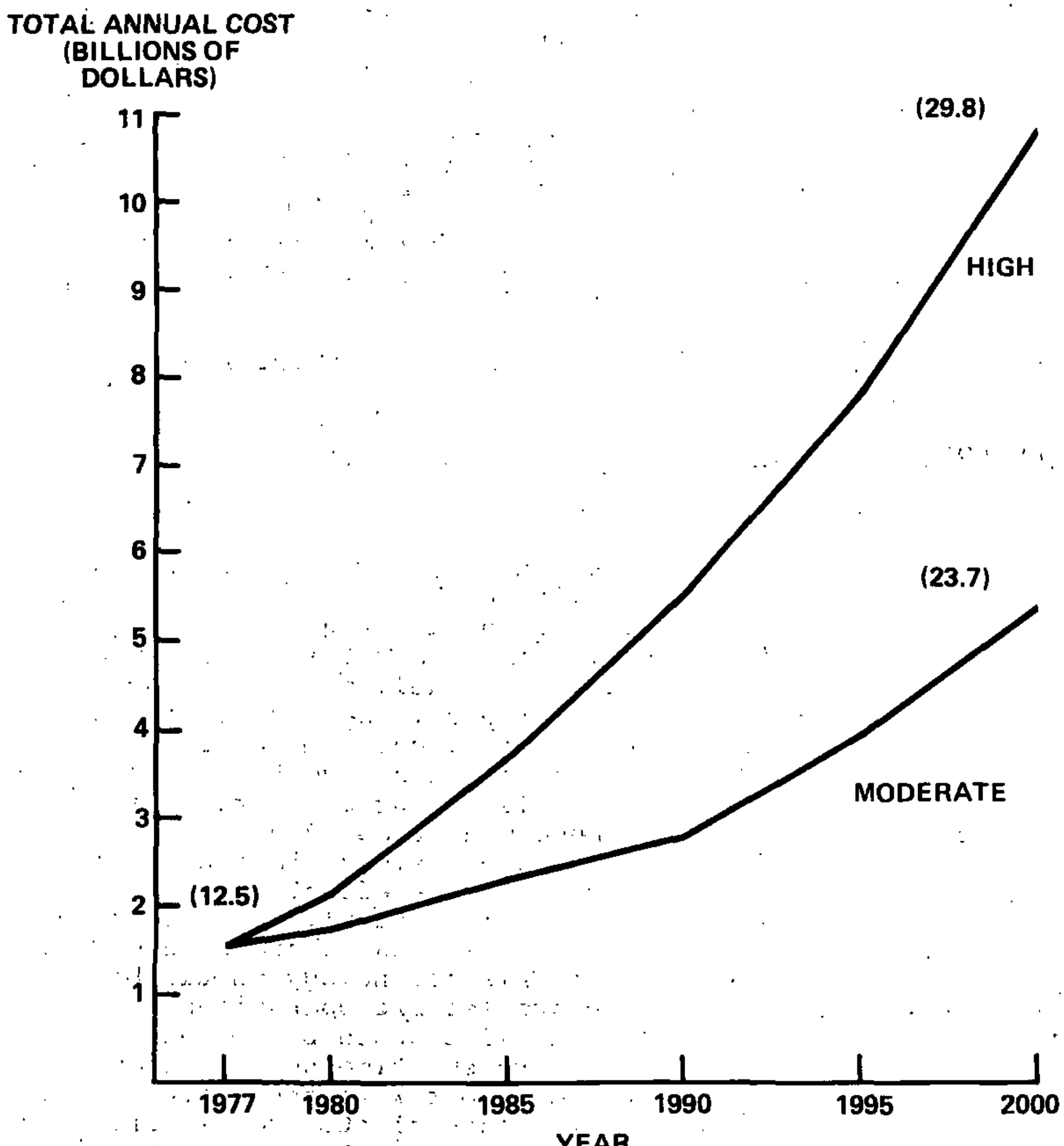
Power system costs

The total annual costs of electric energy in the region under the traditional policy set are shown in figure I.3 for both the moderate- and high-growth cases. Costs include not only annual cost of capital, fuel, and operating costs of the powerplants, but also transmission and distribution costs. Average costs per kilowatt-hour in the region are also shown on the figure; however, it should be noted that costs differ considerably from one utility to another.

1/Assuming that coal-fired generating units would have a 500-megawatt capacity and operate at 70 percent of capacity, while nuclear units would have a 1,250-megawatt capacity and operate at 64 percent of capacity.

FIGURE I.3

TOTAL ANNUAL COST OF ELECTRIC ENERGY—THERMAL/TRADITIONAL POLICY SET



( ) AVERAGE COST OF ELECTRIC ENERGY IN MILLS PER KILOWATT HOUR

High growth

Annual electricity costs to the region in the year 2000 would be higher by more than $2.8 billion under the traditional policy set than under the others. (See tables IV.3A, B, and C.) This is an increase of 35 percent. The cost in mills per kilowatt-hour in the year 2000, excluding conservation cost, would be 29.8 for the traditional policy set, 26.8 for the intermediate policy set, and 24.4 for the renewable policy set. (See table IV.3.)

Moderate growth

The moderate-growth cost comparisons are qualitatively similar to the high-growth case. Total additional costs for the traditional policy set over the other two would amount to at least $1.7 billion annually by the year 2000. (See tables IV.3A, B, and C.) Unit costs in mills per kilowatt-hour in the year 2000 for each policy set, again excluding conservation costs, would be 23.7 for the traditional policy set, 19 for the intermediate, and 15.6 for the renewable. (See table IV.4.)

Environmental impacts

Moderate growth

During the rest of the century, several coal-fired powerplants would be built within the Pacific Northwest itself and additional plants serving the region would be located in eastern Montana, Utah, and Wyoming. The plants in the region are expected to be widely separated, so that while each would have its own impact, there would not be much overlap between plants. The local damage done by the plants, primarily through air pollution, would be small assuming that the best available sulfur and particulate controls were employed. These plants would make a contribution to global carbon dioxide levels and heat balance problems, but the importance of these effects is not yet known. Nuclear power would remain a fairly small component of the total supply system, and assuming there were no major catastrophes, the impacts of this technology should be moderate. The effects of hydroelectric operations on recreation and on fish and wildlife would be somewhat greater than they are at the present time because of peak power fluctuations that would be met with the hydroelectric component. There would not be any effects from solar, wind, or biomass/cogeneration because they would not be used in this policy set.

This policy set is consistent with national policies for preservation of environmental quality, provided that coal plants employed the best available control technology for sulfur and particulates and assuming that sludge disposal did not become a problem. If the best available technology were not employed, there might be a question about whether large multiunit coal plants 1/ were consistent with the policy of preventing significant deterioration of air quality for short-time fluctuations (24-hour maximums). The limited construction of light water reactors is consistent with the National Energy Plan, which calls for recognizing hazards and risks and reducing them to relatively low levels. The regional plan calling for increased use of the hydroelectric system for peaking is not consistent with the principle of preserving environmental quality, although it is consistent with national energy principles.

High growth

The emissions of air pollutants, especially nitrogen oxides, from the many coal-fired powerplants would be come comparable to emissions from all other end uses of energy in the region by the end of the century. However, the remote locations and high stacks at the plants would reduce the effects of the emissions on health and property to values far below those produced by other pollutant emissions. Nuclear power would become a major component of electricity supply by the end of the century. As a result, the region would experience fully the uncertainty and resistance to development of this new technology.

Whether any noticeable environmental effects resulted from the plants would depend on the success of radioactive storage facilities and decommissioning procedures; the prevention of major accidents or those caused by sabotage; and the control of weapons grade materials. All these matters are currently very uncertain.

Equally unclear is whether police powers, extended to control critical nuclear materials, would be noticeably restrictive and obtrusive. At some locations the effects of operation of the hydroelectric system on recreation and on fish and wildlife would be much more pronounced than

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1/It is customary to cluster generating units in multiunit plants. Nuclear plants typically contain one to two units and coal plants one to four units.

they are at present because of the peak power fluctuations that would be met by hydropower. There would of course be no effects of solar, wind, or biomass/cogeneration in this policy set. With the best available control technology, the coal plants are consistent with the national principle of environmental protection. However, the peaking operations of the hydroelectric system are not consistent with this principle.

Equity

The two equity issues in the traditional policy set would relate to the pricing of electricity. One would be the strong variation of price, with geographical location depending on the type of utility serving each area. Publicly owned utilities are preferred customers for low-cost Federal hydropower, according to law. As a result, electricity prices to consumers in areas served by publicly owned utilities would tend to be lower than those in areas served by investor-owned utilities. From the viewpoint of the individual consumer, the price differences would be inequitable. But there is a commonly used justification for the public power preference position based on the channeling of benefits from publicly financed projects to nonprofit organizations. The argument does not apply to the direct sales of low-cost power to industries (direct service customers).

The second equity issue would arise from the common utility practice of averaging low-cost hydropower with expensive thermal power and using the resulting supply cost, together with the cost of distribution to different classes of customers, as the basis for prices. As a consequence of this practice, the charges made for electricity purchased by new customers or for additional purchases by old customers would be below the costs incurred to provide the new service. The difference in cost would be paid by all users in the cost-averaging area.

The net effect would be that costs of new or increased electricity demands would not be borne entirely by users, but would be spread mostly to all continuing users--an inequitable allocation. This effect was limited in times when inexpensive hydropower was available to supply all existing and new demand, and thus there was little inequity in the past. However, by continuing this average cost policy into the era of expensive thermal power, the traditional policy set would ignore an inequity that would likely become increasingly bothersome.

Regional economy and employment

Changes in the regional economy and employment that occurred under the traditional policy set would, on the whole, follow past trends. The aluminum industry would continue to receive favorable rates and would grow to the extent that power was made available, but the overall effect of this growth on employment and regional income would be small. Other industries would grow at rates that were not very dependent on electricity prices, and the growth would, therefore, be very similar to that expected under the other two policy sets.

There would possibly be some shifts in the locations of industries because of the sharp discontinuities in electricity prices across the boundaries of utility service areas. Thus an industry served by an investor-owned utility and paying high electricity costs in an area adjacent to the service area of a publicly owned utility offering much lower rates might decide to move, but such cases would be rare. Most industries are located where they are for reasons quite separate from the local cost of electricity, such as access to raw materials, transportation routes, a skilled labor force, and associated suppliers. Only the very heaviest users of electricity would be likely to find potential rate savings large enough to offset other location-related factors.

Risk and impact of shortfall or idle capacity

The traditional policy set would be very comparable to the other two so far as risks of shortfall or idle capacity were concerned. In all three policy sets, risks and uncertainties would exist to a degree that depended on the nature of the supply system and on the uncertain aspects of demand.

The consequences of relatively long term shortfall or idle capacity would likewise be comparable to those for the other policy sets. Shortfalls would bring restrictions on growth, higher prices, and rationing. Idle capacity would mean unnecessary cost burdens and promotional activity to increase sales.

INTERMEDIATE POLICY SET

INTRODUCTION

The objective of the intermediate policy set would be to achieve as much energy conservation as possible without interfering with economic growth, profitability of business, improvements in the standard of living, and individual freedom of choice. A change in lifestyle is not intended. The intention would be to confine adjustments to those which reduced the energy required to deliver goods, services, and a comfortable standard of living. A strong test of profitability would be applied to conservation measures, so that whatever conservation was brought into the plan would enhance rather than retard overall economic progress. The policies considered should be economically beneficial to all parties and minimize interference with individual freedom of choice in personal consumption and industrial production processes.

Lifestyle under the intermediate policy set would not be greatly different from what it would be under continued growth in electricity use at rates similar to those that have prevailed in the past. People would continue to enjoy an increasing standard of living, including more living space per person and more home appliances per household. Industry would continue to grow in order to supply those expanded demands. Energy efficiency in homes, commercial buildings, and factories would increase considerably.

In the intermediate policy set, conservation and improvements in energy efficiency would be brought about by a number of specific actions. Improved weatherization and insulation would be installed in a majority of the existing homes that now lack it and in virtually all new residences. More efficient appliances would be adopted, and the rush to more and bigger appliances of the 1960s would not be resumed. Commercial and public buildings would also have improved energy efficiency, especially in new structures. Industry would achieve better efficiency through a general tightening up of energy management plus some gradual conversion of the most electricity intensive industries to more efficient processes. Overall, conservation would be reducing the total electric load in the year 2000 to about 80 percent of the amount projected.

The increased energy efficiency in the intermediate policy set would be brought about by relatively painless actions, such as providing information about conservation opportunities, helping to arrange financing for conservation investments, and providing incentive payments to those who did conserve. The working of the conservation program itself would not cause any shocking changes in the accustomed way of doing business. Program costs plus customer costs of conservation would be considerably less than the savings realized due to tapering off of growth in power demand.

SUMMARY OF ADVANTAGES AND DISADVANTAGES

The outstanding advantage of the intermediate policy set would be that it would achieve considerable electricity savings throughout the Pacific Northwest, without requiring that people in the region accept harsh regulations restricting their use of electricity or that they pay sharply higher prices for it. The savings would be achieved without sacrifice through inducements that offered monetary savings to those who conserved electricity. To legislators the advantages of the approach are that they would not need to support unpopular new legislation, that economic growth in the region would be unaffected, and yet that they would be supporting national objectives of energy conservation and use of renewable resources. Furthermore, the electricity supply would rely on domestic energy resources so that supply interruptions would be unlikely.

The principal disadvantage of the intermediate policy set would be that it would not price electricity at its replacement cost and, therefore, would not encourage conservation and energy efficiency. The average cost pricing policy retained is directly contrary to several basic principles, including the national principle of energy conservation, the general economic principle that price should equal marginal cost of supply, and the equity principle that the user should pay for goods and services received. These are very serious policy defects, but by accepting them policymakers would avoid the necessity of imposing electricity price increases that would be unpopular with many consumers.

LOADS AND RESOURCES

The region's basic load in the intermediate policy set would be the same as it would be in the other policy sets except for the effects of conservation. In this policy set it is assumed that modest conservation efforts at residences, commercial establishments, and industries would provide some load reductions beginning in 1980. By the year 2000 these would amount to about 22 percent of forecast demand. The uncertainty in load growth between high and moderate covers a broad range. In the moderate-growth case, the load would be insufficient in the early years to absorb all the generation existing or under construction. However, by the year 2000, additional new plants would be needed. Figures II.1 and II.2 show the total loads in the high- and moderate-growth cases along with the components of supply that would be used to meet them.

The supplies would come from a variety of sources. Hydropower would make up most of the total early in the time period but would have little growth potential. Conventional thermal powerplants, i.e., coal and nuclear, would supply most of the growth.

Renewable resources other than conventional hydropower would contribute only token amounts to the supply but would demonstrate the new technologies on a commercial scale. The resources assumed for this policy set were mostly central station units, although about one-third of the wind and solar generation was considered to be decentralized, i.e., located at the load.

With high-load growth, conventional resources beyond those already scheduled would be required in years 1995 and 2000, but on the other hand it would be possible to delay some scheduled nuclear plants not having construction permits and still meet the 1985 and 1990 loads. With moderate-load growth no additional conventional resources beyond those already scheduled would be required through the year 2000. In fact, about five of the scheduled nuclear plants could be delayed beyond the year 2000, and even with coal-fired and nuclear plants delayed to a maximum, there would be unused capability above that needed for energy reserves in 1980 through 1990.

POLICY MECHANISMS AND INFRASTRUCTURE

Introduction

The intermediate policy set would use economically attractive policies to bring about adoption of conservation measures and renewable energy supply systems. Policies would fall into two general categories, a broad information program to inform people fully of the opportunities available to them and a set of incentives designed to induce people to adopt measures that actually would benefit them economically but that they might be unable or unwilling to adopt spontaneously.

FIGURE II.1

INTERMEDIATE POLICY SET
HIGH GROWTH (4.8 PERCENT)

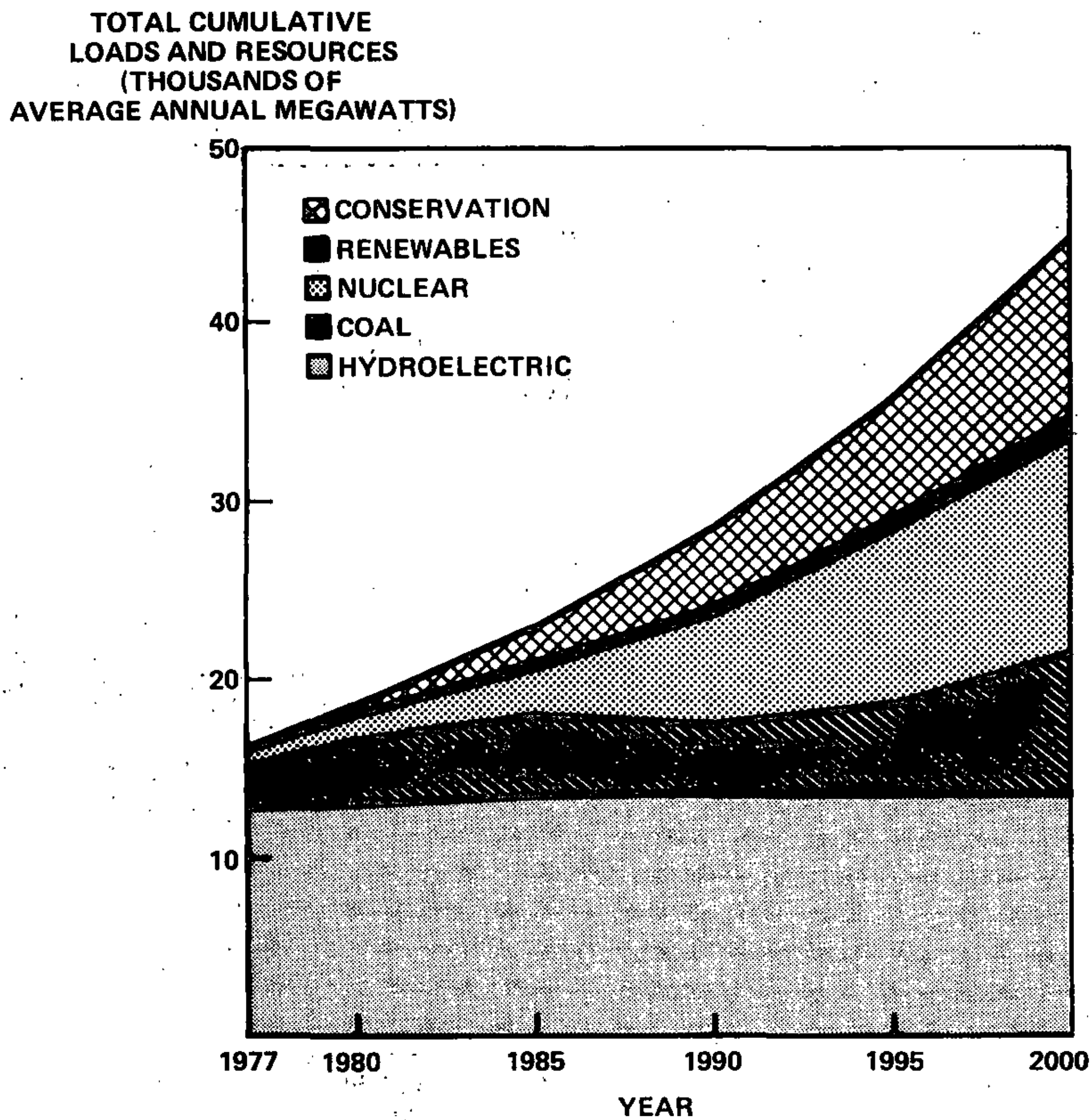
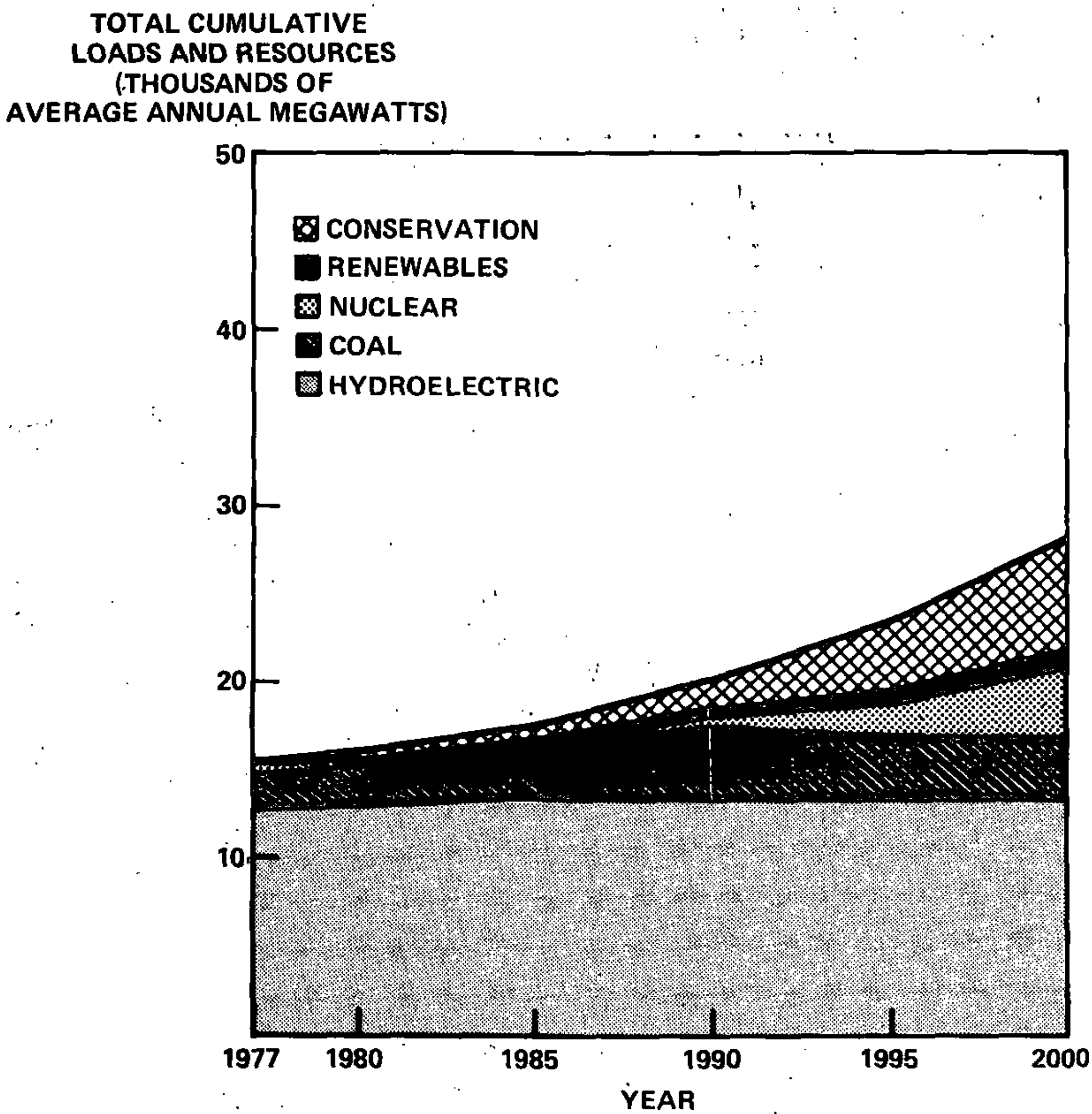


FIGURE II.2

INTERMEDIATE POLICY SET
MODERATE GROWTH (2.7 PERCENT)



Policy mechanisms

Information program: The information program would focus on inducing households, commercial and manufacturing establishments, communities, and electric utilities to adopt the following measures:

Residential:

- Lower thermostats
- Retrofit homes with insulation, etc.
- Use heat-conserving construction
- Reduce energy use in appliances
- Improve heating systems

Commercial:

- Improve ventilation and lighting
- Lower thermostats
- Retrofit existing buildings
- Make new construction energy efficient

Industrial:

- Institute recycling programs
- Improve housekeeping

Communities:

- Improve urban design

Utilities:

- Introduce renewable electricity supply systems

The information program should, of course, bring out the advantages of adopting the measures above. The two principal advantages would be the money savings that would be expected and the greater independence from external fossil fuel sources that would be achieved. In the past, information programs alone have not proved effective. However, if the information could be combined with incentives for adoption, the combination might be particularly effective. Incentives are described later in this section. It also would be important to contact potential conservers on an individual and personal basis. A notice accompanying the monthly utility bill is an example of a communication of this kind. Finally, it would be particularly effective if a social behavior norm of conservation and renewable energy development could be established which would bring on community pressure for conformance to energy-efficient practices.

The specific elements of an energy information program would include at least the following:

1. General public energy information program through media, demonstrations, etc., to provide knowledge and increased understanding of energy issues.

2. Energy education materials and teacher-training sessions for grades kindergarten through 12, plus vocational training.

3. Information materials, training sessions, and demonstration projects for builders, construction workers, equipment retailers and installers, building and equipment operators, and maintenance personnel.

4. Seminars and workshops for architects, engineers, contractors, real estate and financial agents, building owners and managers, and regional planners.

5. General and process-specific information and workshops geared to specific industries, especially smaller firms.

6. Partial subsidization of training and salary of energy-efficiency specialists in schools, State and local governments, etc.

7. Energy information clearinghouse and library, point of access to national information sources and directory of helpful agencies and individuals.

8. Energy audit program for residences, public buildings, and commercial buildings with information on probable life cycle cost effectiveness of possible conservation measures.

9. Energy-efficiency labeling of all residences offered for sale or for rent.

10. Energy-efficiency labeling of home appliances and most common commercial or industrial equipment.

11. "Adaptive" research to develop approaches to energy conservation and alternative energy sources that are suitable for Pacific Northwest conditions.

12. Energy policy analysis and administration of conservation programs.

The general magnitude of such an information program is indicated by suggested funding levels shown in table II.1. The funding levels indicate average program costs during the period 1980-90 of $18 million per year, expressed in 1976 price levels. This level applies to the three Pacific Northwest States and to all energy sources. Approximately one-third of these costs might be allocable to electricity conservation.

Table II.1

Energy Information Program, Suggested Average Annual Funding Level

Pacific Northwest, 1980-90

	Total cost	Federal Government	State government	Local government	Electric utility	Private
	-----(000 omitted)-----					
General information	$ 2,500	$1,000	$ 900	$ -	$ 300	$ 300
Energy education	500	100	300	100	-	-
Worker training	1,600	-	400	-	200	1,000
Designer seminars	800	200	200	-	200	200
Industry workshops	800	200	200	-	200	200
Energy specialists	800	100	200	-	-	500
Clearinghouse	500	200	300	-	-	-
Energy audits	5,000	-	4,000	-	1,000	-
Residential labeling	1,000	-	500	500	-	-
Appliance labeling	500	-	-	-	100	400
Adaptive research	2,000	1,000	500	-	500	-
Policy analysis and program administration	2,000	-	1,500	-	500	-
Totals	$18,000	$2,800	$9,000	$600	$3,000	$2,600

APPENDIX II

A possible division of costs among responsible agencies is also shown in table II.1. This is only one of many ways in which resources might be provided for a broad energy information program. Federal grants and cost sharing would likely provide a significant fraction of the funds for the programs of non-Federal entities.

Incentive program: The incentive program would utilize direct subsidies or rebates, low-interest guaranteed loans, tax relief, and price adjustments to encourage businesses and households to adopt energy conservation measures. The intermediate policy set visualizes the following specific measures would be adopted before 1980 and remain in effect from then until 2000.

1. An income tax credit (or direct rebate if no tax were due) equal to 20 percent of the costs of insulation and weatherization of existing dwelling units.

2. Government purchase, installation, and demonstration of solar space- and water-heating systems for schools, public buildings, publicly supported housing projects, etc.

3. Government waste collection and recycling systems, including systems to use burnable waste as boiler fuel.

4. Government subsidies for experimental and innovative installations to reduce energy consumption in industry.

5. Low-interest loans, with the public sector absorbing the costs of guaranteeing repayment and difference between interest charged and the required yield to cover lender costs. These loans would be available for retrofitting existing dwellings and commercial buildings, improving residential heating systems (either conventional or unconventional), and developing total energy systems and district heating or recycling systems.

6. Tax relief in the form of an exemption from sales tax on energy-conserving items and exemption from increased property taxes for homes and commercial buildings that add energy-conserving features or alternative energy systems.

7. Reduced business taxes to commercial and industrial plants that install energy-conserving devices that are of marginal or questionable profitability to the firm.

Incentive programs are potentially more expensive than even a broad-based information program. Costs depend upon the rate of subsidization and on the response to the program. Some estimates for the programs envisioned in the intermediate policy sets are given in table II.2.

Table II.2

Total Costs of Incentive Programs for Adopters of Energy Conservation Measures Pacific Northwest, 1980-2000 (note a)

	Total regional program			Possible subsidy for conserving electricity
	Maximum amount involved	Possible subsidy		
		Rate	Amount	
	(000,000 omitted)	(percent)	(000,000 omitted)	
Rebate on residential weatherization	$1,200	20	$240	$75
Subsidized solar buildings	300	80	240	40
Subsidized recycling and waste burning	300	50	150	45
Subsidized industrial conservation	300	50	150	50
Low-interest loans	6,000	4	240	80
Tax relief:				
Sales	6,000	4	240	80
Property	2,000	1/yr.	400	100
Tax concession	6,000	1/yr.	1,200	-
Total	$22,100		$2,860	$470

a/In constant 1976 dollars.

Decision rule changes

The policy changes suggested for the intermediate policy set would require rule changes of three general types: (1) State and local governments and utilities would need to allocate much more emphasis and resources to energy information and education programs, (2) State governments and utilities would need to inaugurate programs for financing investments that produce energy savings, and (3) rate structures would need to be adjusted to eliminate incentives that bias customers' choices toward energy consumption rather than conservation.

Agencies and programs for energy information, education, and conservation already exist in each of the State governments, the Bonneville Power Administration, and the larger electric utilities. However, the intermediate policy set visualizes a much broader and more intense program than now exists. The decision change needed would be to allocate more funding and more top level management support to the overall program of energy conservation education and information dissemination. The emergence of energy conservation programs from nearly nothing in less than 4 years gives some grounds for hoping that these programs would continue to grow under existing authorities. However, the relative slowness of that growth to date gives reason to fear that the programs would lag and perhaps never reach the critical level required to bring about a conversion in the basic public thinking about what is wise and proper in energy use.

The energy information activities that would be most beneficially carried forward by the utilities are the provision of information directly to customers, such as energy audits and individualized conservation plans. These are also by far the most expensive programs per customer served. Thus utilities would need encouragement and perhaps some incentives or pressure to bring about enthusiastic promotion of these services.

In the case of utilities, the existing incentive structure does not provide the motivation to push customers to conserve energy. For the most part, managers and especially investor/owners of privately owned utilities have been rewarded in proportion to the size of their energy sales. Conservation tends to run counter to this tradition and will be pushed only out of a sense of social responsibility or in response to pressures from citizen groups and regulatory authorities. Providing citizens and regulators increased power and ease of entry to the decisionmaking process would help to assure continued and expanded attention to energy conservation as well as to energy supply. For example, policy boards that included representatives of general citizenry and environmental concerns might be established and empowered to make decisions regarding the general allocation between power production and conservation.

Special low-cost financing for energy conservation investments is needed to correct the incongruity that arises when utilities use a cost for capital of 7 percent to 12 percent when evaluating power supply system additions, whereas residential and business customers typically apply rates from 10 percent to as much as 40 percent or 50 percent when evaluating conservation measures. Since conservation measures are, in effect, an alternate resource for balancing electricity loads and resources, they should be evaluated on the same basis. One way to make these comparable is to provide financing specifically for conservation investments at terms equivalent to those that apply for investments in the power supply system.

Utilities could have special loan programs for financing customers' investments in conservation. Authorization would have to be obtained from the appropriate regulatory body, i.e., the Congress, the State Public Utility Commission, or a public council or commission. In addition, a structure for handling this program would have to be set up within the utility. Provision would have to be made to retire the loans through regular payments made out of the savings realized in the form of reduced utility bills for customers. The original loan fund might be provided from each utility's own capital plus borrowing or from funds provided for that particular purpose by BPA.

State government and/or the Federal Government also might establish a special program similar to existing programs for financing housing. Such a program would work through existing lending institutions, guaranteeing repayment in order to obtain a lower interest rate and low downpayment requirement for loans made to finance specific conservation investments. As with the housing programs, the loan guarantee program would also establish standards for supplier/contractors, screen applications, and monitor performance. An advantage of having utilities handle these loans would be the existing regular business that they did with customers.

No sweeping pricing policy changes are envisioned. A move to eliminate quantity discount prices is already underway. Under the intermediate policy set, that move would be extended until all decreasing block rates were eliminated. Minimum bills tied to a quantity of energy use would also be eliminated. Replacing both of these would be a greater reliance on demand charges and service charges where there were substantial fixed costs of service.

The end of very inexpensive and plentiful hydropower also would bring an end to the justification for continuing to supply low-priced energy to large industrial consumers. In general, they would be forced to pay the market price for power, which would be several times the rate now paid. Special provision might be made to establish a conservation pricing schedule for direct service industrial customers. Under this schedule power would be supplied to the customers at the lowest rate that could be justified under the principle of average cost pricing. However, that low-cost power would be available only up to an amount necessary to supply their needs under the most energy efficient technology available. Additional power needed due to inefficiencies of the firm's existing plant and equipment would be available only at market price, without the benefit of averaging in low-cost Federal hydropower.

An energy surcharge would be levied on all use of electricity. The surcharge would be kept relatively small--perhaps 1 mill/kilowatt-hour. The proceeds, which would exceed $150 million in 1980, would be used to help finance various State and regional energy conservation programs.

Infrastructure changes

There would be no wholesale reorganization of the electricity supply system under the intermediate policy set. However, some changes in authority and in relation between entities would be necessary in order to implement new policy measures and decision-rule changes.

Broadened charter for BPA and utilities: The need for action to make conservation investments by households and businesses as readily and cheaply available as are utility investments in power supply system components could best be handled by extending utilities' realm of authority and responsibility to include conservation as well as power supply. The charters of BPA and the utilities should be expanded to explicitly include this new responsibility. They should be empowered to lend money for conservation activities, establish subsidiaries to engage in the business (unsubsidized and unregulated) of supplying conservation services, and generally promote and facilitate customers' efforts to conserve energy. Utility involvement in the conservation business would be desirable because it would provide an opportunity for the utilities to expand their overall size and increase profits without increasing their electricity sales. Some of the smaller utilities would find it difficult to provide these additional services on their own. Cooperative programs with other utilities or with BPA would be established to solve this problem.

State regulatory authority extended to publicly owned utilities: Some of the desired policy changes would require regulatory pressure to bring about their universal adoption. Elimination of declining block rates is a case in point. State public utility commissions should have authority over at least rate structures and conservation programs of these utilities, if not over the entire scope of their activities.

Regional power-planning board: Decisions that have regionwide significance, such as the overall rate of growth in power supply capability, would be made the responsibility of an officially constituted entity. This might be one function of an expanded BPA or of a separate new regional power-planning board (RPPB). RPPB would be responsible for (1) making projections of future power demands, (2) evaluating the need for systemwide reserves to cover contingencies, such as low waterflows, unanticipated demand growth, peaking, and unscheduled outages, (3) evaluating regional energy conservation policy alternatives, (4) evaluating unconventional energy sources, and (5) developing a plan for balancing electricity supply and demand to the year 2000.

RPPB would subsume responsibilities that are now diffused among BPA, State regulatory commissions, the Pacific Northwest Utilities Conference Committee, the Washington Public Power Supply System, and individual utilities. Its main contribution would be to bring issues with regionwide impact to open debate in a public forum. RPPB would be responsible for protecting the broadest general public interest. The public would be represented on RPPB, and public participation would be a major consideration in its deliberations.

LIFESTYLE UNDER THE INTERMEDIATE POLICY SET

Regional perspective

The Pacific Northwest lifestyle under the intermediate policy set would be almost identical with a business-as-usual approach with no attempt to encourage energy conservation.

The energy conservation policies would be deliberately selected to neither disrupt nor impose a burden on industry. Therefore, employment and economic activity under the intermediate policy set would be almost identical with that which is projected under continuation of past trends. Employment and economic growth would be governed by the region's competitiveness as a location for industry and commerce. Factors such as availability of natural resources (timber, farmland, minerals, recreation areas), strategic location (Alaskan and Asian trade), or a fortuitous headstart as in aerospace and nonferrous metals would be important determinants of growth.

The only industry that might have its growth slowed by the policies of this policy set would be primary aluminum reduction. That industry accounts for such a large amount of electric energy use and is so energy intensive per employee or per dollar of value added in the region that it is sensitive to energy costs and policies. These characteristics make it almost imperative that special considerations be given to aluminum energy policy. In the intermediate policy set it is assumed that this would lead to adoption of an intermediate pricing policy designed to encourage plant modernization and increased plant energy efficiency but not make it attractive for plants to leave and go to higher cost areas.

On balance, the employment and economic growth projected for the intermediate policy set would follow trends of the past few years. The traditional resource-based industries are expected to continue to grow. In addition, the economy would show more involvement in services and in fabrication of finished products, reflecting the general nationwide trend in that direction, amplified by further maturing of what was recently a frontier-type economy. The projections anticipate that the region would have enough economic success to help it attract an influx of migrants that would be well above that experienced over any previous long period of time.

Individual perspective

Average citizens of the Pacific Northwest living through the rest of this century under conditions of the intermediate policy set would have lifestyles that would be almost indistinguishable from those under the other two policy sets. In all three cases economic growth and rising labor productivity are assumed to combine to give substantial increases in personal incomes. People would be buying more goods and using more services.

The income and consumption growth would be reflected in higher consumption of some goods and services that have particular significance for future growth of electricity demands. Housing would continue to be upgraded into more spacious units, mostly as existing older and generally smaller homes were gradually replaced by the currently typical ranch-style homes and garden apartments. Single-family residences would continue to dominate. Many more of these would be electrically heated, and air-conditioning of residences would be nearly twice as prevalent as at the present time. The proliferation of electrically powered appliances would continue with freezers, dishwashers, stereos, and other appliances becoming virtually standard fare for every home.

The energy conservation program visualized for the intermediate policy set would affect the way in which some of the goods and services were supplied but, for the most part, the end result for the consumer would be indistinguishable from that which would be enjoyed without a conservation program. In housing, two-thirds of the new units would be fully insulated (6 to 12 in. in the ceiling, 3 to 12 in. in walls, 6 inches under floors and double pane glass), and the remainder would fall short in only marginal respects. Retrofitting of existing units would upgrade virtually all existing units to at least the point of insulation in the ceiling. In addition, approximately one-half of the uninsulated walls and underinsulated ceilings would be retrofitted. Consumers would find their homes to be more comfortable as a result of the improved insulation, even though thermostat settings would be lowered in most homes to 68 degrees Fahrenheit in daytime and 55 degrees Fahrenheit at night.

In aspects of everyday life outside the home, shoppers would begin to notice some reductions in lighting levels in retail stores as store operators adopted new lighting standards. Ventilation reductions would also occur but would be less obvious because they would be accompanied by other regulations, especially smoking prohibitions, which would reduce the level of ventilation required to eliminate odor and pathogens. Similar changes would take place in working conditions for other workers and for the employees of manufacturing industries. Energy housekeeping would be more evident. Employees would be asked to turn off lights and machinery when they were not being used. Designs for doors and windows would be changed, and their use would be more carefully monitored.

More people would find attractive planned communities where living quarters were in apartment buildings with their lower utility costs, convenient access to local commercial areas, and reduced distance to work. Development of these communities would be encouraged by governmental policies that provided financial, zoning, and government service incentives for them.

Several of these changes would be consequences of rising electricity prices. In terms of today's dollars, residential customers in the year 2000 would pay between 0.4 and 1 cents per kilowatt-hour more than they do at present, a price increase of 30 to 75 percent. However, the increase in family income by 2000 compared with that in 1977 would be at least as great percentagewise as the price increase, so that a family would not have to spend a greater proportion of its earnings to pay for the same amount of electricity. The overall effect would be that electricity would cost a family in the Northwest from $50 to $400 more per year in 2000 than today depending on usage, but the added cost would be only a small part of the added income, about $10,000 per year (in 1976 dollars), that the family had at its disposal. Lifestyle would be influenced much more by the added income than by the added electricity cost, assuming a continuation of past trends in the growth of per capita income.

Beyond the relatively small effect of increasing cost of electricity on the material well-being of people in the Northwest in the year 2000, there would be some electricity-related changes in people's perceptions about the safety, stability, and healthfulness of the environment in which they lived. The growth of nuclear power would bring to some people increasing anxiety about accidents, radioactive wastes, and diversion of nuclear materials to terrorists or foreign countries. The extent to which this concern would grow and persist through the rest of this century is very uncertain. If such incidents did occur with some regularity and with disastrous results, then people would be greatly concerned as they would be about an epidemic of a serious disease or about a war in which the country was involved. On the other hand, if there were no serious accidents, if waste storage facilities were developed, and if no nuclear extortion threats were made, the concern about nuclear power could remain at present levels or could even subside.

As a point of reference it can be noted that under conditions of the intermediate policy set the number of nuclear reactors in operation in the Northwest in the year 2000 would be smaller than the number currently (1977) operating in the Northeast, where concern about the nuclear industry and security measures deriving from it do not occupy much of the attention of the average citizen. The other two policy sets would also involve sizable amounts of nuclear power according to the high-growth forecast, but in the moderate-growth case the intermediate and renewable policy sets would have less uncertainty about nuclear effects because fewer nuclear plants would be required.

In some other ways also people would notice the environmental changes that would accompany the expansion of the electricity supply. Several new coal-fired powerplants would be sited throughout the region, and under certain atmospheric conditions or periods of malfunction of the exhaust gas cleanup equipment, people in the neighborhood of such a plant, out to a distance of several miles, would see the plume of smoke, might smell it, and might suffer some slight lung irritation caused by it. Over the long term, some people near such a plant could notice some damage to susceptible materials, such as paint and marble, but in most areas the air pollutants contributed by the powerplants would be small compared to those coming from automobiles, oil furnaces, and industrial plants. Under the intermediate policy set there should not be enough plants to cause overlapping regional effects. On the whole, few people in the region would notice changes in air quality that would be brought about by the coal plants constructed under the intermediate policy set.

People would occasionally notice increasing variations of flows along some rivers. Recreational use of portions of these rivers might be affected adversely. These changes would be brought about by the increasing use of the hydroelectric system for peaking purposes and would take place downstream from storage reservoirs, such as the one behind Grand Coulee Dam. These effects would not be unique for the intermediate policy set, but would be shared by the other two policy sets as well. The effect would be smaller to the extent that conservation reduced the load and smoothed its daily variation. The intermediate policy set would be better in these respects than the traditional policy sets but not as good as the renewable policy set.

People would be much more aware of energy conservation opportunities in the future than they are at present. In fact, a large component of the conservation is anticipated to come about due to the change in point of view and appropriate financial incentives rather than more compulsory forces. Public information programs would be continuing at a level somewhat below that of the late 1970s when there were crash programs to get the word out. Basic energy education would be a regular part of school curriculums. There would also be a substantial flow of individualized information directly to households and businesses. This information would be available not only from Federal and State programs but also from energy suppliers and from sellers of energy-conserving materials (like insulation) and services (like an energy auditor might provide).

The information program would contain a full array of "selling" techniques, including use of prominent public persons to sell consumers on the idea that energy conservation not only pays but also enhances one's image in the community. Thinking would have changed to such an extent that most people would be a bit embarrassed to have a neighbor learn that they still had not insulated their ceiling or that they still kept the thermostat set at 72 degrees Fahrenheit. Utilities would offer energy audits of homes and would help arrange for energy-conserving steps to be taken.

People would also be regularly taking advantage of programs that gave tax deductions or credits for expenditures on energy conservation. These programs would help keep energy conservation opportunities in the public's mind and persuade some hesitant adopters that it would really be a good idea.

As a final note on lifestyle, late in the century people would see in operation a number of large new electric powerplants employing renewable resources. Along the coast there would be several windmill farms each several miles on a side. In the sunny interior, a few large solar units would be feeding electricity into the regional grid. As a consequence people would recognize that these new technologies were coming of age and would gradually be replacing conventional coal and nuclear plants. As an indirect consequence of this awareness and greater affluence, individual use of passive and active solar heaters might be accelerated.

IMPACTS OF THE POLICY SET

Power system and conservation costs

The total annual costs of electric energy and conservation in the region under the intermediate policy set are shown in figure II.3 for both the moderate- and high-growth cases. Figures include not only annual cost of capital, fuel, and operating costs of the powerplants but also transmission and distribution costs. Average costs per kilowatt-hour in the region are also shown in the figure; however, it should be noted that costs differ considerably from one utility to another.

High growth

Under the high-growth assumption, the intermediate policy set would achieve annual cost savings compared with the traditional policy set that would amount to $2.8 billion, or 35 percent, in the year 2000. (See tables IV.3A and B.) Compared with those of the renewable policy set, costs would be about the same until the mid-1980s, when the renewable policy set would become least expensive. The comparisons of cost in mills per kilowatt-hour in the year 2000, neglecting conservation cost, would be 29.8 for the traditional policy set, 26.8 for the intermediate policy set, and 24.4 for the renewable policy set. (See table IV.3.)

Moderate growth

In the case of moderate-load growth, the cost comparisons are qualitatively similar to the high-growth case. Total savings compared with those of the traditional policy set would amount to $1.7 billion annually by the year 2000. (See tables IV.3A, B, and C.) The intermediate and renewable policy sets would have very similar costs throughout the period with the renewable being less expensive from 1990 through 2000. Unit costs in mills per kilowatt-hour in the year 2000 for each policy set, again neglecting conservation costs, would be 23.7 for the traditional policy set, 19 for the intermediate, and 15.6 for the renewable.

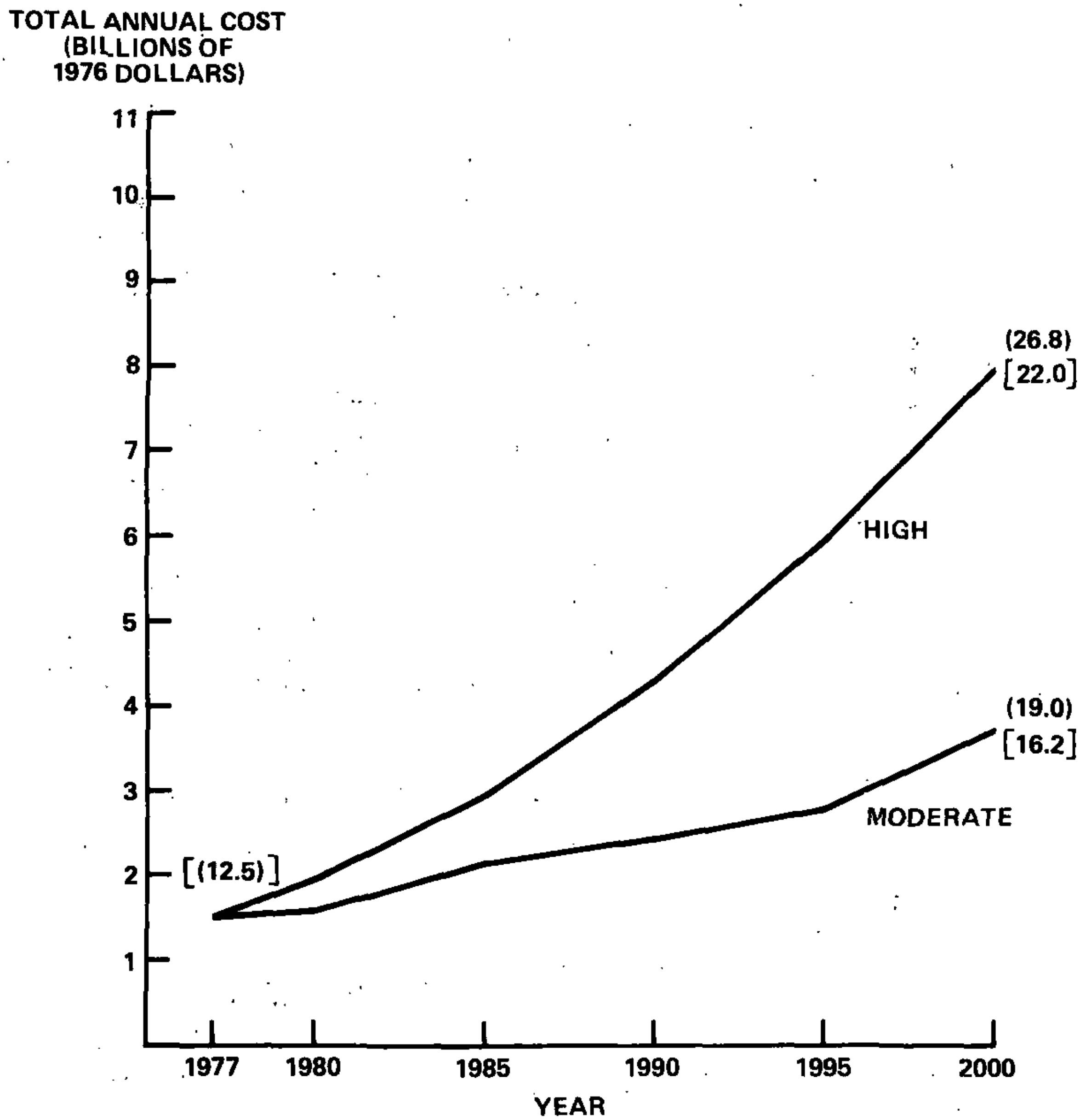
Environmental impacts

Moderate

During the remainder of the century, several coal-fired powerplants would be built and additional plants serving the region would be located in eastern Montana, Utah, and Wyoming. The construction schedule would presumably be the same as the schedule for the thermal/traditional policy set (moderate growth), and the environmental effects should be similar. However, regional electricity planners could reduce coal-fired generation below the level anticipated on the basis of plants

FIGURE II.3

TOTAL ANNUAL COST OF ELECTRIC ENERGY
AND CONSERVATION—INTERMEDIATE POLICY SET



( ) AVERAGE COST OF ELECTRIC ENERGY IN MILLS PER KILOWATT HOUR

[ ] AVERAGE COST OF ELECTRIC ENERGY USED AND CONSERVED IN MILLS PER KILOWATT HOUR

existing and licensed for construction if they chose to do so. Nuclear power would be only a minor component of the supply system, and its impacts should be small. There would be some slight effects of solar, wind, and biomass utilization on air quality, land availability, and regional esthetics. Hydroelectric power production would produce some adverse environmental effects as a consequence of variations in water flow for peaking purposes.

High

The emissions of air pollutants from coal-fired powerplants would be somewhat smaller than the emissions from end uses of fuels, but the effects on health and property of the coal emissions would be only a few percent of end-use fuel emissions because of the stack heights and the remote locations of the powerplants. Thus air quality consequences of the operation of the coal plants would be small and, indeed, smaller than those produced in the traditional policy set. Nuclear powerplants would likewise be fewer in number in this case than in the traditional policy set, but qualitatively the impacts of nuclear power would be very similar in the two policy sets. Effects known to occur would be small, but major uncertainties would remain concerning radioactive waste disposal, accidents, decommissioning, and theft of special nuclear materials. Hydroelectric plant operation would be reduced somewhat compared with that in the traditional policy set, but there would still be some pronounced increases in streamflow fluctuations over those experienced at the present time. Regional esthetics, land availability, and air quality would be only slightly affected by the utilization of solar, wind, and biomass resources.

Equity

An intermediate approach to energy policy would have relatively small equity implications. The conservation measures envisioned are mostly those with quite low costs per kilowatt-hour of power consumption averted. Hence, the net effect would be that the cost of living for most households or the cost of production for most businesses would be reduced to less than it would have been if policies had not been instituted to encourage and expedite adoption of conservation measures.

The bulk of gainers under the intermediate policy set would be particularly evident in the residential sector. The lower level of demand forecasts (NEPP moderate) projects average consumption per household of 26,000 kilowatt-hours by the year 2000 at a cost expected to average 19 mills per kilowatt-hour. This would amount to $494 annual electricity bills per average household (including on the average about 50 percent of households heated by electricity). Conservation is expected to cut the consumption level to 18,700 kilowatt-hours per household per year, saving the consumer $139. The cost of the remaining power used would be lower since conservation would replace the need for some of the highest cost generation.

Thus average generation cost would be reduced by 2.8 mills per kilowatt-hour, which would save the average homeowner another $52 per year. The cost of the conservation measures is estimated to average only about $50 per household. 1/ Tax rebates or subsidies would reimburse householders for about 10 percent of those costs, or about $5 per year. Thus the average householder's total outlay for electricity and for conservation would be reduced by about $146 per year compared with what it would have been without the conservation of the intermediate policy set. Increased taxes to cover the costs of information programs, administration, and the subsidy (or tax rebate) on conservation investments would not be likely to exceed $15 per household per year, leaving the average household about $130 better off than with no conservation program.

All households would stand to gain under this program, including both those that could and did conserve and those that could not or at least did not. The universality of gains would arise because conservation investments would not be compulsory in any situations that could force some individuals to make investments that would not save them money and power rates would be reduced by enough so that even the customer who could not manage to conserve would save more than enough on power bills to cover extra taxes to defray government program costs. If subsidies or other inducements were increased for low-income households, the program could be more effective in gaining participation of that group and, incidentally, could further the general public policy goal of improving the level of living for this strata of society.

1/Much can be achieved through use of better information to increase energy efficiency through better management (lowering thermostat settings and controlling use of lights, appliances, and hot water) and selection of more efficient appliances. Beyond that, only the very high payback conservation investments in insulation, etc., are needed to bring about the estimated savings.

The only aspect of equity that the intermediate policy set might be judged deficient in is a close and direct link between action, cost, and benefits. Households that did nothing to conserve energy would be able to benefit from the generally lower rates made possible by those that did conserve energy. The conservers, on the other hand, would save on their utility bills an amount less (by about one-third) than the savings in power supply costs made possible by their conservation. However, since the discrepancy would be relatively small, it might be tolerable.

Equity between sectors and between subregions within the Pacific Northwest is not as certain under the intermediate policy set as would be equity among individuals. The commercial sector would probably be quite comparable with the residential sector in availability of low-cost opportunities for conservation, and hence those firms would benefit about the same as residences. Industrial customers, however, would be more dissimilar. It appears that energy price increases, which would be larger in percentage terms, would be a major force for conservation in the industrial sector. But general conservation throughout the system would work to reduce these price increases and hence lessen the pressure for conservation in the industrial sector.

There is nothing in the design of the intermediate policy set that would serve to correct the differences between areas served by public utilities with access to low-cost Federal hydropower and areas served by privately owned utilities that are already relying on high-cost thermal generation for an increasing share of their power supply. By leaving average cost pricing in effect, the intermediate policy set would not change the difference among prices to customers in the various systems. In fact, by slowing expansion and hence the movement toward a predominantly thermal system, it would tend to continue the likelihood of significant rate disparities.

Regional economic and employment impacts

Economic and employment impacts would include direct effects, such as reduction in utilities' production and sales of electricity, and indirect effects, such as expansion of industries whose overall costs were reduced as a result of the general adoption of relatively low cost conservation rather than increasingly expensive power generation.

The direct service industrial customers would experience some impacts mostly from the pricing adjustments anticipated under the intermediate policy set. The most noticeable effect would be on primary aluminum producers that are presently using large amounts of low-cost hydropower from the Federal system. Most projections, including those used in this study, implicitly assume that these industries would continue until at least the year 2000 to be supplied power at a rate that would be favorable enough to cause them to increase their purchase of power up to the maximum amount permitted by regional power authorities. Pricing energy to these industries at the average cost of all power (Federal and non-Federal hydro plus thermal) would result in a price of around 10 to 15 mills per kilowatt-hour, which would be low enough to be very attractive to the industry.

However, the intermediate policy set would supply only enough power at this price to produce the industry's present output under the most energy efficient conventional technology. The higher price (equal to replacement cost) for any additional power would discourage the industry from any output expansions in the region and encourage modernization of existing plants to bring energy consumption down to the amount available at the low (average-cost-based) price. As compared with conditions with no policy change, the intermediate policy set would thus anticipate no output expansions after 1979. Furthermore, considerable investment in modernization would be required, but operating costs would be reduced as a result of having cut down on power demands per ton of output.

The other principal direct economic/employment effect of the intermediate policy set would be on industries supplying energy conservation inputs. Growth of these industries would be speeded up as residential, commercial, and industrial purchases were shifted to energy conservation. Suppliers of insulation and other weatherization materials and installation services would all experience increased sales. Appliance and heating system suppliers would experience slight increases in sales as slightly more expensive energy-efficient models were more widely adopted instead of conventional units and as there was some earlier than necessary replacement of existing inefficient units. From the energy user's viewpoint, these changes would amount to substituting capital for the operating cost of energy purchases. But reduced energy purchases would mean reduced capital investments for utilities.

Hence the real substitution would be conservation investments for supply system investments. Many of the better conservation investments would require considerably less capital than would be required at the generating end. Hence conservation would leave more capital that could be invested, used for consumption, etc. A conservation-oriented economy should result in slightly more investment in industries not directly associated with energy and perhaps in residential housing and consumer durables.

Beyond direct effects, there is the possibility that a conservation-oriented economy would be affected in ways that would ultimately be amplified as shocks worked their way through the economy. For example, utility sales would be reduced so utilities would buy less from industries that supplied their inputs, which in turn would cause those industries to contract, and so forth. However, the nature of the direct economic effects from energy conservation would be such that these secondary impacts could be safely assumed to be negligible. In the first place, the changes expected would not be immediate decreases or increases but rather changes in the rate of growth. Electric utilities, for example, are projected to have more than double the value of sales by 2000 even if general growth were only at a moderate rate and energy conservation were practiced. Secondly, increased outputs in some industries would tend to offset the decreases in others, leaving the total direct effect balanced. As a result, secondary effects would tend to balance out as well.

Risk and impacts of shortfall or idle capacity

Shortfall and idle capacity are both possible consequences of mistakes in planning for electricity supply. Evaluation of the risk involves several aspects of the supply system, including ability to meet construction schedule, diversity of the system, early warning capability, and ability of the system to respond to warning signals. In each of these categories, the intermediate policy set would be comparable with the other two policy sets. There would be some risk, but none that would stand out as clearly unacceptable.

The consequences of relatively long term shortfall or idle capacity in this policy set would be likewise comparable with those for the other policy sets. Shortfalls could bring restrictions on growth, higher prices, and rationing. Idle capacity might mean unnecessary cost burdens and promotional activity to increase sales.

RENEWABLE/TRANSITION POLICY SET

INTRODUCTION

In the renewable/transition policy set, the Pacific Northwest region would plan a return to renewable energy sources for all its electrical needs. "Renewable energy" refers to the use of solar radiation directly for thermal energy supply, as in heating and cooling. It includes indirect forms of solar energy, such as photovoltaic, solar-thermal-electric, windpower, and biomass conversion. Geothermal energy is classified as renewable, although some forms are not. The dominant renewable form is hydroelectric power which, until the 1970s, provided essentially all electric power in the region. Since hydropower is so important to the region, we will consider it separately. Our energy sources will thus include (1) renewable--hydroelectric, (2) renewable--nonhydroelectric, (3) nonrenewable--principally coal-fired and nuclear electrical generation, and (4) energy conservation, which is recognized throughout this analysis as an energy resource.

Starting in 1971, when the first large regional coal plant became operational, the energy resources underlying the Northwest Power Grid began to swing away from the traditional hydroelectric base and became increasingly dependent on nonrenewable energy resources, principally coal and uranium. This shift to thermal generation (coal or nuclear based) was planned by the Bonneville Power Administration and the region's electric utilities in what was designated "the Hydro-Thermal Power Program." This policy set examines how rapidly, by what means, and with what impacts this recent, but rapid, turning away from renewable energy resources could be reversed, so that at some point in the future the region could return to a renewable-based electrical system. This goal of electrical self-reliance, necessarily based on conservation and renewable energy, is intended to illustrate application of several national energy principles, including (1) restraint of demand through conservation, (2) vigorous expansion on nonconventional energy sources, (3) protection of the environment, and (4) reduced vulnerability to supply interruptions.

Our strategy is to achieve this transition by implementing conservation as rapidly as possible consistent with cost-effective economic criteria. Conservation, by reducing the significant energy waste which now occurs, would permit the region to minimize new investments in conventional thermal plants and instead wait for commercialization of the more promising renewable energy technologies. These technologies--including photovoltaic, solar-thermal-electric, biomass conversion, wind energy, new hydro, and geothermal--could then begin to pick up the new energy loads which would be inevitable with population increases and industrial growth.

Since this policy set would carry only through the year 2000, its differential costs and impacts would be dominated by conservation as an alternative to thermal power, rather than by renewable energy supplies. Several promising renewable technologies would be commercially competitive within 5 to 15 years and would capture most of the new plant orders soon thereafter. However, thermal plants now under construction or already operating would continue to supply energy until they were decommissioned, starting around the year 2000. In order to see the ultimate effects of this renewable transition, one can look ahead into the next century, when self-reliance, based on indigenous renewable energy sources, would reemerge as an enviable regional strength.

SUMMARY OF ADVANTAGES AND DISADVANTAGES

The principal advantage of the renewable/transition policy set is that regionwide it would provide the cheapest, safest, most resource conserving electrical energy system. Furthermore, this policy set would make the most far-sighted use of the unique regional resource: the Federal Columbia River Power System. In addition, it would:

--Be the most equitable to the rest of the country and to future generations.

--Demonstrate to the United States the feasibility of returning to more permanent (renewable), clean, benign, and indigenous (self-reliant) energy sources.

--Show an advantage (over the other policy sets) in compliance with the national energy principles and other relevant criteria.

The principal disadvantage of the renewable/transition policy set is that it likely would be opposed by most of the region's utilities and energy intensive industries. The renewable policy set would require massive investment in energy efficiency in all consuming sectors throughout the region. Regional utilities and industries would not see as rapid growth as their plans called for, hence their likely hostility. They might have the political power to foreclose this policy option.

Furthermore, this policy set would involve a mechanism common in other areas of commerce and industry but new to regulated monopolies, i.e., replacement cost pricing. Replacement cost pricing would greatly increase power rates to electricity consumers. Electricity prices in the region are presently based on average costs rather than replacement costs. The difference between average costs and replacement costs runs from 15 to 20 mills per kilowatt-hour for industry served directly by BPA. For a commercial owner or homeowner served by an investor-owned utility, the difference is about 10 to 15 mills per kilowatt-hour. All other customers fall somewhere in between.

LOADS AND RESOURCES

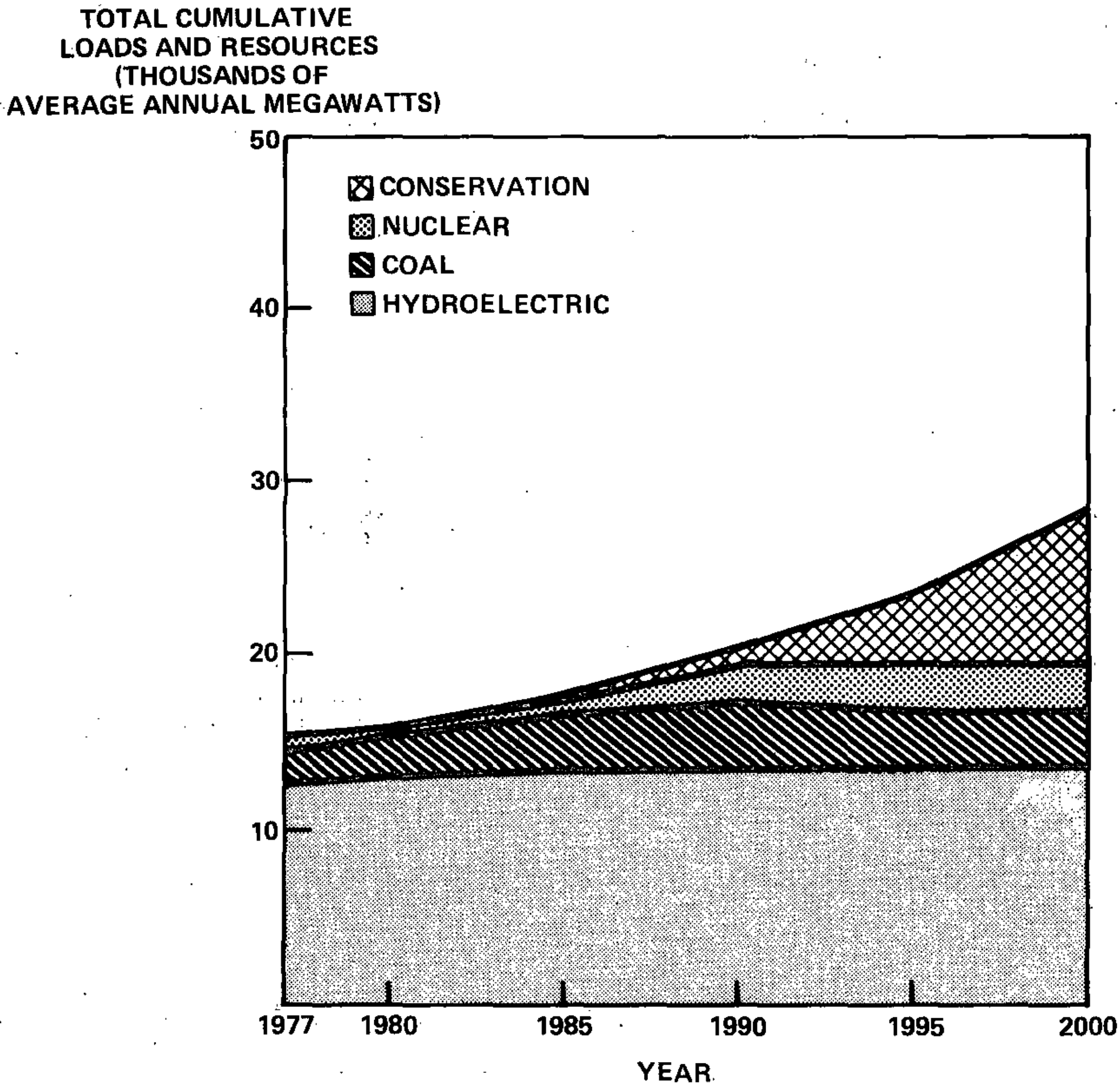
The region's basic electric load in the renewable/transition policy set would be the same as in the other two policy sets. In this policy set vigorous conservation programs, including better insulation and more efficient heating equipment in residences and commercial establishments and more efficient equipment and processes in industries, would provide significant reductions in forecast load growth. By the year 2000 these would amount to about 33 percent of the moderate-growth forecast, or 32 percent of the high-growth case. In the moderate-growth case with these conservation programs, the load growth would be insufficient in the early years to absorb all the generation existing or under construction. Specifically, over 8,000 average megawatts of excess thermal generation would be available in 1985, thereby placing an economic burden of some $700 million per year on the region if the surplus could not be sold. By the year 2000 over 4,000 average megawatts of new renewable energy would be available and would be cheaper than new coal and nuclear plants. Consequently, no further nonrenewable plants would be needed beyond those now operating or under construction.

In the high-growth case 4,000 average megawatts of new (nonhydroelectric) renewable generation would be required by 2000, plus 1,100 average megawatts of new hydroelectric energy. Additionally, 6,800 average megawatts of new nuclear and coal generation capability would be needed, in addition to that already licensed for construction.

Figures III.1 and III.2 show the total loads in the high- and moderate-growth cases, along with components of supply used to meet them. As shown in the figures, energy supplies would come from a variety of sources. Hydropower

FIGURE III.1

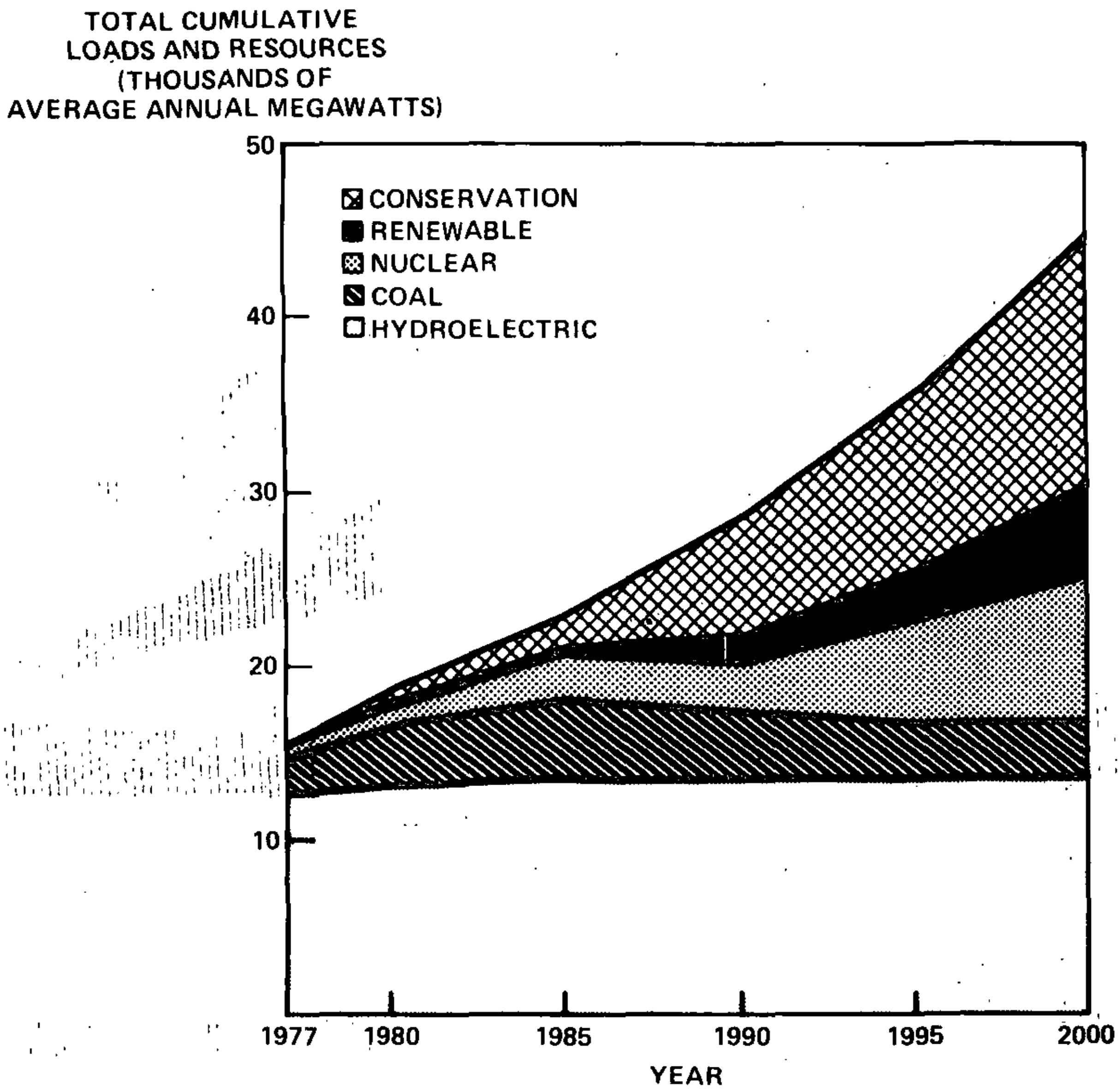
RENEWABLE/TRANSITION POLICY SET a
MODERATE GROWTH (2.7 PERCENT)



a/ THIS POLICY SET HAS THE CAPABILITY OF 4,000 MW IN THE YEAR 2000 FROM RENEWABLE NONHYDROPOWER SOURCES, BUT BECAUSE THE LOAD COULD BE MET BY THE LESS-EXPENSIVE CONSERVATION, THOSE SOURCES WERE NOT USED.

FIGURE III.2

RENEWABLE/TRANSITION POLICY SET
HIGH GROWTH (4.8 PERCENT)



would make up most of the total early in the time period, but is assumed to have limited growth potential, in terms of annual energy. Under moderate growth reduced energy waste (i.e., energy conservation) would handle most of the growth needs into the late 1990s, when renewable technologies would begin to phase in. In the high-growth baseline, some additional nonrenewable plants would be needed, as described above.

The renewable resources assumed for this policy set were mostly central station units, although some wind and solar generation was considered to be decentralized, i.e., located at the load. The decentralization question does not need resolution in this analysis. It will become a critical policy question soon, however, and must be carefully and comprehensively analyzed at that time.

OBJECTIVES AND GENERAL CRITERIA

The primary policy objective of the renewable/transition policy set is to focus on energy conservation through adoption of policies which are economically optimum for the region. A secondary objective is to introduce renewable energy technologies as soon as they become commercially competitive. As the economics of renewable technologies, such as wind and solar generators, began to approach the breakeven point with conventional nonrenewable technologies, primarily coal and nuclear, the crossing of the cost curbs would be anticipated and orders for generating units would be placed. This anticipatory approach would assure that the operational date of the renewable generators would correspond as closely as possible to the first date of their commercial advantage.

If they were to be optimal for the region, all decisions on the feasibility of alternative power supply sources would have to be based on replacement cost pricing of electricity. This policy set would require immediate introduction of energy prices more closely approximating replacement costs than the average costs presently used by BPA and electric utilities generally. Economic analyses based on replacement cost pricing would make it clear that conservation improvements were generally more cost effective than investments in new generating plants.

Conservation (energy-efficiency) investment would be stimulated with grants which would be only partially repaid through long-term/preferred interest rate loans and with comprehensive technical assistance. The conservation programs in each sector would be funded through energy surcharges specific to that sector, thus yielding a side benefit: economic optimality through (approximately) replacement cost pricing.

Policy intervention to reduce risks would assure the rapid integration of commercially competitive renewable technologies. This would require the Government to absorb any unusual financial and technological risks inherent in new technologies so that regional utilities would have an indifferent investment choice between renewable technologies and conventional nonrenewable technology. This policy recognizes that utilities would not risk takers and that they would otherwise oppose introduction of new renewable technologies into the power grid, which would make grid operations more complex and might force their thermal plants into intermediate load status. This policy set's objective is to achieve a return to renewable resources with maximum reliance on the market's signaling capabilities. Note that the surcharge revenues would never leave the sector from which collected. Economic incentives, plus information and technological assistance, would be the primary tools of change. Reliance on mandatory controls would be minimized. In no case would power curtailments or rationing be required.

This policy set focuses on adjustments which would (1) reduce the energy used in delivering goods, services, and a comfortable standard of living to increasing numbers of people and (2) return the region to an electrical energy system that would be more permanent and reliable, i.e., would be based on renewable and indigenous energy resources. All investments in conservation programs or renewable energy projects would be more cost effective (or, at worst, as cost effective) as a comparable investment in conventional coal and nuclear generating facilities.

POLICY MECHANISMS AND INFRASTRUCTURE CHANGES

Since energy conservation can be significantly more cost effective than building new thermal powerplants and since an electrical system based on indigenous renewable energy sources would have the obvious advantages of environmental soundness, reduced health and safety risk, and protection against supply interruptions (plus releasing coal and uranium for the rest of the Nation), it is reasonable to ask why any policy mechanisms and infrastructure changes would be required. To answer that question, we should determine how conservation investments look from an individual's perspective and a regional perspective; why people ignore energy conservation opportunities which would be beneficial to them; and why, when they invest in conservation, they do so at levels well below those necessary to maximize their economic benefits.

It is important to realize that these phenomena are present in all sectors, industrial, commercial, and residential. Homeowners, apartment and commercial building owners, and industries--particularly medium- and small-sized industries--ignore significant savings attainable through energy conservation investments, or they do not invest in conservation, but inadequately to maximize economic benefits. Some of the reasons for this behavior are as follows:

--Investors contemplating energy conscious projects are deterred from making conservation investments by average-cost-based prices, which are substantially below current energy costs.

--Financing rates and terms for conservation investments in the private sector are significantly inferior to those typically obtained in Federal financing and electric utility borrowing.

--"First cost" dominates buying decisions in all sectors. This reflects a de facto discount rate much higher than those assumed in rational investment analyses. Furthermore, industry typically requires a higher rate of return on cost improvement investments, such as energy conservation projects, than on plant construction or expansion. In home purchasing lenders do not use the total cost (utility bills plus principal, interest, taxes,and insurance) in qualifying the home purchaser. Thus builders have no incentive to consider life cycle costs when deciding how much energy efficiency to build into new homes.

--Unawareness of the energy situation in general and energy conservation opportunities in particular is common. Consumers get a mixed signal from energy suppliers, which vocally support conservation while promoting their energy sales. A recent study on public awareness of energy problems revealed that only 48 percent of adult Americans know that the United States imports oil. Unawareness of energy conservation opportunities and how to capitalize on them is just as widespread. This lack of knowledge is prevalent in medium and small businesses as well as in the residential sector. It is typical of apartment owners.

--With the exception of electroprocessors, such as primary metal and chemical manufacturers, electricity costs in industry are normally less than 3 percent of total product costs. Because industry management typically focuses on the larger cost items, energy efficiency improvements and energy conservation do not receive much attention. Furthermore, it often takes significant capital to make energy-efficiency investments, which could involve the addition of new equipment and early retirement of inefficient equipment. Industry is typically concerned about assuring future energy supplies, but often ignores significant cost savings through energy conservation.

Policy mechanisms

The renewable/transition policy set was designed to assure that at all points in time the most cost beneficial energy investments would be made. The desirability of alternative investments was viewed from the perspective of maximum benefit to the region as a whole. Investments in energy conservation were considered viable alternatives to investments in new energy supplies, whether renewable or nonrenewable.

Because the high payoff conservation opportunities would be taken first and less desirable opportunities later, over a period of time the average cost of saving energy through conservation would rise until at some point it would equal the cost of energy from new powerplants, which is also escalating. For the purposes of this policy set, we assumed that renewable technologies would become competitive with thermal generation sometime between 1985 and 1995.

In addition to these dynamics of generating cost, the renewable policy set assumes that replacement cost would be the basis for electricity pricing. This assumption is necessary to assure that the optimum economic investments would be made. Replacement or marginal cost pricing is a natural consequence of competitive enterprise.

Energy conservation investments would be catalyzed by making grants in all consuming sectors. Only partial repayment would be required, and that on very favorable terms. Repayment periods would be much longer than present commercial practice in order to be more consistent with the effective life of the investment. Furthermore, extensive technical expertise would be developed and made available to consumers in all sectors, particularly to small- and medium-sized apartment, commercial, and industrial owners and managers. These services would be funded through a sector-by-sector surcharge, collected by the electric utilities. These surcharges, when added to customers' electric bills, would approximate replacement cost pricing and thus make the utility bill transmit true economic signals. This is a far cry from today's low average cost pricing, which inhibits optimal investment allocation in conservation and renewable technologies. Equity is maintained by providing all funds needed for conservation in a given sector through that sector's surcharge.

An additional policy mechanism would be required to promote the rapid integration of newly competitive renewable energy technologies. Without new policy mechanisms, the region's utilities would have no inducement to complicate their operations with new technologies, particularly with those involving a variable energy source, such as the sun. This would not be true of all renewable technologies, but it would be true of photovoltaic and solar-thermal-electric, and it would be true of wind-electric conversion. Since utilities seek to minimize their technological and financial risks, it would be necessary to backstop the utilities so that their unusual risk in introducing new renewable technologies would be no greater than in building coal or hydroelectric facilities. In this way the utilities would be indifferent to the nature of the technology and would be able to select new supply sources on the basis of economic analysis.

Policies to buffer the risks of new technologies would be especially important in the renewable/transition policy set because it seeks to apply the renewable technologies as soon as they are competitive. This would mean making a commitment to assume the risks of building renewable energy plants while the technology was still in the development and demonstration stage. This approach would signify, in effect, that the Pacific Northwest was prepared to be a demonstration or pilot region for the Nation with respect to renewable energy development. It would be an appropriate role, since the vast and flexible storage capabilities of the Federal Columbia River Power System provide the perfect buffer between the variable power supplies from renewable technologies and the varying load requirements within the region.

It would be unwise to think of economic incentives as the only useful policy mechanisms. Information programs, particularly competent and accessible technological assistance options, would also play a useful supporting role. For example, an energy extension service paralleling the agricultural extension service could take its place within the region to facilitate conservation actions by medium- and small-sized commercial and industrial owners, apartment owners, and homeowners. By assuring that the technological assistance was provided at no direct charge (it would be funded from the energy surcharge), the energy extension service would eliminate much of the inertia which now plagues voluntary conservation programs. The extension service has been very effective in agricultural applications and is badly needed to develop an increased energy awareness. It would be highly competent and responsive regionwide and would set a new standard for this type of technological assistance. Special training programs would be offered to increase regional competence in the skills relevant to energy conservation. Such competence is thinly spread today.

Mandatory policy mechanisms would play a minor role but should not be ignored. Policies oriented toward economic mechanisms and technological assistance would be much more popular, much easier to promote, and less intrusive. However, we already are accustomed to and comfortable with many regulatory requirements, such as building codes. Oregon is beginning to make its residential building codes somewhat more responsive to escalating electricity and other fuel prices. This approach could be spread to all sectors and to other States in the region. Given the long-expected lifetimes of residential and commercial buildings, it is necessary to insure that the energy-efficiency standards built in minimize the full life cycle cost of heating, cooling, and lighting the buildings.

It is always more cost effective to build right in the first place than to remodel later. In many cases, however, corrections can be made by retrofitting existing structures. To encourage such improvements, insulation standards might be applied with the transfer of any improved real property. At a minimum, a statement would be prepared at time of sale to disclose annual energy use. It might be possible to require sellers to bring their homes or commercial buildings up to regional efficiency standards at the time of sale when the financing of such improvements is most attractive. Improved efficiency standards could also be applied to conversions from fossil fuel to electricity. This would be especially important in the case of conversions from fossil fuel heating systems to electric resistive heating, since electric resistive heating is a relatively inefficient application of energy. Heat pumps are available which require half or less the annual energy of a resistive heating system and, in areas where they are cost effective, should perhaps be made a prerequisite in any conversion to electric heating.

Appliance labeling would be required so that regional consumers could make informed decisions as to the energy efficiency of the appliances they were purchasing. It would also be appropriate to establish some equipment labeling in the commercial/industrial sector. Minimum efficiency standards should be adopted, as has been done in California for certain selected household appliances. California standards could be adopted, thus making it easier for appliance manufacturers to comply. Policies such as this, of course, would be opposed by most of the home appliance industry. However, the situation in California revealed that at least one corporation was routinely producing appliances which already met California's new standards, while the rest of the home appliance industry was complaining of inability to meet them.

Infrastructure changes

At present the functions of policymaking and planning are carried out by the region's electric utilities; BPA; and BPA's direct service customers, especially the primary aluminum industry. Thus we have supply-dominated energy policymaking. This would have to be changed if the renewable/transition policy set were to evolve. The citizens of the Pacific Northwest are increasingly indicating their desire to (1) develop new policies in energy conservation and (2) opt for renewable energy technologies in the future. Most energy suppliers, on the other hand, deny the public a role in the power-planning process. They plan to meet growing electrical requirements through additional supplies--that is, more thermal generating plants, although conservation is more economical. This is understandable since it maximizes the growth rate in utility assets, but it denies present and future citizens of the region access to the full range of energy alternatives, specifically the most economical, most environmentally sensitive, and most benign options.

Some new institutional mechanisms would be required which would allow those involved in the technology of supply to begin to function as total energy utilities, rather than merely suppliers of thermal power, and at the same time would open the process to the public in an anticipatory, policy-planning mode. This would provide more balance in analysis of tradeoffs between the need for new power supplies and economic, environmental, health/safety, and equity considerations.

Energy policy should seek that level of consumption where the energy-related benefits outweigh the social, economic, and environmental costs of providing and using that energy. The public must play the central role in making such decisions.

One approach would be to establish a regional board made up of a broad cross section of the citizenry of the region but excluding the energy suppliers. This board would have a permanent staff responsible to it which would prepare load forecasts, analyze alternative energy options, and select the options to pursue. The board would be responsible directly to the citizens within the region. Its members could be chosen in direct election or perhaps be appointed by local officials. Most importantly, the board would have accountability at the grass roots level within the region. It would be important for the board to have a permanent staff with adequate capability to inform the public on the issues and alternatives, as well as the impacts of each alternative. The public could register its support or displeasure directly through its own board and could inspect in a relatively unobstructed manner the full range of options and impacts that are available. This would greatly depart from the present situation, where the public is often informed by the energy suppliers after important decisions have been reached. The California Energy Resources Conservation and Development Commission, with a well-funded staff, provides a good model of this institutional role.

For the Federal Columbia River Power System to play its pivotal role in promoting the renewable technologies, BPA or some Federal agency with regional jurisdiction must be given an expanded capability to develop and operate the grid, made more complex through the introduction of renewable resources and technologies. The most direct way to do this would be to expand the charter of BPA to allow direct financial and technical participation in energy conservation and in the development, financing, construction, and integration of renewable energy technologies.

Since public and investor-owned utilities in the region have shown the ability to finance, build, and operate new thermal powerplants, the construction of thermal powerplants should be left to the utilities. BPA or any Federal entity responsible for the development of a conservation and renewable energy strategy would be barred from participating in the financing and construction of new thermal plants.

If the region's utilities attempted to preempt energy policy decisions by pushing ahead aggressively with thermal plant construction when, in the opinion of the board based on findings of its own staff, such plants were inappropriate (i.e., were using the wrong technology and/or resource) or premature, the board would point out in all relevant proceedings and in other forums the reasons these projects were not in the best interests of the region. It would be difficult for the utilities to prevail over the board except by a thorough and open examination of the options and their impacts. This would elevate regional power planning to the level called for by the problems and opportunities of transition. It would bring the dialog out into the public domain where the public would be represented by competent, independent analysis, funded on a longer term and chartered with a broader view of social goals than the utilities, BPA, and the direct service customers have yet demonstrated.

LIFESTYLE UNDER THE RENEWABLE/ TRANSITION POLICY SET

In order to comprehend the lifestyle under this policy set, it is critically important to understand that energy conservation means eliminating energy waste, that is, getting the same benefits or products from less electrical energy. Conservation does not mean curtailment rationing, rolling blackouts, belt tightening, and other ways of describing what results from breakdowns in planning and policymaking. Investing in energy conservation has been likened to putting a plug in the bathtub rather than trying to fill it by pouring water in faster.

Some energy savings in this policy set would come from diversification in the industrial sector and some from behavioral changes, such as reducing thermostat settings and turning out lights when they are not needed. However, the bulk of the energy saved by conservation would result from new, more efficient production equipment; better insulation in homes; more efficient appliances; and similar changes which, once made, would require little further attention. Consequently, the lifestyle in this policy set would be the same as it would be under the other two.

There would be some exceptions. A better insulated home with storm windows would not only be easier to keep warm, but it could be kept comfortable with lower thermostat settings because the inside surfaces of walls and windows would be warmer and would allow a more favorable radiant heat exchange between the inhabitants and the dwelling. In addition, the well-insulated and storm-proofed house or commercial building would be quieter and less drafty. Comfort would be increased with lower thermostat settings and sharply reduced heating energy requirements.

The future lifestyle under this policy set was well described by Fortune Magazine in May 1977:

> "* * * it would be a tightly organized capital intensive society whose hallmark would be meticulous engineering. In the interim a lot of resources would have to be redirected. Building an energy efficient society would mean altering or retiring a considerable portion of the capital and consumer goods that were designed for an era when energy was cheap and plentiful. A $500 billion capital goods boom: but change of course is what industry is all about. Contrary to businessmen's fear of wrenching decline, constructing that society and its accoutrements represents a seldom matched opportunity to devise and market a vast array of brand new goods. This opportunity comes at a time when slowing population growth and saturating consumer markets are making a lot of business lives either boringly routine or bruisingly over-competitive. * * * far from taking us back to Walden Pond, conservation could open up a great many economic opportunities."

As the same article later pointed out and as our policy sets illustrate, the cost of conservation would be considerable. But it would be much less than the cost of trying to meet the energy need with new supply investments, at least to the end of the century.

The outstanding characteristic of lifestyle differences between the traditional/thermal, the intermediate, and the renewable/transition policy sets is that they are so imperceptible. Homes would be more comfortable, quieter, and healthier because of more even temperatures and reduced drafts. More appliances would proliferate, but they would be much more efficient. By the year 2000 solar systems for water and space-heating purposes in the residential and commercial sectors would not be dominant but very obvious. It would be very unusual for a new home not be have a solar water-heating unit. A higher percentage of people would be living in multifamily units, which they might own (i.e., condominiums), thus capitalizing on the energy efficiency of common wall construction. This would be a result of economic trends, perhaps enhanced by regional energy policy.

The commercial sector would appear little different from today. Lighting standards and ventilation standards would probably resemble those prevalent in the immediate postwar years. Because of the energy savings possible by reducing ventilation requirements in commercial buildings (and because of health reasons), it might be very common to have large no-smoking sections in all buildings.

The industrial sector would be more diverse than it is today. A better balanced mix of industries would give the region an economic stability it has lacked. Energy intensive industries would still be present, but they would be more energy efficient as would all industrial processes. The industrial sector would be more tightly organized, taking advantage of more cogeneration and more cascading of energy uses. Most of today's energy-inefficient processes and equipment would have been replaced by the end of the century. There would be less heat leakage and fewer hotspots, and the typical industrial workplace thus would feature a safer, more comfortable work environment.

Under the renewable/transition policy set, lifestyle differences would be fewer and very subtle and mostly positive. There would be more individual choice in energy use, modest decentralization of the electrical energy supplies, and more comfortable homes and workplaces. Because the individual consumer would be less reliant on the central power grid, there might be a greater feeling of self-reliance. Environmental quality and human health and safety conditions would be slightly worse than today but decisively better than under the thermal/traditional policy set and slightly better than under the intermediate policy set. The region's people would sense that they had a greater degree of control over their futures and were leaving a better legacy for their children than today, because they and their representatives actively would participate in energy planning and policymaking.

The Pacific Northwest would be shared by many more people. It would still be a good place to live. There would be levels of responsibility, self-reliance, and integration greater than now exist. The region could return to a pattern of environmentally sound economic growth and electrical self-sufficiency.

IMPACTS OF THE POLICY SET

Costs of production and conservation

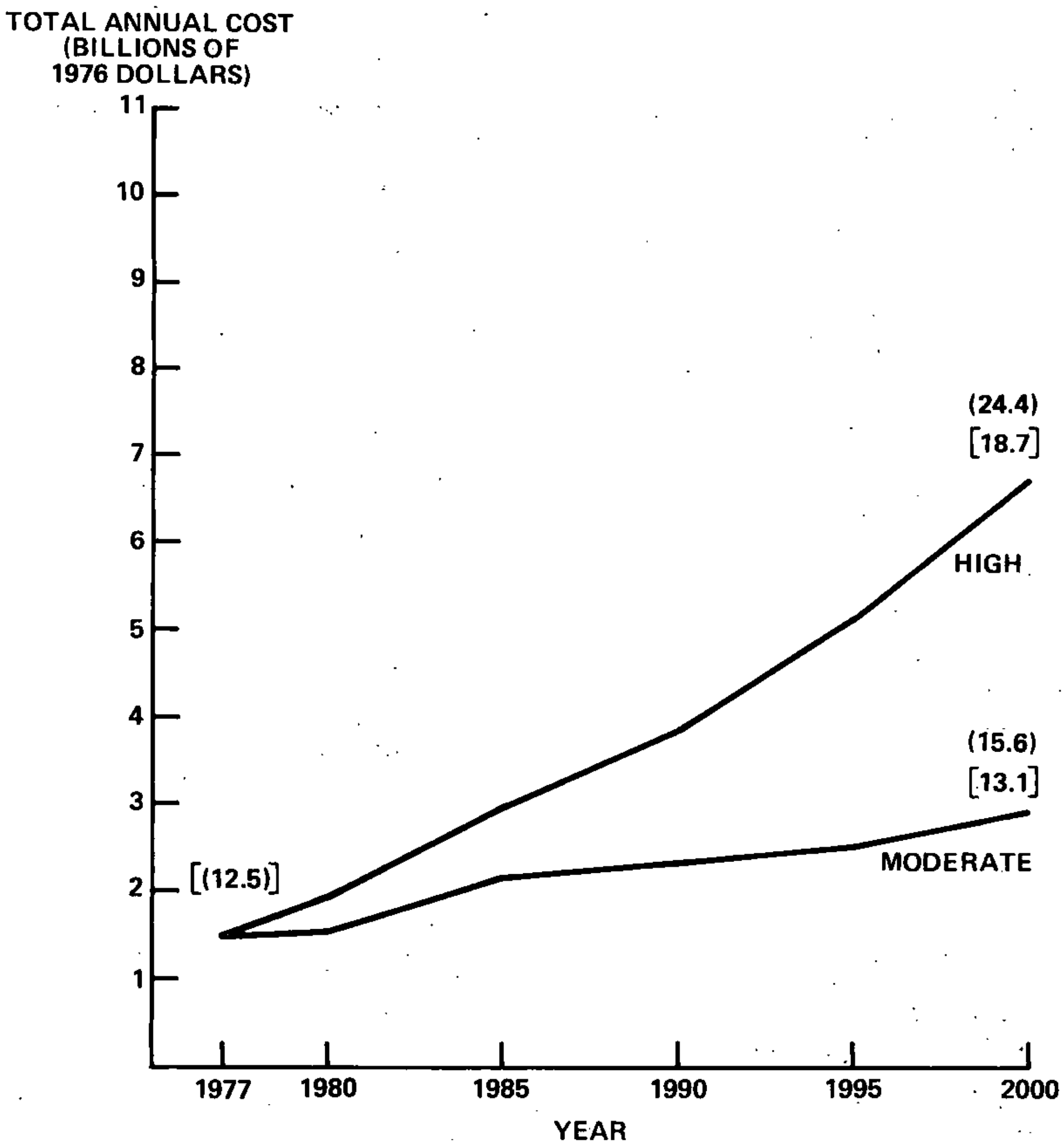
By the year 2000 the annual systemwide cost of renewable/ transition policy set would be less than the annual costs of the traditional/thermal and the intermediate policy sets. Figure III.3 shows the total annual cost of electric energy and conservation from 1977 through 2000. In the initial years the renewable transition policy set would cost about the same as the intermediate policy set. (See table IV.3 and IV.4.) This would occur partly because, according to our analytical ground rules, conservation would be achieved as rapidly as possible even though it was not immediately needed because of overbuilding of thermal plants in the recent past. The full impact of this overbuilding would not be felt until the thermal plants now under construction were brought on line. Also cost reductions were not assumed for the sale of surplus power. As a result, the cost burden of the renewable/transition policy set would be artificially high. The systemwide electrical supply.cost would be significantly less in the renewable/transition policy set than in the other policy sets. Power consumption would be reduced by conservation, but power rates in mills/kilowatt-hour would be higher due to energy surcharges which would approach replacement cost pricing and generate surplus revenues for financing conservation programs and renewable energy developments.

Environmental effects

The environmental effects of the renewable transition policy set would in general be less adverse than those of the other two policy sets. The environmental impacts of conservation would be much less severe than generating the equivalent amounts of energy. The renewable energy technologies would have more impact on land use, and might have more visual impact for the same reason, although those impacts would occur in remote areas. However, in terms of environmental pollution, ecosystem functioning, and resource depletion, the renewable technologies would be clearly superior. Furthermore, the health and safety risks, some of the more intrusive restrictions on individual freedom, as well as the threats of terrorism and sabotage inherent in nuclear technology, would be greatly reduced in the renewable/ transition policy set.

FIGURE III.3

TOTAL ANNUAL COST OF ELECTRIC ENERGY AND CONSERVATION–RENEWABLE/TRANSITION POLICY SET



( ) AVERAGE COST OF ELECTRIC ENERGY, IN MILLS PER KILOWATT HOUR

[ ] AVERAGE COST OF ELECTRIC ENERGY USED AND CONSERVED IN MILLS PER KILOWATT HOUR

Equity considerations

The equity question is multidimensional: There are many ways in which equity can be assessed. An apparent inequity in the renewable transition policy set would be the energy surcharge which would raise electricity prices toward replacement cost levels. Equity would be preserved, however, by earmarking the surcharge revenues and feeding them back into the same consuming sectors (e.g., industrial, commercial, residential, and agricultural), in the form of either conservation investment incentives, technical assistance, or tax relief.

The policy set's increasing reliance on renewable regional resources and corresponding reduction in use of fossil fuels would be clearly more equitable than the other two policy sets to future generations both within and outside the region.

Regional economy and employment

The three policy sets were designed so that regional employment and regional economic output would not be disrupted. However, there would be some differences between the moderate-growth and the high-growth projections. These are imponderables, mainly beyond the direct control of the region's policymakers, and for the three policy sets they would be identical.

The nature of the employment mix and the composition of the commercial/industrial sectors could be slightly different in each policy set. A better balance and greater diversification in the renewable/transition policy set could lead to less vulnerability and greater economic stability.

Risk and impact of shortfall or idle capacity

The most obvious conclusion in this aspect is that there would be problems either way, that is, with shortfall risk or idle capacity stemming from overconstruction. However, there would be no inherent difference between the three policy sets on balance. The threat of shortfall or idle capacity would be shared in all three policy sets, although more idle capacity would be manifest in the renewable/transition moderate-growth case.

If the moderate-growth case should materialize rather than the high-growth case, an aggressive conservation program would produce substantial amounts of idle capacity. In this situation the utilities might seek to promote the increased use of electricity in order to put their idle capacity to work. One of the region's gas utilities, given new supplies of Canadian natural gas, recently applied to the public utility commission in its State to allow promotional advertising, that is, to promote the sale of more gas. This situation could be repeated for electricity if the moderate-growth forecast materialized. In such cases thermal plants now under construction would be revealed as the offspring of exaggerated load forecasts.

LOADS, RESOURCES, AND COSTS

ELECTRIC ENERGY LOADS

The Pacific Northwest area selected for study included the States of Oregon, Washington, Idaho, and Montana west of the Continental Divide. Loads, resources, and total system costs were examined.

Two load forecasts were examined, a higher level and a somewhat lower forecast, or moderate level. The higher forecast was based on the "Pacific Northwest Utility Conference Committee West Group Forecast," dated February 17, 1977, as extended by the "Long Range Projection of Power Loads and Resources for Thermal Planning, West Group Area," dated April 30, 1977. These loads were modified by adding Montana Power Company loads west of the Continental Divide in Montana, all the Idaho Power Company loads, and Utah Power and Light Company loads in Idaho. Estimated firm exports out of the area are included as part of the firm load. This adjusted forecast, representing annual load growth of about 4.8 percent, was selected as the higher load level. The forecast approximates the higher load level in the Northwest Energy Policy Project draft report. Table IV.1 shows the high basic energy load forecast in average annual megawatts. Conservation in the intermediate policy set and the renewable/transition policy set would reduce the load to be served below the high basic load forecast.

The lower, or moderate-load, analysis was based on the moderate forecast of electrical requirements in the NEPP draft report "Module II," dated May 1977. This forecast was also modified in several respects. First, the forecasted loads were increased to include the Montana Power Company and BPA loads in western Montana. Second, since the actual 1976 load was higher than the forecast for that year, the actual 1976 load was used as the starting point and the initial year of 1977 load was adjusted accordingly. Third, the NEPP forecast was increased by 8 percent--the estimated transmission losses--to represent the loads at point of generation rather than of the load location. Fourth, using the adjusted load for the year 1977 and the adjusted forecast for the year 2000, we interpolated forecasts for the intervening years 1980, 1985, 1990, and 1995.

The moderate basic load, excluding reserve requirements, would increase at about 2.7 percent annually from 1977 through 2000. The loads in average megawatts are shown in table IV.2. As in the high-load estimate, conservation in the intermediate policy set and the renewable/transition policy set would reduce the energy to be served by various amounts during the 23-year period. The estimated amounts of conservation in the high- and moderate-growth modes are shown in average annual megawatts in tables IV.1 and IV.2, respectively.

In all instances secondary energy loads were initially excluded to provide the firm energy load to be served under critical water conditions. For determining annual power costs under average water conditions, it was assumed that the secondary energy loads would be served before displacing the higher cost fuel generation. Since the effect of meeting the secondary energy loads does not significantly change costs and is the same in each policy set, only the use of additional surplus secondary for fuel displacement and export was included.

Load levels--thermal/traditional

High-load forecast

The energy load level in this policy set represents a continuation of conditions currently being experienced in the area. Load growth would amount to about 4.8 percent annually during the 23-year period starting in the year 1977 and ending in the year 2000. The initial year's firm energy load would be 15,160 average megawatts. By the year 2000 the annual load would increase to 44,930 average megawatts. The loads are shown in average megawatts on table IV.1A. The load growth alone during the 23-year period would amount to 29,770 average megawatts.

Moderate-load forecast

A moderate-load level was adopted for study based on the area conditions assumed in the NEPP draft report. The initial firm energy load, the same in all policy sets, would be 15,160 average megawatts. The firm energy load for the year 2000 would be 28,060 average megawatts, an increase of 12,900 average megawatts during the 23-year period, representing an annual load growth rate of about 2.7 percent. The load would be insufficient in the early years to absorb all the generation existing or under construction. However, by the year 2000, added resources would be required.

Load levels--intermediate

High-load forecast

The area's basic load in the intermediate policy set would be the same as in the thermal/traditional policy set; however, it was assumed that conservation efforts at residences, commercial establishments, and industries would provide some load reductions. The amount of conservation is shown in average megawatts on table IV.1B. Conservation opportunities would be much greater with high-load growth than with the moderate-load growth, and the amount of conservation achieved would therefore be larger. Conservation efforts amounting to 10,270 megawatt-years in this policy set would reduce the basic load in the year 2000 by about 23 percent.

Moderate-load forecast

Under the moderate-load forecast conservation opportunities would be more limited. Although somewhat smaller than in the high-load forecast, important amounts of conservation would be accomplished to reduce load requirements. The total estimated amount that conservation could achieve under these circumstances is shown on tables IV.2 and IV.2B. The total amount includes conservation achievable at residences, commercial businesses, and industries. In the year 2000 the load reduction due to conservation would be about 22 percent and would amount to 6,210 megawatt-years.

Load levels--renewable/transition

High-load forecast

Under this policy set efforts would be made to achieve maximum energy conservation and pollution reduction. The reduction computed for the year 2000 as a result of conservation would nearly equal the current, or 1977, load level. The amount of conservation, i.e., load reduction for each of the years studied, beginning in 1980, is shown on table IV.1C. The load reduction in this policy set due to conservation in the year 2000 would amount to 14,540 megawatt-years, or about 32 percent of the basic load forecast.

Moderate-load level

Although the energy load for this level would not present the same opportunities for conservation as the high-load level, a considerable amount of conservation would be indicated under the all-out effort assumed for this policy set. The estimated load reduction due to conservation in the year 2000 would be about one-third of the load that could otherwise be expected in that year. The smaller increments that would occur in earlier years would reduce the loads in 1980, 1985, and 1990 to below the current, or 1977 level. This would make existing and under-construction resources more than sufficient to meet all loads through those years and extending through 2000. The magnitude of the conservation effort in terms of thousands is shown in table IV.2C. The percentage of load reduction due to conservation in the year 2000 would amount to 9,350 megawatt-years, or 33 percent of the basic load.

Demand growth reduced by conservation

Throughout this analysis we treated electricity saved through conservation as a resource which could be used to meet future demand growth. By doing so we were emphasizing the importance of energy conservation as an economical alternative to the construction of new generating plants. The schedule below shows how the conservation savings projected for each policy set would impact on the need for additional generation.

Demand level/ policy set	Power supply source--years 1977 and 2000: 1977 Generation	2000 Conservation	2000 Generation	Average annual growth rates: Total demand (note a)	Generation only
	----(MWy)----			(percent)	
High growth:					
Thermal/ traditional	15,160	-	44,930	4.8	4.8
Intermediate	15,160	10,270	34,660	4.8	3.7
Renewable/ transition	15,160	14,540	30,790	4.8	3.1
Moderate growth:					
Thermal/ traditional	15,160	-	28,060	2.7	2.7
Intermediate	15,160	6,210	21,850	2.7	1.6
Renewable/ transition	15,160	9,350	18,710	2.7	.9

a/In 1977 total regional electrical demand was 15,160 MWy. In the year 2000 it is projected at 44,930 MWy (high growth) and 28,060 MWy (moderate growth).

SUPPLY ALTERNATIVES

The amounts of conventional resources expected to be available were obtained from the "Long-Range Projections of Power Loads and Resources for Thermal Planning, West Group Area, 1977-78 through 1996-97," dated April 20, 1977, prepared by PNUCC. Some 1976-77 data was also obtained from the April 16, 1976, issue of that report.

Resource data from these West Group Area reports was modified by adding the generation planned by the Idaho Power Company, the Utah Power and Light Company to serve its load in Idaho, and the Montana Power Company to serve its load west of the divide in Montana. These added amounts were derived from information in "Summary of Estimated Loads and Resources," Western Systems Coordinating Council, January 1, 1977, as supplemented by information from BPA, Branch of Power Resources. Thus the planned generation was obtained for loads in the Pacific Northwest area of study which includes Washington, Oregon, Idaho, and Montana west of the Continental Divide.

The following power supply criteria were applied in developing the amounts of resources of each type available, planned, and needed to serve load for each year of study in the policy set.

From a firm energy generation standpoint, practically all the planned hydroelectric capability has been installed. All existing, under-construction, and planned hydroelectric plant units were assumed available to serve load on scheduled completion.

Coal-fired and nuclear plants were assumed completed by the probable energy date if needed to serve load. When additional thermal plants were needed beyond those scheduled it was assumed that energy would be provided equally from coal-fired and nuclear plants.

Completion of scheduled coal-fired and nuclear plants was delayed if not immediately needed to serve load. However, those coal-fired plants scheduled for completion in 1980 and 1981, Boardman and Colstrip Numbers 3 and 4, were assumed completed by 1985 even though not needed under the moderate-load forecast. Similarly, nuclear plants having construction permits WNP 2 and 1 were assumed completed on schedule, 1980 and 1981, respectively, even though they might not be immediately needed in some policy sets. Jim Bridger Number 4 was assumed completed on schedule in 1979. Combustion turbine generation was assumed available on schedule.

The amounts of energy generation in average megawatts considered available from existing, licensed-for-construction, and planned resources are shown for each policy set, high and moderate loads, in tables IV.1 and IV.2. The various classes of resources are successively balanced against load to obtain a resource surplus or deficit.

<u>Supply alternatives--thermal/traditional</u>

Resources were confined to conventional hydroelectric, coal-fired, nuclear, combustion turbine, and miscellaneous older small thermal plants. No significant amounts of renewable resources, e.g., new hydro, biomass/cogeneration, wind, or solar installations, were assumed available.

Tables IV.1A and IV.2A show the amounts of generation available, planned, and needed from each type of resource under the above criteria.

<u>High-load forecast</u>

With high-load growth all scheduled resources would be required. Additional modest amounts above those scheduled would be needed in 1980 and 1985. (See table IV.1A.)

In 1980 under critical water conditions, it would be necessary to operate combustion turbine and miscellaneous small thermal plants more than normally desirable using expensive gas or oil fuel. For years after 1980 more peaking operation of combustion turbines was assumed, since substantial amounts of energy would be needed above that provided by scheduled resources. In all cases the fuel for the combustion turbines plus some for coal-fired plants could be saved in an average water year by curtailing those plants and substituting hydrogeneration.

Substantial additional amounts above scheduled coal-fired and nuclear generation would be needed in 1990, 1995, and 2000. These additional amounts are shown as deficits at the bottom of table IV.1A.

<u>Moderate-load forecast</u>

With moderate-load growth, completion of resources on schedule would produce significant surpluses of capability in 1985 and 1990. However, additional thermal plants beyond those presently planned would be required in the year 2000. (See table IV.2A.) Within the criteria applied to all policy sets as previously described, it would be possible to delay scheduled thermal generation in 1985, 1990, and 1995. However, with these delays of large nuclear plants, it would be necessary to operate combustion turbines to generate reasonable amounts of energy during critical water years.

Supply alternatives--intermediate

The amount of energy required from conventional resources for either high- or moderate-load growth would be less than in the thermal/traditional policy set because conservation would reduce load requirements and a modest buildup of renewable type resources was also assumed to occur. (See tables IV.1B and IV.2B.)

The renewable resources assumed for this policy set were mostly central-station-type generation. However, about one-third of the wind and solar generation was considered to be decentralized, i.e., located at the load. Decentralized sources were combined with centralized and would have little effect upon the amounts of transmission and distribution required because conventional generation backup would be necessary.

High-load forecast

With high-load growth, conventional resources beyond those scheduled would be required in years 1995 and 2000. (See deficits on bottom of table IV.1B.) However, as indicated by surpluses in 1985 and 1990, it would be possible to delay scheduled nuclear plants not having construction permits and still meet the 1985 and 1990 loads.

Moderate-load forecast

With moderate-load growth, no additional conventional resources beyond those scheduled would be required; in fact, about five of the scheduled nuclear plants could be delayed through the year 2000. (See table IV.2B, which shows a 4,690-average-megawatt surplus at that time.) Even if coal-fired and nuclear plants were delayed to a maximum extent within the criteria previously described, large amounts of unused capability above that needed for energy reserve would be available in 1985, 1990, and 1995.

Supply alternatives--renewable/transition

This policy set includes relatively large amounts of planned conservation and renewable resources. The need for conventional resources would be reduced substantially below those now scheduled. (See tables IV.1C and IV.2C.)

High-load forecast

Even with high-load growth, scheduled conventional resources would handle the load through year 2000. Large amounts of unused capability would exist in 1985 and 1990 (see table IV.1C), and conventional generation could be delayed to a maximum extent within the previously described criteria.

Moderate-load forecast

Under moderate-load growth conditions, very large surpluses would occur in all years if scheduled conventional resources were installed. (See table IV.2C.) With maximum delay of these resources under previously described criteria, very large amounts of unused conventional capability would result in 1980, 1985, 1990, and 1995. Under the renewable/transition policy set and moderate-load conditions, thermal plants existing and having construction permits would be sufficient to meet year 2000 load if they were aided in that year by about 700 average megawatts of new hydro resources.

If additional renewable resources had been assumed installed in this policy set under moderate-load growth, as shown in figure 6.3 on page 6.15, the unused conventional capability would be increased by comparable amounts. However, installation of renewable resources would be economically unsound at the assumed estimated costs. The unit costs of energy from additional renewable resources, such as wind, solar, and biomass, would generally exceed the conventional thermal fuel cost that might be saved. Furthermore, such savings could be achieved only in low water years, since under better water conditions additional hydroenergy would be available for fuel savings.

POWER SYSTEM AND CONSERVATION COSTS

The total cost of providing electric energy and conservation to the Pacific Northwest is one of the major determinants of the economic desirability of any policy set. The total annual cost (in 1976 dollars) was estimated for high- and moderate-load growth under the three policy sets during 1977, 1980, 1985, 1990, 1995, and 2000. These total annual costs for an average water year are shown in figure IV.1 and in tables IV.3 and IV.4.

The total annual electric energy cost was determined from the estimated cost of power resources, including conservation, transmission, and distribution elements of the power system under the conditions assumed for each policy set and load level. The unit costs used were those immediately available that appeared reasonable and were agreed to by our representatives and the team of energy consultants.

The total annual conservation cost included the estimated cost of residential, commercial, and industrial conservation.

Power system costs

The total annual power cost was compiled on the basis of the system required to meet load during critically low water conditions on the hydroelectric system. The cost was then adjusted by the savings in thermal plant fuel that would be achieved during an average water year. Thus the final total annual power cost recorded is that which would occur during an average water year.

Power resource costs

Resource costs were split into two categories, "resources used" and "resources unused." "Resources used" includes the total cost, i.e., fixed and variable, of operating the resources to meet load. "Resources unused" includes the fixed charge of surplus capability, or if no surplus is available, it includes the minimum required to provide energy reserves.

Generally resources were selected to meet load at lowest cost. Each year all the hydroelectric energy was used. Since coal-fired generation plus transmission from coal mine-mouth plants is about the same cost as nuclear generation, the amount from each type was prorated proportionally to the amounts scheduled to be available. If additional amounts were required, they were provided by half nuclear and half coal-fired generation. Combustion turbines were operated as a peaking energy resource only if more than the scheduled amounts of coal-fired and nuclear power were needed. Renewable resources were operated to meet load when they delayed or displaced the construction of conventional thermal plants or when the modest amount scheduled would not significantly increase the total cost. However, when assumed load growth was small and would be met by existing or soon-to-be-completed resources, renewable generating units were listed but not added to the total cost.

When load requirements allowed conventional thermal plants to be delayed, the interest on sunk cost was neglected; however, as discussed later, fixed costs were increased to cover potential technological improvements that might be required by the date of initial operation.

Hydroelectric resources, existing, under construction, and planned

The Federal Columbia River Power System fiscal 1976 production cost was $102,252,000. 1/ On the basis of critical water year generation, this amounts to 1.5 mills per kilowatt-hour for about 65 percent of the total Pacific Northwest hydro generation. The average cost of investor-owned hydro production was estimated at 2.5 mills per kilowatt-hour for 24 percent of the total and publicly owned at 2 mills per kilowatt-hour for 15 percent of the total.

The weighted average cost of Pacific Northwest hydro production is about 1.8 mills per kilowatt-hour. This unit cost in 1976 dollars is expected to remain essentially constant since under-construction and planned additions to the system are relatively small compared with existing installations.

Coal-fired thermal resources

The annual cost of existing coal plants, Centralia, Jim Bridger, and Colstrip, were estimated from 1976 Federal Power Commission Form 1, construction and variable cost data. The weighted average annual costs are $67 per kilowatt fixed cost and 6.3 mills per kilowatt-hour variable cost for a total of 17.2 mills per kilowatt-hour at 70 percent capacity factor.

For plants completed subsequent to 1977, an investment cost was derived from the average public-private Washington-Oregon cost given in BPA environmental impact statement table V-14 for 1976. This amount of $526 per kilowatt for 1976 was increased each year to plant completion by $13 per kilowatt, tapering to zero in 1990. The adjustment accounts for potential costs of environmental and technological plant improvements. An average publicly owned/investor-owned fixed cost ratio of 0.15 was applied to the investment cost to derive the annual fixed cost, including fixed operating and maintenance expenses. Variable costs were assumed to remain constant in 1976 dollars at 11.4 mills per kilowatt-hour, the average for publicly owned/investor-owned plants in Washington and Oregon from EIS table V-14. In any particular year the cost of coal-fired thermal energy was computed as the weighted average cost of all completed coal-fired plants operating at 70 percent capacity factor. When it was necessary to use scheduled imports to meet load, such imports were costed as coal-fired thermal energy.

1/BPA, "Summary of Financial Data," June 30, 1976, table 6.

Nuclear thermal resources

The annual cost of the Trojan Nuclear Plant was derived from 1976 public-private cost in BPA Role EIS table V-16, obtaining $85 per kilowatt-year plus 4.8 mills per kilowatt-hour, which, at the 64-percent capacity factor assumed, totals 20 mills per kilowatt-hour. Hanford atomic generation costs were assumed to be 7 mills per kilowatt-hour in 1976-77 and 10 mills per kilowatt-hour in 1979-80.

The fixed cost of generation from nuclear plants coming into operation after 1977 was based upon a capital cost in 1976 dollars of $716 per kilowatt. 1/ This cost was increased each year to plant completion by an amount starting at $31 per kilowatt in 1977 and tapering to zero in 1990. The increase was intended to cover the cost of technological improvements required. An average annual fixed-charge ratio amounting to 0.143 for publicly owned/investor-owned plants in Washington and Oregon was derived from BPA Role EIS table V-16. This ratio was applied to the investment cost to obtain the annual fixed cost, including fixed operation and maintenance expense. A publicly owned/investor-owned average variable cost of 4.9 mills per kilowatt-hour from EIS table V-14 was combined with the fixed cost applicable to the plant completion year to obtain the total annual cost of that plant. The weighted average fixed and total costs of power from all completed nuclear plants were used in determining the nuclear generation cost in a particular year.

Combustion turbine and miscellaneous resources

The cost of generation from Beaver's combustion turbines was derived from 1976 Federal Power Commission formal information: the fixed cost was $23 per kilowatt-year, and the variable cost was 40 mills per kilowatt-hour. These unit costs were used for all combustion turbine generation and for the miscellaneous older small thermal plants.

New renewable resources

Generally the intermediate and renewable/transition policy sets are designed to include in later years progressively larger amounts of cost-competitive new renewable

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1/NEPP Study Module III-A, table V-11, ERDA 76-141, average light water reactor amounts escalated 12.1 percent to 1976 dollars.

resources to displace the construction of coal-fired and nuclear plants.

For purposes of this report, the following unit costs were utilized:

Renewable energy resources	Mills per kWh
Hydroelectric	21
Solar-thermal	34
Solar-photovoltaic--centralized	28
--decentralized	22
Wind--centralized	22.5
--decentralized	22
Biomass/cogeneration	25

Centralized and decentralized resource costs were combined to obtain weighted average costs used in the power cost tables.

The schedule below shows the cumulative total costs which would be required for the new renewable energy sources planned for the intermediate and renewable/transition policy sets.

Policy set	Cumulative total costs in 1980	1985	1990	1995	2000
	--------(000,000 omitted)--------				
Intermediate:					
High	$ -	$ 60	$ 269	$ 720	$1,578
Moderate	-	60	269	720	1,578
Renewable:					
High	-	208	1,066	3,200	7,397
Moderate	-	-	-	-	326

Transmission costs

The BPA power transmission cost for energy handled in 1976 amounted to 1.14 mills per kilowatt-hour. 1/ A private utility transmission cost of 1.37 mills per kilowatt-hour was derived from supporting data to the BPA EIS. These were combined 80 percent BPA and 20 percent private to obtain a base Pacific Northwest transmission system cost estimate of 1.2 mills per kilowatt-hour. The amount of non-Federal public

1/BPA, "Summary Financial Data," table 7, June 30, 1976.

system transmission in the Pacific Northwest is relatively small and would not materially affect the base system cost. It was assumed that the base system cost in 1976 dollars would remain relatively constant as system loads grew, provided the pattern of load and generation location were not substantially altered. The location of planned nuclear plants would not modify the pattern. However, additional coal-fired generation located in Montana and Wyoming would tend to increase the system transmission cost. It has been estimated that the transmission cost from such plants to Hanford, Washington, would range from 3.65 to 4.65 mills per kilowatt-hour, according to the amount of power and number of lines required. As Montana and Wyoming coal plants were added to the system to meet load, the base transmission system cost of 1.2 mills per kilowatt-hour was accordingly increased. The transmission cost was applied to the total system load.

Distribution costs

The weighted average public and private system distribution costs in 1976 were estimated at 6.6 mills per kilowatt-hour. This amount was derived from econometric study data used for the BPA EIS. Historically the distribution cost per kilowatt-hour has trended downward, primarily because increased use per customer and technological progress has balanced inflation. However, in recent years the increased use of underground distribution and higher land costs have tended to increase distribution costs. These counterbalancing trends are expected to continue. For purposes of this study, the distribution cost per kilowatt-hour (in 1976 dollars) was assumed to remain constant regardless of the policy set conditions or rate of load growth. Distribution costs were assessed on the total system load less large direct service industrial loads.

Conservation costs

Estimated energy savings achieved through conservation investments in the intermediate and renewable/transition policy set, as well as the estimated cost of various conservation investments, are summarized in appendix V. Using the data summarized in that appendix, we developed the cumulative total costs of conservation (fixed and variable costs) for the years 1980 through 2000, as follows:

Policy set	Cumulative total costs in 1976 dollars 1980	1985	1990	1995	2000
	-----------(000,000 omitted)----------				
Intermediate:					
High	$156	$1,073	$2,577	$4,432	$ 6,610
Moderate	100	639	1,557	2,759	4,231
Renewable:					
High	311	1,881	4,354	7,463	11,127
Moderate	262	1,526	3,568	6,131	8,994

Annual conservation costs consistent with appendix V and with the design of the intermediate and renewable/transition policy sets are shown in tables IV.3B, V.3C, IV.4B, and IV.4C.

Total system costs

Total annual costs, including conservation, range from $1.5 billion in 1977 to a possible high of $10.8 billion in the year 2000. The schedule below shows the total annual power costs for each of the policy sets and growth rates.

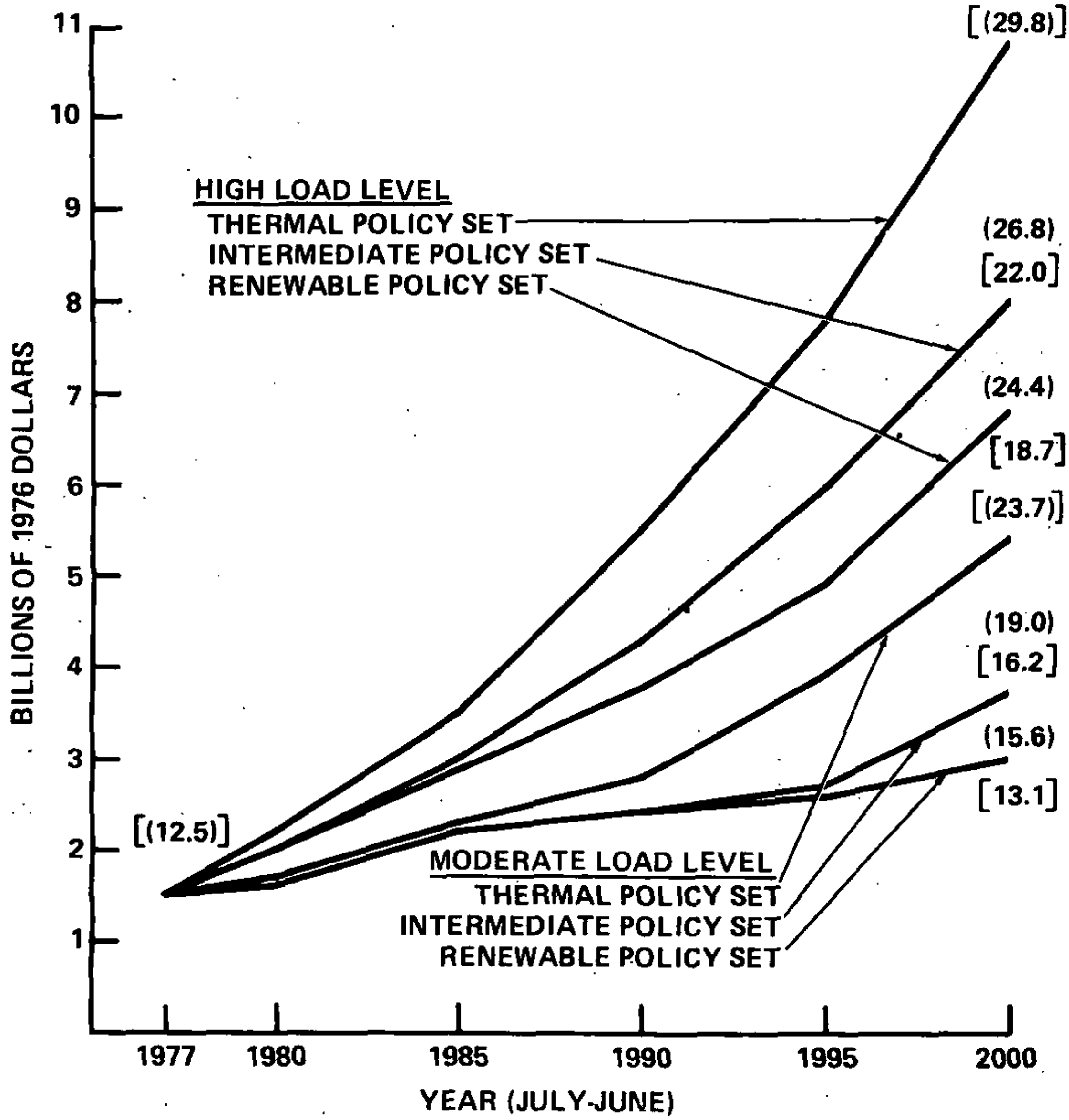
Demand level/policy set	Total annual cost, including conservation, in 1976 dollars 1977	1980	1990	2000
	----------(billions)---------			
High-demand growth (4.8 percent):				
Thermal/traditional	$1.5	$2.2	$5.5	$10.8
Intermediate	1.5	2.0	4.3	8.0
Renewable/transition	1.5	2.0	3.8	6.8
Moderate-demand growth (2.7 percent):				
Thermal/traditional	1.5	1.7	2.8	5.4
Intermediate	1.5	1.6	2.4	3.7
Renewable/transition	1.5	1.6	2.4	3.0

Cumulative total costs and capital requirements for the period 1977-2000 are presented in tables IV.5 and IV.6, respectively.

Average annual costs for the regional power system in terms of mills per kilowatt-hour are shown in figure IV.1.

FIGURE IV.1

TOTAL ANNUAL COST OF ELECTRIC ENERGY AND CONSERVATION



( ) AVERAGE COST OF ELECTRIC ENERGY IN MILLS PER KILOWATT HOUR

[ ] AVERAGE COST OF ELECTRIC ENERGY USED AND CONSERVED IN MILLS PER KILOWATT HOUR

TABLE IV.1

Summary of Loads and Resources--High-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	18,620	22,990	28,540	35,680	44,930
Reserves	390	410	500	630	800	1,000
Total	15,550	19,030	23,490	29,170	36,480	45,930
Resources:						
Total existing and licensed	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	-830	-2,790	-9,160	-16,950	-26,450
Thermal/Traditional Policy Set						
Planned conservation	-	-	-	-	-	-
Planned renewable resources	-	-	-	-	-	-
Planned thermal resources	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	-830	-370	-2,470	-10,260	-19,760
Intermediate Policy Set						
Planned conservation	-	1,520	3,130	4,720	6,970	10,270
Surplus or deficit (-)	-	690	340	-4,440	-9,980	-16,180
Planned renewable resources	-	-	130	280	580	1,080
Surplus or deficit (-)	-	690	470	-4,160	-9,400	-15,100
Planned thermal resources	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	690	2,890	2,530	-2,710	-8,410
Renewable/Transition Policy Set						
Planned conservation	-	2,290	4,670	6,890	10,290	14,540
Surplus or deficit (-)	-	1,460	1,880	-2,270	-6,660	-11,910
Planned renewable resources	-	-	410	1,250	2,800	5,100
Surplus or deficit (-)	-	1,460	2,290	-1,020	-3,860	-6,810
Planned thermal resources	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	1,460	4,710	5,670	2,830	-120

APPENDIX IV

TABLE IV.1A

Thermal/Traditional Policy Set--High-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	18,620	22,990	28,540	35,680	44,930
Reserves	390	410	500	630	800	1,000
Total	15,550	19,030	23,490	29,170	36,480	45,930
Resources:						
Existing and licensed for construction:						
Hydro	12,940	13,020	13,090	13,060	13,060	13,060
Coal	2,920	3,620	4,860	4,200	3,720	3,670
Nuclear	1,040	1,420	2,610	2,610	2,610	2,610
Combustion turbine and miscellaneous	120	140	140	140	140	140
Total	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	-830	-2,790	-9,160	-16,950	-26,450
Planned energy conservation	-	-	-	-	-	-
Surplus or deficit (-)	1,470	-830	-2,790	-9,160	-16,950	-26,450
Planned renewable resources:						
Hydro	-	-	-	-	-	-
Biomass/cogeneration	-	-	-	-	-	-
Wind	-	-	-	-	-	-
Solar	-	-	-	-	-	-
Total	-	-	-	-	-	-
Surplus or deficit (-)	1,470	-830	-2,790	-9,160	-10,950	-26,450
Planned thermal resources:						
Coal	-	-	-	70	70	70
Nuclear	-	-	2,420	6,620	6,620	6,620
Total	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	-830	-370	-2,470	-10,260	-19,760

APPENDIX IV

TABLE IV.1B

Intermediate Policy Set--High-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	18,620	22,990	28,540	35,680	44,930
Reserves	390	410	500	630	800	1,000
Total	15,550	19,030	23,490	29,170	36,480	45,930
Resources:						
Existing and licensed for construction:						
Hydro	12,940	13,020	13,090	13,060	13,060	13,060
Coal	2,920	3,620	4,860	4,200	3,720	3,670
Nuclear	1,040	1,420	2,610	2,610	2,610	2,610
Combustion turbine and miscellaneous	120	140	140	140	140	140
Total	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	-830	-2,790	-9,160	-16,950	-26,450
Planned energy conservation	-	1,520	3,130	4,720	6,970	10,270
Surplus or deficit (-)	1,470	690	340	-4,440	-9,980	-16,180
Planned renewable resources:						
Hydro	-	-	50	100	200	400
Biomass/cogeneration	-	-	50	100	200	300
Wind	-	-	-	-	30	80
Solar	-	-	30	80	150	300
Total	-	-	130	280	580	1,080
Surplus or deficit (-)	1,470	690	470	-4,160	-9,400	-15,100
Planned thermal resources:						
Coal	-	-	-	70	70	70
Nuclear	-	-	2,420	6,620	6,620	6,620
Total	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	690	2,890	2,530	-2,710	-8,410

APPENDIX IV

TABLE IV.1C

Renewable/Transition Policy Set--High-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	18,620	22,990	28,540	35,680	44,930
Reserves	390	410	500	630	800	1,000
Total	15,550	19,030	23,490	29,170	36,480	45,930
Resources:						
Existing and licensed for construction:						
Hydro	12,940	13,020	13,090	13,060	13,060	13,060
Coal	2,920	3,620	4,860	4,200	3,720	3,670
Nuclear	1,040	1,420	2,610	2,610	2,610	2,610
Combustion and miscellaneous	120	140	140	140	140	140
Total	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	-830	-2,790	-9,160	-16,950	-26,450
Planned energy conservation	-	2,290	4,670	6,890	10,290	14,540
Surplus or deficit (-)	1,470	1,460	1,880	-2,270	-6,660	-11,910
Planned renewable resources:						
Hydro	-	-	200	400	700	1,100
Biomass/cogeneration	-	-	100	200	400	600
Wind	-	-	30	300	750	1,500
Solar	-	-	80	350	950	1,900
Total	-	-	410	1,250	2,800	5,100
Surplus or deficit (-)	1,470	1,460	2,290	-1,020	-3,860	-6,810
Planned thermal resources:						
Coal	-	-	-	70	70	70
Nuclear	-	-	2,420	6,620	6,620	6,620
Total	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	1,460	4,710	5,670	2,830	-120

APPENDIX IV

TABLE IV.2

Summary of Loads and Resources--Moderate-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	15,960	17,590	20,110	23,390	28,060
Reserves	390	390	410	470	560	710
Total	15,550	16,350	18,000	20,580	23,950	28,770
Resources:						
Total existing and licensed	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	1,850	2,700	-570	-4,420	-9,290
Thermal/Traditional Policy Set						
Planned conservation	-	-	-	-	-	-
Planned renewable resources	-	-	-	-	-	-
Planned thermal resources	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	1,840	5,120	6,120	2,270	-2,600
Intermediate Policy Set						
Planned conservation	-	1,270	2,330	3,320	4,480	6,210
Surplus or deficit (-)	-	3,110	5,030	2,750	60	-3,080
Planned renewable resources	-	-	130	280	580	1,080
Surplus or deficit (-)	-	3,110	5,160	3,030	640	-2,000
Planned thermal resources	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	3,110	7,580	9,720	7,330	4,690
Renewable/Transition Policy Set						
Planned conservation	-	2,100	3,600	5,390	6,840	9,350
Surplus or deficit (-)	-	3,940	6,300	4,820	2,420	60
Planned renewable resources	-	-	410	1,250	2,800	5,100
Surplus or deficit (-)	-	3,940	6,710	6,070	5,220	5,160
Planned thermal resources	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	3,940	9,130	12,760	11,910	11,850

APPENDIX IV

TABLE IV.2A

Thermal/Traditional Policy Set--Moderate-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	15,960	17,590	20,110	23,390	28,060
Energy reserve	390	390	410	470	560	710
Total requirements	15,550	16,350	18,000	20,580	23,950	28,770
Resources:						
Existing and licensed for construction:						
Hydro	12,940	13,020	13,090	13,060	13,060	13,060
Coal	2,920	3,620	4,860	4,200	3,720	3,670
Nuclear	1,040	1,420	2,610	2,610	2,610	2,610
Combustion turbine an miscellaneous	120	140	140	140	140	140
Total	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	1,850	2,700	-570	-4,420	-9,290
Planned energy conservation	-	-	-	-	-	-
Surplus or deficit (-)	1,470	1,850	2,700	-570	-4,420	-9,290
Planned renewable resources:						
Hydro	-	-	-	-	-	-
Biomass/cogeneration	-	-	-	-	-	-
Wind	-	-	-	-	-	-
Solar	-	-	-	-	-	-
Total	-	-	-	-	-	-
Surplus or deficit (-)	1,470	1,850	2,700	-570	-4,420	-9,290
Planned thermal resources:						
Coal	-	-	-	70	70	70
Nuclear	-	-	2,420	6,620	6,620	6,620
Total	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	1,850	5,120	6,120	2,270	-2,600

APPENDIX IV

TABLE IV.2B

Intermediate Policy Set--Moderate-Demand Growth
(Year July-June Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	15,960	17,590	20,110	23,390	28,060
Energy reserve	390	390	410	470	560	710
Total requirements	15,550	16,350	18,000	20,580	23,950	28,770
Resources:						
Existing and licensed for construction:						
Hydro	12,940	13,020	13,090	13,060	13,060	13,060
Coal	2,920	3,620	4,860	4,200	3,720	3,670
Nuclear	1,040	1,420	2,610	2,610	2,610	2,610
Combustion turbine and miscellaneous	120	140	140	140	140	140
Total	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	1,850	2,700	-570	-4,420	-9,290
Planned energy conservation	-	1,270	2,330	3,320	4,480	6,210
Surplus or deficit (-)	1,470	3,120	5,030	2,750	60	-3,080
Planned renewable resources:						
Hydro	-	-	50	100	200	400
Biomass/cogeneration	-	-	50	100	200	300
Wind	-	-	-	-	30	80
Solar	-	-	30	80	150	300
Total	-	-	130	280	580	1,080
Surplus or deficit (-)	1,470	3,120	5,160	3,030	640	-2,000
Planned thermal resources:						
Coal	-	-	-	70	70	70
Nuclear	-	-	2,420	6,620	6,620	6,620
Total	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	3,120	7,580	9,720	7,330	4,690

APPENDIX IV

TABLE IV.2C

Renewable/Transition Policy Set--Moderate-Demand Growth
(Year July-June) Energy in Average Megawatts (Rounded to 10s)

	1977	1980	1985	1990	1995	2000
Load:						
Firm load	15,160	15,960	17,590	20,110	23,390	28,060
Energy reserve	390	390	410	470	560	710
Total requirements	15,550	16,350	18,000	20,580	23,950	28,770
Resources:						
Existing and licensed for construction:						
Hydro	12,940	13,020	13,090	13,060	13,060	13,060
Coal	2,920	3,620	4,860	4,200	3,720	3,670
Nuclear	1,040	1,420	2,610	2,610	2,610	2,610
Combustion turbine and miscellaneous	120	140	140	140	140	140
Total	17,020	18,200	20,700	20,010	19,530	19,480
Surplus or deficit (-)	1,470	1,850	2,700	-570	-4,420	-9,290
Planned energy conservation	-	2,100	3,600	5,390	6,840	9,350
Surplus or deficit (-)	1,470	3,950	6,300	4,820	2,420	60
Planned renewable resources:						
Hydro	-	-	200	400	700	1,100
Biomass/cogeneration	-	-	100	200	400	600
Wind	-	-	30	300	750	1,500
Solar	-	-	80	350	950	1,900
Total	-	-	410	1,250	2,800	5,100
Surplus or deficit (-)	1,470	3,950	6,710	6,070	5,220	5,160
Planned thermal resources:						
Coal	-	-	-	70	70	70
Nuclear	-	-	2,420	6,620	6,620	6,620
Total	-	-	2,420	6,690	6,690	6,690
Surplus or deficit (-)	1,470	3,950	9,130	12,760	11,910	11,850

APPENDIX IV

TABLE IV.3

Average Costs of Power Used and Conserved
High-Demand Growth

	1977	1980	1985	1990	1995	2000
	(in mills per kWh)					
Average cost of power, including conservation (mills/kWh of energy used and conserved):						
Thermal/traditional	12.5	14.3	19.9	23.9	27.1	29.8
Intermediate	12.5	13.1	16.0	18.8	20.8	22.0
Renewable/transition	12.5	13.1	15.7	16.6	17.8	18.7
Average grid cost--generation, transmission, and distribution (mills/kWh of energy used):						
Thermal/traditional	12.5	14.3	19.9	23.9	27.1	29.8
Intermediate	12.5	13.5	16.9	20.1	24.1	26.8
Renewable/transition	12.5	13.4	16.8	18.7	21.7	24.4

APPENDIX IV

TABLE IV.3A

Annual Power Costs
Thermal/Traditional Policy Set--High-Demand Growth

	1977	1980	1985	1990	1995	2000
	(millions of 1976 dollars)					
Resources used:						
Hydro	$ 204	$ 205	$ 206	$ 206	$ 206	$ 206
Coal	236	609	929	1,015	1,778	2,840
Nuclear	125	179	1,131	2,436	3,388	4,567
Combustion turbine and miscellaneous	-	229	80	80	80	80
Conservation	-	-	-	-	-	-
New hydro	-	-	-	-	-	-
Biomass/cogeneration	-	-	-	-	-	-
Wind	-	-	-	-	-	-
Solar	-	-	-	-	-	-
Total	565	1,222	2,346	3,737	5,452	7,693
Resources needed or available but unused:						
Coal	98	21	29	39	51	65
Nuclear	8	32	47	62	80	101
Combustion turbine and miscellaneous	31	-	-	-	-	-
Total (critical water year)	137	53	76	101	131	166
Transmission	159	196	296	380	541	701
Distribution	731	918	1,151	1,459	1,865	2,394
Total	890	1,114	1,447	1,839	2,406	3,095
Average hydro fuel savings	-67	-236	-181	-176	-185	-181
Total costs (average water year)	$ 1,525	$ 2,153	$ 3,688	$ 5,501	$ 7,804	10,773
Total firm load (MWy)	15,160	18,620	22,990	28,540	35,680	44,930
Transmission and distribution losses at 8 percent	1,213	1,490	1,839	2,282	2,854	3,594
Load delivered to customers	13,947	17,130	21,151	26,257	32,826	41,336
Average cost of power, including conservation (mills/kWh of energy used and conserved)	12.5	14.3	19.9	23.9	27.1	29.8
Average grid cost-generation, transmission, and distribution (mills/kWh of energy used)	12.5	14.3	19.3	23.9	27.1	29.8

APPENDIX IV

TABLE IV.3B

Annual Power Costs
Intermediate Policy Set--High-Demand Growth

	1977	1980	1985	1990	1995	2000
	(millions of 1976 dollars)					
Resources used:						
Hydro	$ 204	$ 205	$ 206	$ 206	$ 206	$ 206
Coal	236	472	768	808	924	1,528
Nuclear	125	173	479	1,434	2,462	3,164
Combustion turbine and miscellaneous	-	-	80	80	80	80
Conservation	-	104	263	339	403	468
New hydro	-	-	8	19	38	74
Biomass/congeneration	-	-	10	23	45	65
Wind	-	-	-	-	4	16
Solar	-	-	6	18	34	68
Total	565	954	1,820	2,927	4,196	5,669
Resources needed or available but unused:						
Coal	98	42	56	36	49	62
Nuclear	8	-	-	61	80	101
Combustion turbine and miscellaneous	31	33	-	-	-	-
Total (critical water year)	137	75	56	97	129	163
Transmission	159	180	263	300	365	507
Distribution	731	830	970	1,186	1,468	1,800
Total	890	1,010	1,233	1,486	1,833	2,307
Average hydro fuel savings	-67	-77	-147	-176	-185	-181
Total costs (average water year)	$1,525	$1,962	$2,962	$4,334	$5,973	$7,958
Total firm load (MWy)	15,160	18,620	22,990	28,540	35,680	44,930
Transmission and distribution losses at 8 percent	1,213	1,490	1,839	2,283	2,854	3,594
Load delivered to customers	13,947	17,130	21,151	26,257	32,826	41,336
Average cost of power including conservation (mills/kWh of energy used and energy conserved)	12.5	13.1	16.0	18.8	20.8	22.0
Average grid cost-generation, transmission, and distribution cost (mills/kWh of energy used)	12.5	13.5	16.9	20.1	24.1	26.8

APPENDIX IV

TABLE IV.3C

Annual Power Costs
Renewable Transition Policy Set--High Demand Growth

	1977	1980	1985	1990	1995	2000
	(millions of 1976 dollars)					
Resources used:						
Hydro	$ 204	$ 205	$ 206	$ 206	$ 206	$ 206
Coal	236	384	507	808	717	708
Nuclear	125	163	433	653	1,328	2,013
Combustion turbine and miscellaneous	-	-	-	80	80	80
Conservation	-	207	421	568	676	790
New hydro	-	-	38	74	128	202
Biomass/Cogeneration	-	-	23	45	88	132
Wind	-	-	4	58	147	292
Solar	-	-	18	84	230	460
Total	565	959	1,650	2,576	3,600	4,883
Resources needed or available but unused:						
Coal	98	96	167	36	46	57
Nuclear	8	-	32	57	78	99
Combustion turbine and miscellaneous	31	33	33	-	-	-
Total (critical water year)	137	129	232	93	124	156
Transmission	159	172	246	271	309	362
Distribution	731	786	876	1,060	1,276	1,552
Total	890	958	1,122	1,331	1,585	1,914
Average hydro fuel savings	-67	-77	-97	-176	-185	-181
Total costs (average water year)	$ 1,525	$ 1,969	$ 2,907	$ 3,824	$ 5,124	$ 6,772
Total firm load (MWy)	15,160	18,620	22,990	28,540	35,680	44,930
Transmission and distribution losses at 8 percent	1,213	1,490	1,839	2,[illegible]	2,854	3,594
Load delivered to customers	13,947	17,130	21,151	26,2[illegible]	32,826	41,336
Average cost of power, including conservation (mills/kWh of energy used and energy conserved)	12.5	13.1	15.7	16.6	17.8	18.7
Average grid cost-generation, transmission and distribution cost (mills/kWh of energy used)	12.5	13.4	16.8	18.7	21.7	24.4

APPENDIX IV

TABLE IV.4

Average Cost of Power Used and Conserved
Moderate-Demand Growth

	1977	1980	1985	1990	1995	2000
	(in mills per kWh)					
Average cost of power, including conservation (mills/kWh of energy used and conserved):						
Thermal/traditional	12.5	13.1	16.2	17.2	20.7	23.7
Intermediate	12.5	12.7	15.2	14.9	14.2	16.2
Renewable/transition	12.5	12.2	15.5	14.6	13.7	13.1
Average grid cost--generation, transmission, and distribution (mills/kWh of energy used):						
Thermal/traditional	12.5	13.1	16.2	17.2	20.7	23.7
Intermediate	12.5	13.2	16.3	16.2	15.9	19.0
Renewable/transition	12.5	12.5	16.5	15.9	15.3	15.6

APPENDIX IV

TABLE IV.4A

Annual Power Costs
Thermal/Traditional Policy Set--Moderate-Demand Growth

	1977	1980	1985	1990	1995	2000
	(millions of 1976 dollars)					
Resources used:						
Hydro	$ 204	$ 205	$ 206	$ 206	$ 206	$ 206
Coal	236	329	523	815	724	921
Nuclear	125	158	353	578	1,520	2,462
Combustion turbine and miscellaneous	-	-	-	80	80	80
Conservation	-	-	-	-	-	-
New hydro	-	-	-	-	-	-
Biomass/cogeneration	-	-	-	-	-	-
Wind	-	-	-	-	-	-
Solar	-	-	-	-	-	-
Total	565	692	1,082	1,679	2,530	3,669
Resources needed or available but unused:						
Coal	98	99	166	-	-	41
Nuclear	8	-	95	59	117	71
Combustion turbine and miscellaneous	31	33	33	-	-	-
Total (critical water year)	137	132	294	59	117	112
Transmission	159	168	185	255	289	352
Distribution	731	765	839	971	1,154	1,418
Total	890	933	1,024	1,226	1,443	1,770
Average hydro fuel savings	-67	-72	-108	-176	-185	-181
Total costs (average water year)	$ 1,525	$ 1,685	$ 2,292	$ 2,788	$ 3,905	$ 5,370
Total firm load (MWy)	15,160	15,960	17,590	20,110	23,390	28,060
Transmission and distribution losses at 8 percent	1,213	1,277	1,407	1,609	1,871	2,245
Load delivered to customers	13,947	14,683	16,183	18,501	21,519	25,815
Average cost of power, including conservation (mills/kWh of energy used and energy conserved)	12.5	13.1	16.2	17.2	20.7	23.7
Average grid cost--generation, transmission, and distribution cost (mills/kWh of energy used)	12.5	13.1	16.2	17.2	20.7	23.7

APPENDIX IV

TABLE IV.4B

Annual Power Costs
Intermediate Policy Set--Moderate-Demand Growth

	1977	1980	1985	1990	1995	2000
	(millions of 1976 dollars)					
Resources used:						
Hydro	$ 204	$ 205	$ 206	$ 206	$ 206	$ 206
Coal	236	186	237	393	571	689
Nuclear	125	45	160	286	462	893
Combustion turbine and miscellaneous	-	-	-	-	-	-
Conservation	-	67	149	218	263	326
New hydro	-	-	8	19	38	74
Biomass/cogeneration	-	-	10	23	45	65
Wind	-	-	-	-	4	16
Solar	-	-	6	18	34	68
Total	565	503	776	1,163	1,623	2,337
Resources needed or available but unused:						
Coal	98	226	334	215	59	-
Nuclear	8	96	248	148	8	152
Combustion turbine and miscellaneous	31	33	33	33	33	33
Total (critical water year)	137	355	615	396	100	185
Transmission	159	154	160	177	199	245
Distribution	731	691	704	781	897	1,052
Total	890	845	864	958	1,096	1,297
Average hydro fuel savings	-67	-71	-103	-104	-139	-147
Total costs (average water year)	$ 1,525	$ 1,632	$ 2,152	$ 2,413	$ 2,680	$ 3,672
Total firm load (MWy)	15,160	15,960	17,590	20,110	23,390	28,060
Transmission and distribution losses at 8 percent	1,213	1,277	1,407	1,609	1,871	2,245
Load delivered to customers	13,947	14,683	16,183	18,501	21,519	25,815
Average cost of power, including conservation (mills/kWh of energy used and energy conserved)	12.5	12.7	15.2	14.9	14.2	16.2
Average grid cost--generation, transmission, and distribution cost (mills/kWh of energy used)	12.5	13.2	16.3	16.2	15.9	19.0

APPENDIX IV

TABLE IV.4C

Annual Power Costs
Renewable/Transition Policy Set--Moderate-Demand Growth

	1977	1980	1985	1990	1995	2000
	(millions of 1976 dollars)					
Resources used:						
Hydro	$ 204	$ 205	$ 206	$ 206	$ 206	$ 206
Coal	236	52	105	191	374	527
Nuclear	125	45	73	138	310	440
Combustion turbine and miscellaneous	-	-	-	-	-	-
Conservation	-	175	331	486	539	606
New hydro	-	-	-	-	-	130
Biomass/cogeneration	-	-	-	-	-	-
Wind	-	-	-	-	-	-
Solar	-	-	-	-	-	-
Total	565	477	715	1,021	1,429	1,909
Resources needed or available but unused:						
Coal	98	287	412	327	169	60
Nuclear	8	28	319	266	128	25
Combustion turbine and miscellaneous	31	33	33	33	33	33
Total (critical water year)	137	348	764	626	330	118
Transmission	159	146	147	155	174	197
Distribution	731	642	638	661	759	877
Total	890	788	785	816	933	1,074
Average hydro fuel savings	-67	-42	-92	-92	-111	-147
Total costs (average water year)	$ 1,525	$ 1,571	$ 2,172	$ 2,371	$ 2,581	$ 2,954
Total firm loan (MWy)	15,160	15,960	17,590	20,110	23,390	28,060
Transmission and distribution losses at 8 percent	1,213	1,277	1,407	1,609	1,871	2,245
Load delivered to customers	13,947	14,683	16,183	18,501	21,519	25,815
Average cost of power, including conservation (mills/kWh of energy used and energy conserved)	12.5	12.2	15.5	14.6	13.7	13.1
Average grid cost--generation, transmission, and distribution cost (mills/kWh of energy used)	12.5	12.5	16.5	15.9	15.3	15.6

APPENDIX IV

TABLE IV.5

Total Fixed and Variable Costs
1977 Through 2000 (note a)

	High-demand growth (4.8%)			Moderate-demand growth (2.7%)		
	Thermal	Intermediate	Renewable	Thermal	Intermediate	Renewable
	(billions of 1976 dollars)					
Thermal generation:						
Coal	$ 29.5	$19.7	$15.7	$15.8	$12.9	$11.2
Nuclear	48.4	31.6	19.0	20.8	10.0	7.8
Combustion turbine	2.4	1.6	1.3	1.3	0.7	0.7
Total	80.3	52.9	36.1	37.9	23.7	19.8
Conservation	-	6.6	11.1	-	4.2	9.0
Renewable sources:						
Existing hydro	4.7	4.7	4.7	4.7	4.7	4.7
New renewables	-	1.6	7.4	-	1.6	0.3
Total	4.7	6.3	12.1	4.7	6.3	5.0
Transmission and distribution	42.0	33.9	30.1	28.0	22.6	19.8
Total costs (note a)	$127.0	$99.7	$89.4	$70.6	$56.8	$53.6

a/Total costs include capital costs, interest expense; fixed and variable operation and maintenance costs; and where appropriate, fuel costs. The totals exclude small credits (less than 5 percent) for the differences between critical water years and average water years.

APPENDIX IV

TABLE IV.6

Estimated Electric Power and Conservation Capital Requirements, 1977 Through 2000

	High-demand growth (4.8%)			Moderate-demand growth (2.7%)		
	Thermal	Intermediate	Renewable	Thermal	Intermediate	Renewable
	(billions of 1976 dollars)					
Thermal generation:						
Coal	$ 9.4	$ 4.5	$ 1.5	$ 2.1	$ 0.9	$0.9
Nuclear	26.3	18.2	11.5	13.9	5.6	1.9
Total thermal (note a)	35.7	22.7	13.0	16.0	6.5	2.8
Conservation	-	3.5	5.8	-	2.4	4.5
Renewable energy sources (note c)	0.1	1.4	7.3	0.1	1.5	b/1.0
Transmission and distribution	15.7	10.1	7.3	6.2	2.9	1.3
Total capital requirements	$51.5	$37.7	$33.4	$22.3	$13.3	$9.6

a/Includes trace amounts of capital for combustion turbines.

b/Conservation would be sufficient under this scenario that full investment in nonhydropower renewable resources would not be required.

c/Excludes present Federal and electric utility plans to invest about $3 billion in new hydro capacity for peaking and secondary energy production.

APPENDIX IV

ESTIMATED ELECTRICITY CONSERVATION SAVINGS

"Energy conservation savings" are defined in this study as a reduction in energy demand below that which would be projected on the basis of past tendencies and energy use patterns. Energy conservation savings can arise from several very diverse types of actions or measures. One very important category of conservation measures is investments in more energy efficient items of equipment or facilities. Examples that fall into this category are improved insulation in buildings, more efficient heating and air-conditioning equipment, and more efficient industrial process equipment. The second major type of energy conservation action is simply to curb the demand for energy by measures such as reducing the temperature setting in residences and commercial buildings or lowering the level of ventilation and lighting in commercial or public buildings.

There is an impressively long list of measures that might be employed to reduce energy consumption. A recent study for the Northwest Energy Policy Project identified and evaluated the potential for savings through 19 principal measures for reducing energy consumption. 1/ Some of these, such as improving the efficiency of operation of conventional fuel-burning heating systems, have no direct effect on electric energy consumption. Even so, in that study it was estimated that electricity consumption in the Pacific Northwest by the year 2000 could be reduced by 40 percent if all these conservation measures were fully implemented by all potential adopters.

Although it is true that all energy users can adopt the technically feasible conservation measures, in actuality many are not likely to do so because they lack, to some degree, the necessary inducement. The level of adoption that is actually realized will depend on the level of inducements or incentives and on the responsiveness of the adopters. These both will vary from measure to measure. Placing insulation in an uninsulated attic space is one measure to which homeowners tend to be fairly responsive, and the incentive for adopting this measure is very high. Thus one would expect that this is one measure that will be widely adopted without the necessity of particularly strong policy

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1/Walter R. Butcher and George W. Hinman, "Energy Conservation Policy--Opportunities and Associated Impacts, Study Module I-A," final report to the Northwest Energy Policy Project, Portland, Oregon, 1977.

measures. On the other hand, presently known systems to collect and reuse powerplant waste heat appear to be lacking in practicality for the heat user, and thus it is likely that there will be very little adoption of this measure unless there are very high inducements applied.

In the section that follows, there is a brief discussion of the conservation measures that were incorporated into the estimate of conservation savings associated with intermediate and renewable policy sets. The actual estimates of conservation savings, item by item, are presented in table V.1 and table V.2.

RESIDENTIAL SECTOR

In the residential sector, electricity consumption is attributed approximately one-fourth to space heating, one-fourth to water heating, and one-half to various electrical appliances and lights. Projections anticipate a more rapid growth in these other uses than in space heating. Thus it is important to look for conservation in home uses other than space heating, especially in the long run. Fortunately prospects are good for more efficient appliance models and more careful patterns of use. In addition, some of the projected great increase in appliance use of electricity (year 2000 rates per household are more than double those of 1975) may be avoided by simply curbing some of the implied increase in household appliances. We estimated that savings in the year 2000 under the intermediate policy set conditions would be 2,600 annual megawatt-years if moderate growth materialized and 4,100 annual megawatt-years if general growth were more rapid. Under the renewable policy set, savings in this category would be about 20 percent higher.

Energy savings in electric space heating may be obtained by lowering thermostats, adopting insulation and other weatherization measures, and by substituting heat pumps or solar devices to offset resistence heating requirements. The potential for savings is limited since indications are that many Pacific Northwest homes have already lowered thermostats and electrically heated homes are generally insulated, at least to some extent. The economics of heat pumps and solar substitutes is not highly favorable at this time, so adoption may be limited. Nevertheless, it is estimated that conservation savings amounting to about 18 percent of projected space heat demands under the intermediate policy set and 25 percent under the renewable policy set might be achieved by the year 2000. About two-thirds of this expected savings is attributable to building more energy efficiency into new residential construction and thereby reducing average electricity requirement per residence.

COMMERCIAL SECTOR

In the commercial sector electric space heating is not as widespread nor as great a consumer of electricity as in the residential sector. Conservation savings of electricity are mostly realizable in this sector through better control of ventilation and lighting and through appliance and equipment savings similar to those available for residences. Overall these measures could lead to significant savings of electric energy in this sector. But the more visible adjustments, such as turning off external lighting, have mostly symbolic importance. With moderate growth the sector savings could run to 1,200 annual megawatt-years in the year 2000 and about one-third higher if there were more rapid general growth.

INDUSTRIAL SECTOR

In the industrial sector the opportunities for energy conservation are as different as the widely different systems of energy use. Most industrial plants make use of heat and power in a variety of ways. Many of these operations are subject to efficiency improvements by cutting equipment operation to the necessary minimum, reducing heat loss from installations such as steam lines and furnaces, tightly scheduling and controlling heat delivery, etc. These measures are commonly referred to as energy housekeeping. Because almost every installation is a unique case, it is difficult to specify what could be done in general for the entire industrial sector. Surveys have indicated that the potential savings, in the long run, could probably be 15 percent to 20 percent of industrial energy use. But additional savings, beyond what has already been achieved since 1974, would be difficult to obtain without stronger incentives for the industries. We estimated that savings in electricity under the intermediate policy set would be 460 annual megawatt-years, or about 4 percent of total industrial electricity use projected for the year 2000. Under the renewable policy set, the conservation savings would be an estimated 16 percent larger in the moderate-growth case.

In addition to housekeeping measures, there is a possibility that certain sectors can save even more energy by making major process changes. That possibility is particularly important for the aluminum industry, which accounted for 37 percent of all industrial use of firm electrical energy in 1975 in the Pacific Northwest. A study by Charles Rivers Associates indicates that a savings of one-fourth in electrical energy use could be achieved by modernizing Pacific Northwest aluminum plants so that they equaled the most energy efficient of the new plants just now coming on line. Somewhat greater savings than these could be gained if the new "ALCOA" process were substituted (assuming that the process proved out in production) for the standard Hall process now used. In our conservation analysis, we assumed a pricing policy in the intermediate policy set that would induce all plants to modernize by about 1990 and to make no capacity expansion beyond that time. The savings would amount to 700 annual megawatt-years by 2000 compared with the moderate-growth forecast and 1,000 annual megawatt-years compared with the high-growth forecast. Under the renewable policy set with replacement cost pricing, the industry would respond more swiftly, seek even greater efficiency, and top out capacity expansion at a lower level. Savings by 2000 under the renewable policy set would be an estimated 1,270 annual megawatt-years for the moderate-growth forecast and 1,550 annual megawatt-years for the high-growth forecast.

The wood products industry is also a large user of electricity. Projections that are based on industry following past patterns of change and response to energy prices show very large increases in electricity used in the pulp and paper industry, even though output growth is expected to be slowed due to limitations on raw material supplies. Because of these diverging trends, electricity use per employee or per dollar of value added is projected to increase severalfold by 2000. We surmised that whatever process changes are leading to this digression could possibly be dampened, so that electricity use in the industry would grow no more rapidly than value added (the intermediate policy set) or employment (the renewable policy set). These patterns would yield much lower projected growth and a substantial "savings" under either growth projection.

TABLE V.1

Projected Conservation Savings--
Intermediate Policy Set
(annual average MW x 10^3)

Item	Moderate growth 1980	1985	1990	1995	2000	High growth 1980	1985	1990	1995	2000
Residential:										
Space heat (18-percent base rate)	.24	.31	.39	.41	.43	.40	.50	.61	.64	.66
Appliances (41-percent base rate)	.72	1.18	1.54	2.08	2.62	.77	1.40	1.97	2.94	4.05
Total residential	.96	1.49	1.93	2.49	3.05	1.17	1.90	2.58	3.58	4.71
Commercial	.18	.47	.70	.94	1.21	.22	.54	.77	1.14	1.59
Industrial:										
Aluminum (firm)	-	.23	.40	.52	.70	-	.50	.66	.81	.98
Pulp and paper	-	-	.05	.25	.79	-	.04	.42	1.06	2.32
Housekeeping	.13	.14	.24	.28	.46	.13	.15	.29	.38	.67
Total industrial	.13	.37	.69	1.05	1.95	.13	.69	1.37	2.25	3.97
Total savings	1.27	2.33	3.32	4.48	6.21	1.52	3.13	4.72	6.97	10.27

APPENDIX V

APPENDIX V

TABLE V.2

**Projected Conservation Savings--
Renewable Policy Set**
(annual average MW x 10^3)

Item	Moderate growth 1980	1985	1990	1995	2000	High growth 1980	1985	1990	1995	2000
Residential:										
Space heat	.40	.50	.61	.64	.66	.48	.57	.66	.78	.87
Appliances	.86	1.41	1.85	2.50	3.14	.92	1.68	2.36	3.53	4.86
Total residential	1.26	1.91	2.46	3.14	3.80	1.40	2.25	3.02	4.31	5.73
Commercial	.18	.47	.70	.94	1.21	.22	.54	.77	1.14	1.59
Industrial:										
Aluminum (firm)	-	.51	.97	1.09	1.27	-	.78	1.23	1.38	1.55
Pulp and paper	-	-	.05	.25	.79	-	.04	.42	1.06	2.32
Housekeeping	.66	.71	1.21	1.42	2.28	.67	1.06	1.45	2.40	3.35
Total industrial	.66	1.22	2.23	2.76	4.34	.67	1.88	3.10	4.84	7.22
Total savings	2.10	3.60	5.39	6.84	9.35	2.29	4.67	6.89	10.29	14.54

TABLE V.3

Potential Conservation Investments
Year 2000--Moderate Growth

Residential sector			Policy set: Intermediate		Policy set: Renewable	
			Percent adopt	Total cost (millions)	Percent adopt	Total cost (millions)
Item description and useful life (in years)						
Temperature reduction, time thermostat:						
Retrofit (15)	835,000 electric heat units	@ $80 each	5	$ 3.5	10	$ 7
New (15)	788,000 units	@ 50 "	10	4	20	8
Retrofit ceiling insulation:						
Uninsulated units (20)	84,000 "	@ 315 "	70	18.5	90	24
Partially insulated (30)	501,000 "	@ 160 "	25	20	90	72
Retrofit other:						
Walls (30)	334,000 "	@ 435 "	45	65	90	130
Floors (30)	334,000 "	@ 360 "	45	54	90	108
Windows and doors (15)	501,000 "	@ 670 "	45	151	90	302
Weatherstrip (5)	501,000 "	@ 180 "	45	41	90	81
New construction (40)		@ 400 "	65	205	95	300
Heating units (new residences) 1980-2000:						
Heat pumps (20)	788,000 new electric heat	@1,500 "	5	59	20	236
Solar system (20)	788,000 " " "	@5,100 "	.5	20	10	400
Passive solar (40)	788,000 " " "	@ 500 "	20	79	50	197
Appliances:						
Energy-efficient models (15)	3,755 households	@ 100 "	75	141	90	169
No-frills models (15)		@ -50 "				
Sector totals				$861		$2,034

APPENDIX V

Commercial sector		Policy set			
		Intermediate		Renewable	
		Percent adopt	Total cost (millions)	Percent adopt	Total cost (millions)
Item description and useful life (in years)					
Temperature control					
Ventilation and light					
Retrofit (20) 10.55 x 10 kWh @ $0.08/kWh		10	$ 84	15	$ 126
New construction					
Total energy systems (20)		5	100	10	200
Sector totals			184		326
Industrial sector					
Aluminum (20)	1.5-million-ton capacity @ $1,700/ton	50	1,303	75	1,955
Pulp and paper	No added capital (note a)				
Housekeeping (15)	20 percent 100 x 10^9 kWh @ $0.0425/kWh saved	7	60	20	170
Sector totals			1,363		2,125
Total, all sectors			$2,408		$4,485

a/Energy conservation investments are projected to be a natural part of the pulp and paper industry's growth process during the period of our policy sets. No special conservation investments are considered necessary to achieve energy savings.

APPENDIX V

REGIONAL ECONOMY AND EMPLOYMENT

Regional energy policy could impact on regional economic growth and employment in several ways.

--Directed allocations with forced curtailment of energy use could retard growth or even force contractions.

--Increased charges for energy and outlays for conservation could raise costs and could decrease the industry's ability to compete with firms in other locations or with other products vying for the consumer's dollar.

--Reduction in the quality of service (increased probability of temporary outages) could reduce production (output, income, employment) in the short run. In the long run the effect could be mostly to increase the cost of production as industry adjusted through higher capacity, standby energy supplies, etc.

--Increased costs of energy could require consumers to divert expenditures from commercial/industrial products.

--Changes could occur in output and employment of the energy industries and of suppliers of substitutes.

THERMAL/TRADITIONAL POLICY SET

1. Direct allocations: These would be charged only to BPA's direct service customers. Contracts are available at average cost rates, which although higher than past rates, are still advantageous to those industries in the region. BPA's projections of power demand anticipate that sales to aluminum companies will increase by 1980 to 30 percent above the 1974 level. About one-half of that increase is due to projected sales to a new aluminum plant. After 1980, the projections call for further increasing power sales to direct service customers by about 1 percent per year. By the year 2000 this would yield an additional increase in power sales of about 30 percent over the 1980 level. Aluminum industry output would probably grow by about 50 percent during the 1980-2000 period due in part to increases in efficiency.

2. Higher rates: Inevitably factoring in high-cost thermal power would cause industrial rates to grow substantially. The average rate for industry in 2000 is projected to be 1.3 cents/kilowatt-hour for the intermediate policy set, which is nearly 190 percent above the average 1976 rate of 0.45 cents/kilowatt-hour. Even so, electricity costs would still be a very small fraction of total costs for all except the electroprocess industries, where they would rise to nearly 25 percent of total production costs. Regional power rates under this policy set would still be well below rates charged industrial and commercial customers in any other region. Therefore, there would be no incentive for industries to relocate.

3. Quality of service: The thermal/traditional policy set anticipates maintaining an adequate reserve margin to assure conventional levels of reliability. The cost of reserve margins would be included in the cost of power.

4. Consumer retrenchment: The total residential electric bill, assuming high growth, would increase in 1976 dollars from $500 million in 1974 to $3,000 million in 2000. However, population growth alone would increase it to $810 million. Household increases (by factor of 2.1) would increase the residential electric bill to $1,050 million. The average residential electric bill would grow from $220/year in 1974 to $625/year in 2000 due to higher prices and increased usage. The increase would be partly offset (about $100) by reduced oil bills due to substitution of electric space heat. The remaining increase would be small relative to projected increases in income from about $4,000/capita in 1974 to $9,000/capita in 2000 ($12,000/household to $22,500/household). Such a relatively small increase in expense of one item would be widely dispersed among many other consumption items and would generally be overwhelmed by the projected income increases.

5. Energy supply industries: There would be substantial growth in the electrical industry. Construction of thermal plants and transmission facilities would require approximately $2 billion investment per year and employ many construction workers. Operations and maintenance would require additional effort and expenditure.

INTERMEDIATE POLICY SET

1. Direct allocations: These would not be employed, except that explicit requirements would be employed to induce the aluminum industry to improve its energy efficiency to the best attainable by Hall process in 1976. Indications

are that the industry could be induced to do this, if required, without chasing capacity to other regions.

2. Lower rates: Since demand would be reduced through conservation, the requirement for high-cost thermal power would be much less and average costs that must be recovered in rates would be considerably less than under the thermal/traditional policy set. However, rate schedules could be raised so that effective rates more nearly approached thermal levels; any surplus would be used to finance conservation or give "hardship" rebates. Conservation costs would generally run well below energy costs when calculated on a longrun social cost basis. Total costs to industry and commerce would be well below thermal/traditional policy set levels. This should provide some stimulation to economic growth.

3. Quality of service: There would be no perceptible difference from the thermal/traditional policy set.

4. Costs to customers: This would be even less of a factor than under the thermal policy set due to less demand growth and possibility of covering costs with lower (more hydro determined) rates.

5. Energy supply industries: There would be less growth than under the thermal/traditional policy set, which would be reflected in reduced costs to businesses and households.

RENEWABLE/TRANSITION POLICY SET

1. Direct allocations: Mandatory cutbacks would not be used in any situation. Conservation measures may be required, but energy would be available at whatever demand level resulted. Pricing energy at replacement cost would eliminate that need for allocations to direct service industrial customers.

2. Higher rates to industry: Pricing at replacement cost would mean substantially higher rates, especially to industry and most especially to direct service industrial customers and irrigators. Most industry could absorb the increase without feeling any significant pressure on total costs or competitive position. Exceptions would be the electroprocess metals and chemicals, mainly aluminum and phosphorus. The aluminum industry would probably reduce regional production somewhat rather than continue to expand. Efficiency would also be improved. Employment in aluminum would be down slightly from present levels. The phosphorus industry would also be affected but might respond with more process changes.

3. Quality of service: A high fraction of unconventional energy sources under heavy reliance on unproven price response and conservation could lead to reduction in the reliability of service under this policy set.

4. Costs to consumers: These costs would be minimized by aggressive emphasis of conservation as a means of meeting new power needs. Bills, however, would be much higher due to use of an energy surcharge to implement replacement cost pricing and to finance a grant and loan fund for conservation programs and renewable energy projects.

5. Energy supply industries: Growth would be slowed and resources would be redirected to investment opportunities in energy conservation and renewable energy sources. Investment strategies for decentralized energy projects would be developed.

ENVIRONMENTAL QUALITY AND THE ELECTRICITY SUPPLY SYSTEM

The generation of electricity in the Pacific Northwest will produce side effects which are damaging, or at least offensive, to many people. The specific effects experienced will depend on the types of powerplants being used. These effects will range from the direct and obvious, such as lung irritation produced by air pollutants, to the indirect and subtle, such as the exercise of police power to prevent theft of nuclear materials. A summary of the types of environmental impacts associated with the major energy sources is presented below.

HYDROELECTRIC GENERATION

--recreational benefits and problems

--esthetic effects

--fish and wildlife changes

The adverse environmental impacts of new hydroelectric power will generally be related to the welfare of fish and wildlife, the loss of the use of land that will be inundated, the loss of free-flowing streams, and other esthetic changes and recreational problems. New energy capability that comes about as a result of installing more generators in existing dams can be expected to be, on the average, less disruptive than energy produced by raising existing dams or by constructing new dams. Past experience indicates that residents in the Northwest place a high value on the preservation of natural conditions in the vicinities of most of the undammed sections of streams and rivers in the region. Furthermore, the benefits of further dam construction to navigation, irrigation, and flood control seem minimal. Therefore, in most cases the environmental impacts of raising existing dams or building new dams on flowing streams will be negative, but the addition of generating capacity at existing dams may or may not be, depending on circumstances.

COAL FUEL CYCLE

--air pollution effects of powerplants and coal transport

--land disruption from mining and solid waste disposal

--occupational hazards of deep mining

--water pollution from mine drainage, coal and ash piles, and settling ponds

--acid rain damage

--possible global heating from combustion and added carbon dioxide in the atmosphere

Coal-fired plants will add particulates (sulfur dioxide, nitrogen oxides, and hydrocarbons) to the air in their vicinity, and the plumes can be expected to produce effects on health, esthetics, and property. Some appreciation for the seriousness of the impacts can be achieved by comparing coal plant air emissions with emissions resulting from the end uses (home heating, automobile operation, etc.) of fuels in the region. The thermal/traditional policy set moderate-growth conditions were assumed for purposes of calculating the table entries. The average megawatts of coal-fired generation were assumed to be 1,170 megawatts in 1980, 2,290 megawatts in 1990, and 4,400 megawatts in 2000.

	Air emissions (thousands tons/yr.)		
Pacific Northwest	1980	1990	2000
Particulates:			
End uses (note a)	140	240	370
Coal plants (note b)	4.8	9.4	18
Sulfur dioxide:			
End uses (note a)	160	260	450
Coal plants (note b)			
(with BACT) (note c)	24	46	89
(with NSPS) (note d)	170	320	630
Nitrogen oxides:			
End uses (note a)	345	370	515
Coal plants (note b)	43	84	160

a/Emissions take place wherever fuels are burned, thus largely in urban areas.

b/Emissions take place at coal plants.

c/BACT is Best Available Control Technology, 90 percent removal of sulfur dioxide from 0.7 percent sulfur contact assumed.

d/NSPS is New Source Performance Standard, 1.2 of sulfur dioxide emitted per million Btus of fuel burned.

These numbers show that the coal plant emissions range from 4 percent to 30 percent of the end use values. In terms of effects, the percentages would be much smaller, probably ranging from 0.2 percent to 1.5 percent, because of the remote locations of the coal plants and the great heights above ground level at which their pollutants were emitted. Some additional air pollution, primarily particulates, would result from rail transport of coal to the Boardman, Oregon, plant. An important factor in controlling air pollution from coal plants is the use of best available control technology, assumed in these estimates.

The preceding paragraph has provided some indication of the relative magnitudes of impacts of air pollutants from end uses of fuels and from coal-fired powerplants. Other measures of relative magnitudes are the concentrations of pollutants normally found at ground level. The table below shows annual average concentration of particulates and sulfur dioxide at several points in the region along with approximate values to be expected from a coal-fired powerplant.

Location	Time	Total suspended particulates (micrograms/cubic meter)	Sulfur dioxide
Boise, Idaho	1/62-12/62		13
	1/57-12/72	92	
Moscow, Idaho	1/72-12/72	108	
Kellogg, Idaho	1970-72	100-130	
	1975		160-180
Downtown Seattle, Wash.	1971-75	40-60	
	1975		12-30
Tolt River Watershed (near Joy, Wash.)	1970-75	10-20	
Downtown Portland, Oreg.	1970-73	65-100	
	1972-73		15-30
Downtown St. Helens, Oreg.	1972-75	25-40	
500 MW coal-fired powerplant located in flat country with scrubbers and electrostatic precipitators, burning low-sulfur coal and using Best Available Control Technology		a/0.1-0.5	a/0.2-1.0
500 MW coal-fired powerplant as above, except using New Source Performance Standards		a/0.1-0.5	a/1.4-7.0

a/Maximum concentration, generally occurring about 5 miles from plant.

The numbers indicate that the annual average concentrations of particulates and sulfur dioxide produced by a coal-fired powerplant in its vicinity are small compared with levels in typical locations in the Northwest. However, it should be noted that the maximum short-term concentrations from a powerplant will be higher than the annual average values, and furthermore the size distribution and composition of the coal plant particulates may lead to greater damage per ton emitted than is the case for other particulates, such as wind-raised dirt. Also the sulfur dioxide concentrations in rural areas away from industrial and automobile sources will be lower than the values in the tables, probably in the range 1-3 micrograms per cubic meter.

Land disturbances associated with the coal plants come about as a result of coal mining and solid waste disposal. Except for the Centralia, Washington, plant the coal mining will take place outside the Pacific Northwest, but solid waste disposal (ashes and chemicals) will presumably be inside the region. Restoration of strip-mined lands is a somewhat uncertain matter but appears to be feasible in much of the area in the Rocky Mountain States. A closely related effect is the interruption of aquifers during mining. The changes in ground water quality and availabilty can be serious depending on local circumstances.

NUCLEAR FUEL CYCLE

--possible terrorism and extortion following theft of nuclear materials

--possible widespread contamination from leaking radioactive waste storage

--possible contamination from reactor accidents and sabotage

--routine exposure of workers and the public to radiation

--expansion of number of nations with nuclear weapons (nuclear proliferation)

The principal environmental effects of nuclear power arise from uncertainty about the ability of government regulatory agencies and the nuclear industry to prevent catastrophic consequences of malfunctions and misapplications of the technology. A derivative concern is that covert investigations, invasions of privacy, and massive exercise of police power in an emergency may be necessary to prevent the diversion of nuclear weapons grade material in a nuclear economy employing spent fuel processing and plutonium separation. There will also be some effects on health that arise from routine plant operation, but they will be small.

The determination of nuclear environmental effects is an exercise in evaluating the significance of catastrophies of low probability. Events leading to enormous disasters can be conceived, but the likelihood of their occurrence is estimated by most (but not all) analysts to be infinitesimally small. The average effect can be found by multiplying the "infinite" effect by the "zero" probability of occurrence, a very uncertain business. However, the average is not the quantity that establishes most people's reactions to nuclear side effects. One faction focuses on the major consequences of a reactor core meltdown, nuclear blackmail of a major city, or contamination of a regional water supply by a leaking radioactive waste disposal site. The opposite faction emphasizes redundant safety features, elaborate security measures, and stable geologic formations. The first side fears the complex nuclear technology and mistrusts the Government security that surrounds it. The second side sees few problems with either.

In view of this broad range of uncertainty, the impact of nuclear power in the policy sets is simply described in terms of the level of potential effects as it is determined by the number of nuclear reactors in the region. In a somewhat arbitrary way, a qualitative distinction is made between having fewer than 5 nuclear reactors, 5 to 20, or more than 20 in the Pacific Northwest. Fewer than five are regarded as manageable on an individual basis. If there were from 5 to 20, all the risks and hazards of nuclear power would be present to a significant degree and must be dealt with on a regional as well as an individual basis. In this range the problems would be much the same regardless of number of plants. If there were beyond 20 plants, the actual and potential impacts would again rise as the technology spread.

BIOMASS AND COGENERATION

Biomass and cogeneration contribute residuals characteristic of wood fuels. In the table below, tons of residuals produced in this way are compared to end use residuals for the intermediate policy set under moderate-growth conditions.

Source (Pacific Northwest)	Air emissions (10^3 tons/year) 1980	1990	2000
Particulates:			
End use	140	240	370
Wood plants	-	1.1	3.5
Sulfur dioxide:			
End use	160	260	450
Wood plants	-	.4	1.2
Nitrogen oxides:			
End use	345	370	515
Wood plants	-	6.8	20
Hydrocarbons:			
End use	325	305	381
Wood plants	-	1.4	4

The schedule shows that wood wastes generate air residuals in amounts up to 4 percent of those produced by end-use applications in the region. The effects of the wood plant emissions will, however, probably not be over 0.5 percent of the end-use effects because of the remote locations of the plants and the height above ground of the emissions.

SOLAR AND WIND ENERGY

--land use

--visual impacts

--electromagnetic disturbances

The principal impacts of solar and wind units appear to be commitments of land. Land occupied by central station solar power is 1-2 square miles per 100 megawatts. For wind the commitment is 0.4-.8 square miles per 100 megawatts. Using these numbers we computed the land area committed to these renewables in the renewable/transition policy set under moderate growth as follows:

Resource (Pacific Northwest)	Land commitment (square miles) 1980	1990	2000
Solar	-	1	4-8
Wind	-	0.7-1.5	4-8

These are larger land commitments than are required by thermal plants but are rather comparable to the land commitments involved in transmitting the power from the generating stations to the power markets.

The visual impact of these units is uncertain, but it might be quite different from the visual impact of thermal powerplants because the technologies involved represent a very different approach to energy supply. The disruption of television service in the vicinity of large wind turbines would be very objectionable to many nearby residents. However, the effect would be local and should be correctable through use of cable reception.

The impacts described here are limited to those associated with central station powerplants; distributed (i.e., decentralized) systems are not included because the acquisition of such units is voluntary to the user and the impacts appear to be small and widely dispersed.

The severity of the impacts for each policy set is summarized in the table below. A distinction is made between local impacts (subscript L) near the plant, regional impacts (R) extending over the Northwest, and global impacts (G).

TABLE VII.1

Summary of Environmental Impacts

Technology and impacts	Degree and location of impacts for each policy set and demand level: Thermal Moderate	Thermal High	Intermediate Moderate	Intermediate High	Renewable Moderate	Renewable High
Coal-fired powerplants:						
Air pollution	M L	M L	L L	M L	L L	M L
Land disruption	M L	M L	L L	M L	L L	M L
Ecosystem threats	L L	U R	L L	U R	L L	L L
Water pollution	L R	L R	L R	L R	L R	L R
Occupational hazards	M L	M L	M L	M L	M L	M L
Heat balance	U G	U G	U G	U G	L G	U G
Esthetic	M L	M L	L L	M L	L L	M L
Land use	L L	L L	L L	L L	L L	L L
Nuclear powerplants:						
Routine radiation exposure	L L	L L	L L	L L	L L	L L
Radiation exposure of workers	L L	L L	L L	L L	L L	L L
Accidents--primarily reactor	U L	U L	L L	U L	L L	U L
Sabotage--primarily reactor	M L	M L	M L	M L	L L	M L
Diversion impacts:						
Terrorism	U G	U G	U G	U G	U G	U G
Extortion	U G	U G	U G	U G	U G	U G
Repressive and obtrusive police power	U G	U G	U G	U G	U G	U G
Waste disposal problems	U R	U R	U R	U R	L R	U R
Land use	L L	L L	L L	L L	L L	L L

Technology and impacts	Thermal: Moderate	Thermal: High	Intermediate: Moderate	Intermediate: High	Renewable: Moderate	Renewable: High
	Degree and location of impacts for each policy set and demand level					
Hydroelectric (operations and extensions):						
Loss of fish and wildlife	M_R	M_R	M_R	M_R	M_R	M_R
Esthetic	M_R	M_R	M_R	M_R	M_R	M_R
Recreation	M_R	M_R	M_R	M_R	M_R	M_R
Solar:						
Land use	L_L	L_L	L_L	L_L	L_L	L_L
Visual impact	L_L	L_L	L_L	L_L	L_L	L_L
Wind:						
Land use	L_L	L_L	L_L	L_L	L_L	L_L
Visual impact	L_L	L_L	L_L	M_L	M_L	M_L
Electromagnetic	L_L	L_L	L_L	M_L	M_L	M_L
Transmission lines:						
Esthetic	M_R	M_R	M_R	M_R	M_R	M_R
Land use	L_R	L_R	L_R	L_R	L_R	L_R

Degrees of adverse impact

H--High adverse impact; objectionable to most people.
M--Medium adverse impact; objectionable to some people.
L--Low adverse impact; objectionable to a few people.
U--Uncertain but possibly damaging impact; of concern to many people.
V--Uncertain but possible damaging impact; of concern to only a few people.

Subscripts

L--Refers to local area around plant.
R--Refers to regional impacts extending beyond local area.
G--Refers to global impacts.

EQUITY CONSIDERATIONS

The terms "equity" and "fairness" are not sufficiently precise to be operational as measures by which alternative energy polices can be judged. More specific aspects of equity that can be considered are:

--Individuals' share of costs ought to be equal to the costs caused by their actions (i.e., no free riders, no windfalls or profiteers).

--The burden and/or sacrifice associated with expanding alternative energy supplies or achieving conservation ought to be levied on energy users in proportion to their opportunity for recouping their costs through subsequent energy savings and on their ability to bear the initial cost without undue hardship.

--Poor people, lagging regions, and struggling industries ought to be protected, insofar as possible, from any increases in their costs.

THERMAL/TRADITIONAL

Charges equaling costs: Mediocre. Costs of expanding the conventional system would be spread over all users rather than paid by the specific users that required the expanded output. However, the shifting would be "close"--partly just among units by a given customer.

Charge the most able: Mediocre. Rates conventionally would be set on the basis of willingness to pay, with a strong tendency to give lowest rates to customers with greatest opportunity to institute conservation or switch to nonelectric energy sources.

Spare the poor and needy: Mediocre. No special provisions would be made to protect the needy from continuing rate increases.

INTERMEDIATE

Charges equaling costs: Mediocre. Costs of expanding the conventional system would be spread over all users. Some conservation costs would be subsidized by tax funds, but benefits (energy savings) would be realized by the users.

Charge the most able: Good to mediocre. Universal availability of subsidy and low-interest loans would mean that even those who benefited greatly would get public assistance on the conservation programs.

Spare the needy: Good. Conservation programs which included financial and other assistance would help the needy take advantage of opportunities for investments that would yield good payback in the form of reduced energy bills. Special provisions (larger refunds, free services, etc.) could be easily included to further assist needy individuals, areas, and industries.

RENEWABLE/TRANSITION

Charges equaling costs: Good. Pricing at replacement cost with possibility of low rates on initial residential block and indirect return of "hydro dividend" would give excellent charge-to-cost matchup. However, for industry the connection would not be as good.

Charge the most able: Good. Mandatory features would require those who could benefit to adopt the measure at their own expense. Incentives would be necessary. They might be reserved only for the most needy of the customers or those that had least opportunity to recoup losses.

Spare the needy: Good to excellent. Low front-end rates would help the poor as would the disbursement of excess revenues used to subsidize energy conservation, provide tax rebates, etc.

RISK AND IMPACT OF SHORTFALL OR SURPLUS CAPACITY

VISUALIZING AN ELECTRICAL ENERGY SHORTFALL

This section concerns itself with an energy shortfall ranging from several days to 2 or 3 years. We are not concerned specifically with short-term forced outages in which service would be restored within a matter of hours, or at most a few days. The reason is that the economic employment and perhaps environmental impact of the short-term forced outage is not severe. Our concern is specifically with the differences in risk and impact of shortfall or idle capacity due to the policy set differences that we have defined. For each of the three policy sets under examination in this study, the conventional utility grid reliability criteria of 1 day's outage in 10 years, or 1 day's outage in 20 years, was adopted and applies equally to each of the three policy sets. Thus there is no difference between them.

Strictly speaking, an energy shortfall would be impossible, because the electricity generated either would be consumed or would appear as losses somewhere through the grid or distribution system. We used the somewhat broader definition of "shortfall" as meaning a negative difference between the generation and the demand that would occur given no constraints other than economic ones.

In the minds of many people, shortfall conjures up an image like the New York blackout. This is clearly unrealistic. There would be warning for most types of shortfall as we have defined it, and measures could be taken. In fact, an entire series of graduated responses would be undertaken as the potential shortfall developed. This sequence is indicated by the tabulation of assessment criteria shown in table IX.1.

The first sign of difficulty would occur when construction or installation of generating facilities or conservation improvements began to fall behind schedule. This could occur because of serious cost overruns; scarcities of skilled workers or capital; inadequate public support, which would show up in the form of increased opposition in siting hearings; or in work interruptions through peaceful site demonstrations. Inadequate public support could also show up in the form of failure to enact necessary legislative and executive programs to implement conservation. Other factors would include an inadequate research; development; and, particularly, demonstration program in government and industry, such that the expected technological and economic improvements did not occur far enough ahead of time for plant construction.

The next phase where an impending shortfall would manifest itself would be in the below-design performance levels of new supply technologies or conservation improvements. Three different facets of this type of low performance are indicated in table IX.1 under "early warning capability." The first would be the existence of a plant which systematically performed well below others of the same class. The second would be development of a sudden failure, such as a generic design failure, which appeared in a number of plants of the same type and which would require the redesign and repair of a given class of plants. Finally, there would be the possibility of a performance degradation with the age of the plant as, for example, in the later years of operation of a nuclear plant. Maintenance difficulties might rise drastically as the plant itself became more irradiated and the time for routine maintenance became correspondingly larger due to the limited dosage that maintenance personnel could absorb in a given period of time. The corresponding possibility in the case of conservation would be deterioration, perhaps from moisture, of insulation in the structure of commercial and residential buildings.

It should be noted that with concentrations, in terms of either very few technologies or very few plants, the system becomes more vulnerable to performance degradations and thus jeopardizes the regional supply due to the greater possibility of unavoidable shortfall. In energy networks, as in all other systems, stability and diversity are correlated. The popular expression is "don't put all of your eggs in one basket."

On the demand side, shortfall can evolve due to an economic boom. In an economic boom, demand for the region's output is suddenly increased over the long-term trend level, thus causing need for additional energy, and it is in the crest of the economic wave that shortfall is most likely to occur. This will be discussed in more detail later.

This all raises the question of what would occur in real life given a developing shortfall situation.

For an immediate crisis which would occur when one or more large generators suddenly failed or were required to be derated or shut down, a very rapid, although temporary, response could be obtained through voluntary belt tightening. If the public perceived that a crisis was real and immediate, they would respond, as they always have, and a 10- to 20-percent reduction in energy consumption could be achieved virtually overnight. The key is that the crisis must be uniformly perceived and it must be real. This sort of a 10- to 20-percent buffer would not last for long. For example, the 55-mile-an-hour speed limit was almost uniformly adhered to at the time of the gas shortage following the oil embargo imposed in 1973 by the Organization of Petroleum Exporting Countries. As the crisis was resolved, things returned to normal and driving speeds moved upward again to the level that they had been previously. This may be deplorable, but it is human nature. At least we can take comfort in the fact that we have a reserve which can be tapped for a short time in the event of an immediate crisis.

Belt tightening, however, is a temporary measure with temporary results. For a shortfall situation of more than a few months, more permanent measures would be required. A sequence of fallback positions actually exists, and although the sequence would vary from region to region, it would go something like this: First, surplus power would be sought from all standby generators within the region and probably from secondary markets outside the region. If the shortage were due to an economic boom, there would not be surplus electricity available for sale inside or outside the region, but if it were due to local factors, then help could be received from outside the region.

Voluntary cutbacks would be asked for by the existing political leadership, but it would probably try to achieve cutbacks of a more permanent nature rather than those mentioned above. If the crisis began to develop and deepen, the next fallback position would be a crash investment program in conservation. Conservation measures would be taken with State or Federal Governments, or both, meeting most of the costs in order to start conservation projects rapidly and on a widespread basis.

The next step, perhaps simultaneous with the last, would be conversion, perhaps temporarily, to other energy forms or sources. Some conversions are relatively capital free, and these would presumably be made.

The next step would be to impose penalties on those customers who did not cut back. This was done, for instance, in Los Angeles and was highly successful. Significant cutbacks were achieved very, very quickly with the threat of a fine, and in fact, very few fines had to be levied. In this case, each customer would be given some schedule, perhaps based on the size of the operation of the structure, perhaps based on a percentage cutback, or maybe a combination of each. Under any circumstances, the fine would be levied, probably a very severe one if customers did not stay within their energy budgets.

The next fallback position would be the cutoff of nonessential uses altogether. Such things as outdoor advertising could be eliminated altogether for 1 or 2 years without significant economic damage to the region. Other measures would be explored, of course. If these actions were agreed on in advance, the response in time of emergency could be quick and without rancor.

The final step, of course, would be cutting off customers for several hours per day. This could be achieved by installing interruptible service such that during the peak hours of the day, a hard limit would be imposed. It could be done with a utility-controlled switching device outside the structure in such a way that a positive control would be achieved. If necessary, this control would be used to implement a rolling blackout. Such a blackout would be well publicized in advance so that customers would know which days they would not have electricity. Presumably this would be done in the industrial/commercial and commercial sectors first, because a total cutoff of electricity--even for a day--could be serious in the residential sector.

Needless to say, critical services would be provided for at all times. Such things as hospitals, essential public services, and the like would be provided for, although each would have a standby generator for handling the load during peak periods when the system generating capacity would be inadequate.

The purpose of this description of the sequence of fallback positions is to show that a graduated response is available even for a greatly protracted energy shortfall situation. Regardless of the policy set under examination, the graduated response would necessarily focus on the demand side. A vast array of energy efficiency improvements are available which are never treated in the analysis of "normal" conservation programs, because they seem a little too novel or because they would require some unusual attention on the part of the homeowner or the business or factory owner to make them effective. These measures, of course, in time of emergency would quickly be pressed into service and could in fact become part of the permanent operation without disruption. Night window shutters for commercial and residential buildings are a good example. These could be quickly fabricated and installed and are quite effective. They would result in saving much more energy than a complete storm window installation throughout the region, at much less cost. They would enable windows on the east, south, and west to be used judiciously during the day for their solar gain but closed in order to prevent heat loss during dark days and the night hours. The only behavioral change required would be a few minutes added to the daily routine in the morning and evening.

The timing of an energy shortfall was mentioned previously. A shortfall situation is most likely to occur during the crest of an economic boom. The effect of such a shortfall, provided it was not too severe, would be merely to clip the crest of the boom and in terms of employment would probably result in preventing unemployment from ever dropping below 3 to 4 percent, unless the boom persisted for several years.

The severity and duration of the shortfall and hence the significance of the negative impact would be a function of the rate at which the problem developed, the existence of adequate warning signals, and the timeliness of preventive or corrective measures.

SHORTFALL RISK ASSESSMENT

This section contains an item-by-item evaluation of each of the policy sets against the criteria for assessment of comparative risk of shortfall. (Surplus capacity will be discussed in a subsequent section utilizing the same assessment criteria.)

This discussion will focus on table IX.1. The ratings against each criteria follow the format of L, M, and H for low, medium, and high risk. Each criterion is construed in such a way that H in all cases means the greatest vulnerability to shortfall risk; L means the safest or the least vulnerable to shortfall. All ratings are on a comparative scale between policy sets. No attempt is made to establish an absolute rating system. Similarly no attempt is made to weigh the different criteria in order to allow a single number index to be derived for each policy set for an absolute comparison.

In table IX.1, which summarizes these risks, each policy set is evaluated for each of the two basic growth assumptions: moderate growth, which corresponds to the NEPP moderate growth projection, and high growth, which corresponds to the PNUCC forecast. Each criterion will first be discussed and then the evaluation ranking explained.

Ability to meet construction schedule

A serious cost overrun could result in delay or truncation of the construction schedule, thus increasing the risk of shortfall. The risk for the traditional policy set was assessed at medium due to the high reliance on new thermal generating capacity, which has shown a consistent cost escalation through the years without any sign of slowing. This could result in attempts at cost cutting which would reduce the reliability and performance of plants critical to the traditional policy set. The renewable/transition policy set, on the other hand, would rely chiefly on conservation with a minor reliance for new capacity toward the end of the century from renewable technologies. There is an uncertainty in the ultimate cost of conservation improvements because it has been less studied, so it was assigned a medium ranking. For the high-growth case, where the renewable technologies would be required in some intensity toward the end of the century, the vast uncertainty with respect to the cost of power from these new technologies caused a high ranking. The intermediate policy set would take the most cost effective conservation in a somewhat milder degree than the renewable policy set and thus would have the best of both worlds. It would require less addition of thermal plants and therefore is less vulnerable to serious cost overruns, hence the low ranking in terms of shortfall risk.

Under the criterion of scarcity of skilled workers, the high-growth assumption under the traditional policy set would have the highest vulnerability since it would require large numbers of the superskilled workers. Conservation requires the least skilled workers and therefore would be least vulnerable, hence the low-risk rating for the moderate-growth case of the intermediate and the renewable/transition policy sets. The intermediate policy set, given the high-growth assumption relies significantly on thermal plant construction and therefore got a medium rating, the same as for the traditional moderate growth and for the renewable/transition high-growth case. In the latter case some skilled labor would be required for the renewable technologies, a greater skill level than that required for conservation.

Scarcity of capital could also lead to shortfalls. The traditional policy set would require the most capital since it would have the highest reliance on thermal energy. The renewable/transition policy set would require the least because it would have the most emphasis on conservation, which is purchased whenever it is more cost effective. This assumes that the renewable/transition policy set would not employ conservation indiscriminately if it meant burdening the region with a large surplus capacity. It is realistic to suppose that conservation programs would be slowed until it was clear that the generating plants already under construction would not be made to stand idle by conservation.

Public support would be critical to both the traditional and the renewable/transition policy sets but for different reasons. Public support, which the power industry has been trying very hard to win, would be critical to the thermal construction program of the traditional policy set, especially in view of the rapidly escalating price of nuclear technology, which at one time had been felt would be the answer to inexpensive power. Now it can be seen that power would not be inexpensive under any supply technology except hydroelectric, and no significant expansion of that is likely. Furthermore, with the public increasingly alarmed about the dangers of various aspects of the nuclear power program (both here and abroad), siting proceedings, both at the State and Federal level, are becoming more hotly contested. Increasing demands are being made that the public be included in the planning process, and it is quite clear that many people want to study the alternatives to new thermal plants, particularly nuclear plants.

Corresponding to this is the need for public support to promote and implement adequate and systematic energy conservation programs. Since the primary policy device of the renewable/transition policy set would be to use replacement cost pricing as a means of promoting cost-effective conservation, it is easy to imagine the public turning against conservation if it meant higher electric bills. The reality--as shown in figure IV.1--is that the total energy cost would be less for the renewable/transition policy set, but public recognition of this fact would call for a level of sophistication in the public's comprehension that is so far not evident. The difficulties encountered by the present administration in getting its energy message through to the Congress testify to this difficulty. If the public could be made to understand that the increased electricity prices would be used to promote conservation and that surcharge revenues would be fed back directly to the same sector where the surplus revenues had initially been generated, then it could be a popular program. However, because it would be novel and require a long-term perspective, we classified the renewable/transition policy set in the high-risk category for public support.

The intermediate policy set was assigned either a low or moderate risk, depending on the load growth assumption, on the basis of the fact that it would be more conservation oriented but would stop short of moving to replacement cost pricing. Thus it would yield much lower costs than the traditional policy set without the innovative pricing mechanisms intrinsic in the renewable/transition policy set.

Limited Government research, development, and demonstration funding for conservation and solar energy would result in progressively higher risks as we look from the traditional policy set across to renewable/transition policy set. The Government has been generous in its development and transfer of the necessary technology to support a nuclear power industry, but has yet to devote equal resources to conservation and solar energy. The trend of the most recent years since 1974 has been more encouraging, and indications are that the public will demand that conservation and solar energy move to some type of parity with nuclear power research throughout the next 20 years. But there is no assurance of that and, as a result, for those policy sets which would rely increasingly on conservation and renewable technology, we assigned a higher risk of shortfall.

Threatened access to basic resources would create the highest vulnerability for the traditional policy set due to its emphasis on new thermal generation. Since the basic construction resources are least demanded for conservation and next lowest for renewable technologies, these were given correspondingly lower risk values.

Diversity of generation/conservation

Diversity has several dimensions--diversity by type and newness of technologies, by size of a typical installation, and by geographical concentration. Since the thermal/traditional policy set would involve the highest concentration in all cases and since the renewable/transition policy set would have the lowest concentration, this would correspond to the high and the low risk of shortfall, respectively. The intermediate policy set would lie in between these two with respect to shortfall risk.

The integration of newest technology needs some explanation. There would be a technological diversity inherent in the renewable transition policy set because its conservation program would involve small increments of investment for a new technology, which could be integrated at once. At a given time, one would be dealing with a very diverse technology, which might span several decades. Storm window design may have been standard for the last 30 years, whereas a new type of cellulose insulation was introduced within the last year. This type of technological diversity is a protection against failure in performance, and this reduces the risk of shortfall. In contrast, to bring a nuclear plant in line in 1990, proceedings must begin roughly 10 years before in 1980, and in order to expedite the design and certification phase, there must be a design freeze so that design of several years before, say 1975, would ultimately find its way into a plant coming on line for the first time in 1990. There is not the diversity in nuclear technology that one finds in conservation technology or will find in the renewable technologies with their shorter leadtimes.

Early warning capability

An early warning system must be in place in order to alert power suppliers and consumers and provide time for protective or preventive actions. Because it is inherently easier to monitor the overall performance of a thermal-energy or central-station-based system, low vulnerability rankings were given in the thermal/traditional and intermediate policy sets with respect to the data base and data collection system requirement. For the conservation-oriented renewable/transition policy set, an adequate data base does not now exist. The ranking was only moderate vulnerability, however, because such a data collection system could be designed and put in place with modern solid-state electronics.

The large thermal generators characterizing the thermal/traditional policy set bring on line suddenly a generating increment ranging from 500 megawatts for a new coal unit to 1,250 megawatts for a new nuclear unit. These large, discrete, and incremental developments make predictions very uncertain, although reliable predictions are the heart of an early warning capability. The conservation-based renewable/transition policy set would feature a near continuous development since each installation in itself would be quite small. A continuous program like this would offer a predictability that is unique and would deserve a low vulnerability ranking. The intermediate policy set falls in between the other two.

The final category has to do with the drop in performance with age of any energy installation, be it conservation or new supply. We have become accustomed to a performance degradation which varies with the age of thermal plants and, particularly, nuclear plants because of the increased irradiation of the plants. As plant irradiation increases, the maintenance calls not only are more frequent, but take much longer to carry out, due to dosage limitations for the maintenance workforce. However, the key here is the predictability, and if a performance degradation with age were assigned to thermal plants and if this were maintained reliably and predictably, it would not increase the risk of shortfall. Correspondingly, there can be performance dropoff with age in conservation, through deterioration from moisture and recycling of insulation in commercial and residential buildings. Insulation may also deteriorate around key elements in industrial process design. Very little is known about the maturity and the performance degradation factor in most of the conservation technologies. In summary, it seems that there is a rough balance of risk between the policy sets, and a medium vulnerability was assigned therefore to each.

Ability to respond to warning signal

The long construction and regulatory leadtimes typical of thermal plant construction processes, particularly nuclear plants, forced a high rating of shortfall risk for the traditional policy set. Short leadtimes with no regulatory lag characterize conservation programs and indicate little vulnerability in the renewable/transition policy set. The intermediate policy set falls in between these two.

In all cases the potential for temporary belt tightening, as discussed earlier, would be ample at about the level of a 10- or 20-percent reduction, provided that the crisis was apparent and imminent. At first glance it might appear that the renewable/transition policy set and, to a lesser degree, the intermediate policy set would have less potential for temporary belt tightening. That would not be the case since the belt tightening involves behavioral changes different from energy efficiencies and technological changes that were considered as conservation throughout this analysis. Furthermore, if a conservation ethic were developed, it would make an additional increment of savings more readily available at a time of temporary crisis.

Summary of comparative risk of shortfall

Table IX.1 reveals what could be described best as mixed reviews. It is impossible to conclude that there would be any clear advantage to any of the three policy sets with respect to the risk of shortfall. We hope the previous discussion and the summary table communicate how complex and how frequently nonintuitive or counterintuitive this consideration is.

It is possible to say that there would be a much higher risk of shortfall should the high-growth baseline develop, but this would be a function of factors over which we would have little or no control, such as population growth, average per capita income; labor force participation; strength of the external market for the Northwest economic output; and many, many other factors. Should the underlying determinants of demand produce a growth rate similar to the high-growth projection, there would be an extremely high vulnerability to shortfall. If the moderate-growth or anything less prevailed, the risk of shortfall would be correspondingly less.

There would be no net balance with respect to risk of shortfall between the thermal/traditional, the intermediate, and the renewable/transition policy sets. Those are the policy sets illustrating policy decisions over which we do not have control. After analyzing the situation, however, we concluded that the risk of shortfall would be rather indifferent to our policy choices.

Should a shortfall situation develop, the impact would be less in terms of severity and duration under the renewable/transition policy set than under the intermediate and less under the intermediate under the thermal/traditional policy set. This would be due to the improved early warning capability and flexibility inherent in the continuous development characterizing the conservation-oriented renewable/transition policy set and to a lesser degree the intermediate policy set.

In the conservation-oriented policy sets there would be a much lower vulnerability to the sudden failure of a large energy resource or systematic derating of several generators of a given class. Furthermore, the response time would be shorter, and the flexibility of response would be greater.

RISK OF SURPLUS ELECTRICAL GENERATING CAPACITY

The risk of excess capacity is the opposite side of the coin to the risk of shortfall. There is one lack of symmetry: Whereas consumption plus losses equals generation and by definition cannot exceed generating capacity, consumption plus losses can be considerably short of generating capacity, resulting in idle capacity, plant shutdown, and an overall economic burden to the region.

It is not necessary to recite again all the steps which can be taken in response to electrical energy surpluses or shortfall. Suffice to say that a number of fall-back positions exist for coping with the risk of excess capacity. It should be noted, however, that excess capacity can be a serious problem and must be carefully considered. For the renewable/transition policy set, moderate-growth case, a serious excess capacity problem would threaten for the mid-1980s and early 1990s.

As an excess capacity situation evolved, a series of responses might be developed as follows: First, the surplus power might be sold to the Pacific Southwest or sold to utility grids to the east of the region. However, if excess capacity developed when it was most likely to occur--in the trough of an economic recession--it is unlikely that a secondary market would be available since the same conditions would probably be experienced elsewhere. In this case the generating facilities with the highest variable cost would be shut down. These would be shut down in roughly the following order: oil generators, combustion turbines, coal-fired thermal plants, and nuclear plants. Then, depending on the operating and maintenance costs, either the renewable generators using solar, wind, or biomass would be shut down or the hydroelectric facilities would be forced to spill water.

If the surplus persisted, the next step would be to allow electric utilities to undertake promotional advertising. At first this would probably be restricted to use of offpeak power, either daily or seasonal. However, it might ultimately expand into all uses. Perhaps suggestions would be made and financial inducements offered to convert oil and gas users more quickly to electricity, although it is anticipated in all the policy sets that such a conversion would occur steadily through the remainder of the century for space heating. Volume purchasing at discount (declining block rates) would be reinstituted, and any hope of evolving a conservation ethic would be effectively destroyed, rather than let the generators stand idle.

As in the case of shortfall, the severity and duration of excess capacity problems would be a function of the rate at which the problems developed; the precision and the timeliness of the early warning signals; and, of course, the timeliness of corrective measures.

Comparative risk of surplus capacity

To establish the comparative risk of excess capacity, the reader can refer to table IX.1 and notice the footnoted items. The assessment criteria where the footnote appears are the same for risk of shortfall or risk of surplus, and the rankings are the same as can be verified by examining each one carefully. It is not necessary to reiterate the rationale for each since this deals with risk of excess capacity rather than the impact. The risk rankings are the same as those for the risk of shortfall.

Assuming as before that a monitoring or data collection system would be instituted, then the renewable/transition policy set would be preferred to the intermediate and the intermediate preferred to the thermal/traditional policy set with respect to the comparative risk of excess capacity. Excess capacity would be most likely to occur under the thermal/traditional policy set and least likely to occur under the renewable/transition policy set.

Because of the early warning capability inherent in the continuous development of the conservation-oriented policy set and the rigidity inherent in the long construction and regulatory leadtimes in the traditional policy set, the region would be impacted more severely by the development of excess capacity under the thermal/traditional policy set.

CONCLUSIONS REGARDING RISK OF SHORTFALLS OR SURPLUSES

--The likelihood that a shortfall situation would develop would be essentially the same for each of the three policy sets.

--Should a shortfall develop, then the impact would be more severe under the thermal/traditional policy set than it would be under the intermediate policy set and would be more severe under the intermediate policy set than under the renewable/transition policy set.

--The likelihood of the development of excess generating capacity would be slightly greater under the thermal/traditional policy set than under the intermediate policy set and greater under the intermediate policy set than under the renewable/transition policy set.

--Should excess capacity develop, its impact would be most severe under the thermal/traditional policy set and least severe under the renewable/transition policy set.

--Shortfall is most likely to occur during the crest on an economic boom, when it could be most easily tolerated; excess capacity would most likely occur in the trough of an economic recession, when it would be least tolerable.

--The impact on the region of a shortfall situation might not be significantly more damaging than the development of excess capacity.

TABLE IX.1

Comparative Likelihood of Shortfall or Excess Capacity

Assessment criteria	Policy set/growth assumption: Thermal/traditional Moderate	Thermal/traditional High	Intermediate Moderate	Intermediate High	Renewable/transition Moderate	Renewable/transition High
Ability to meet construction and operation schedule:						
Costs may seriously exceed projections	M	M	L	L	M	H
Scarcity of skilled workers	M	H	L	M	L	M
Scarcity of capital	H	H	M	H	L	M
Inadequate public support	H	H	L	M	H	H
Inadequate Government/ industrial research, development, and demonstration funding	L	L	L	M	M	H
Threatened access to basic resources	H	H	M	H	L	L
Diversity of generation/ conservation:						
Narrow spectrum of technologies	H	H	M	M	L	L
Few large installations	H	H	M	M	L	L
Geographically concentrated installations	H	H	M	M	L	L
Inability to integrate newest technology	H	H	M	M	L	L
Early warning capability:						
Historical and relative data unobtainable (note a)	L	L	L	L	M	M
Discrete versus continuous deployment (note a)	H	H	M	M	L	L
"Lemon" potential/offdesign performance	M	H	L	L	L	M
Possibility of sudden failure or derating	H	H	M	M	L	L
Possibility of performance drop with age	M	M	M	M	M	M

Assessment criteria	Policy set/growth assumption					
	Thermal/traditional		Intermediate		Renewable/transition	
	Moderate	High	Moderate	High	Moderate	High
Ability to respond to warning signal; to prevent/attenuate shortfall or idle capacity:						
Long construction leadtimes (note a)	H	H	M	M	L	L
Long regulatory leadtimes (note a)	H	H	M	M	L	L
Inadequate public support (note a)	H	H	M	M	L	L
Unresponsive support systems:						
Technical	M	M	L	L	L	L
Political (note a)	M	a/H(L)	M	a/H(L)	M	a/H(L)
Lack of surplus or markets outside region (note a)	M	H	M	H	M	H
No potential for temporary belt tightening	L	L	L	L	L	L
Correlation to economic cycles (note a)	M	M	M	M	M	H

Definition of comparative rankings:

H = Highest likelihood of shortfall (excess capacity (note a)) occurrence

M = Intermediate likelihood of shortfall (excess capacity (note a)) occurrence

L = Lowest likelihood of shortfall (excess capacity (note a)) occurrence

a/Also applies to likelihood of excess capacity. The comparative likelihood ranking is the same as the likelihood of shortfall, except where parentheses indicate otherwise.

BASELINE ENERGY DEMAND FORECASTS

There is no shortage of electricity demand forecasts, but there is a serious lack of agreement among the forecasts as to the expectable rate of growth in demand during the next 20 to 25 years. Among the annual average growth rates suggested for firm load power demands are:

7.2 percent	The historical growth rate until, starting in 1973, it began to slow.
4.5 percent	The rate of growth in PNUCC's most recent (1976) West Group forecast. Related to the NERA econometric forecast.
4.4 percent	Northwest Energy Policy Project high-demand forecast.
2.9 percent	NEPP moderate- or most-likely demand forecast.
1.8 percent	NEPP low-growth forecast.
0	Goal of various scenarios, such as NRDC Alternative Scenario and Ford Foundation Energy Policy Project's Zero Growth Scenario.

It is very difficult to foresee which of the above rates of growth does in fact, most accurately predict the growth that will actually occur. The difficulty arises because actual energy demand results from a complicated aggregation of many different components and determinants, most of which are themselves subject to somewhat unpredictable variation over time. For example, population levels and appliance use per household are both important determinants of future electricity use levels, but no one knows for sure what population or lifestyles will be 15 or 20 years from now. In the end the forecaster must inevitably face the fact that the final result is subject to uncertainty. Recognizing this, we have used two baseline energy demand forecasts, each based on plausible assumptions, to reflect part of the possible range of future demand growth.

The two alternative baseline forecasts we used--4.8 percent and 2.7 percent--approximate regional utilities' (PNUCC's) projection of loads and resources and NEPP's moderate- or most-likely-demand projection. These are not the most extreme forecasts that can be proposed and defended as having some likelihood of realization, but they do bracket a range that includes several of the more well-accepted points of view on future growth of regional electricity demand.

A set of underlying assumptions that is consistent with these two forecasts is shown in table X.1. The assumptions associated with the high forecast were taken from NEPP high-growth projection. The NEPP assumptions were used because the PNUCC forecast does not have an explicit set of underlying assumptions associated with it. However, the NEPP high and the PNUCC electricity projections are quite similar, so it is reasonable to use the NEPP high-growth assumptions as a plausible set of assumptions for the PNUCC forecasts as well. The NEPP moderate-growth assumptions were used directly with the lower electricity demand growth forecasts used in this study.

The principal factors that lead to electricity demand growth in the NEPP projections are growth of population, households and income, and growth of employment and economic activity. The moderate-growth assumptions foresee the Northwest's population growing slightly more rapidly than that of the Nation as a whole due to net migration to the region of about 125,000 persons per year. The number of persons per household would be expected to fall to an average of only 2.5 in 2000, so the number of households would increase almost 50 percent more rapidly than population. The added households would lead to a proportionate increase in residential demands for energy.

Real income per person is expected to continue to increase. In the NEPP moderate-growth projection, the expected rate of income gain would be 2.6 percent per year. Income growth is important in the NEPP econometric model because the past association between income growth and energy use is assumed to continue into the future. This results in a forecast of very significant growth in "other" or miscellaneous residential use of electricity, following energy use/income trends that existed during the 1950s, 1960s, and early 1970s. These trends suggest that

TABLE X.1

Alternatives Growth Projections, Pacific Northwest (note a)

Item	Units	Base (1975)	Medium projection (2000) average rate (note b)		High projection (2000) average rate (note c)	
Population	1,000	6,802	9,356	1.3%/yr.	11,245	2.0%/yr.
Households	1,000	2,353	3,755	1.9%/yr.	4,900	3.0%/yr.
Income	$/person	4,300	8,300	2.7%/yr.	9,500	3.2%/yr.
Gross regional product	1,000	2,721	4,350	1.9%/yr.	4,965	2.4%/yr.
Total employment	$1,000,000	49,000	127,000	3.9%/yr.	175,000	5.2%/yr.
Employ in energy intensive industry (note d)	1,000	67	82	0.8%/yr.	97	1.5%/yr.
Labor productivity index		100	209	3.0%/yr.	236	3.5%/yr.

a/Washington, Oregon, Idaho, and western Montana.

b/Taken from NEPP, Medium Energy Growth Projections. The medium projection is characterized as the most likely.

c/Taken from NEPP, High Energy Growth Projection. The High Growth has growth rates comparable to those in PNUCC load forecasts.

d/Primary metals, pulp and paper, and chemicals.

APPENDIX X

electricity use per person for functions other than space and water heating would be far above present levels by the year 2000. That can only come about through much higher energy consumption in basic appliances and widespread adoption of several new appliances that use energy at rates comparable with those used by water heaters, refrigerators, etc.

Industrial use of electricity in the NEPP projections is based on projected employment and labor productivity in the various industrial sectors. These factors, also taken from BPA base economic projections, are consistent with the population and income projections. The moderate-growth projections do imply that average electricity use per industrial employee would increase by about one-fourth between 1974 and 2000. This average increase would be due mostly to projected very large increases in electricity use in the pulp and paper industry.

The primary aluminum industry is treated as a special case in these projections, as it is in most. Consumption of firm power by the aluminum industry is projected to be up substantially in 1980, compared to its actual 1974 level as the plants are expected to be operated at closer to capacity and a new plant (Alumax) is projected to be on line. From that point on, demand by 2000 is projected at about 30 percent above the projected 1980 level and nearly 65 percent above actual 1974 use by the industry.

The high-demand forecasts in the NEPP study are attributed mostly to an assumption that there would be more rapid rates of growth in population and economic productivity. Employment would be higher than in the medium-growth forecast since there would be a larger work force and, it is assumed, that a higher percentage of the work force would be gainfully employed. Worker productivity is assumed to rise more rapidly than in the medium forecast and, therefore, industrial output and energy requirements for the industrial sector would rise even more rapidly than employment. Higher productivity would mean larger personal incomes per worker and per person. This, in turn, would result in higher levels of personal consumption, including direct consumption of energy by households.

As a consequence of the various assumptions of high-growth factors, the overall rate of growth of electricity demand would be approximately 50 percent higher under the high-growth demand forecast. (See table X.2.) Thus there is a plausible set of assumptions that could lead to growth rates comparable to those forecasted by PNUCC. Alternatively, one might imagine that basic growth factors would not accelerate quite as much but energy use in residences and businesses would become considerably higher relative to industrial output, population, and income.

TABLE X.2

Electricity Use Projections--Without Conservation
(annual average MW x 10^3)

Item	Base (1974)	Moderate growth 1980	Moderate growth 1990	Moderate growth 2000	Moderate growth Rate (percent)	High growth 1980	High growth 1990	High growth 2000	High growth Rate (percent)
Residential:									
Space heat	.96	1.60	2.24	2.42	3.6	1.65	2.13	2.82	4.2
Water heat	.95	1.05	1.28	1.50	1.8	1.12	1.50	1.99	2.9
Other	2.16	2.78	4.06	7.12	4.7	3.02	5.32	11.27	6.6
Total residential	4.07	5.43	7.58	11.04	3.9	5.79	8.95	16.08	5.4
Commercial	2.0	2.14	2.68	3.48	2.2	2.26	3.05	4.57	3.2
Industrial:									
Aluminum	1.86	2.34	2.74	3.04	1.9	2.34	3.00	3.32	2.3
Pulp and paper	.83	.91	1.43	3.87	6.1	1.04	2.19	5.30	7.4
Chemicals	.62	.80	.93	1.16	2.4	.76	.91	1.42	3.2
Other manufacturing and residual	3.32	3.64	4.05	4.29	1.0	3.75	4.74	7.66	3.3
Total industrial	6.63	7.69	9.15	12.36	2.4	7.89	10.84	17.70	3.9
Total demand	12.70	15.26	19.41	26.82	2.9	15.94	22.84	38.35	4.3

Source: NEPP data adjusted to include BPA industrial sales in Montana.

APPENDIX X

GAO ENERGY CONSULTANTS

Walter R. Butcher, Professor of Agricultural Economics, Washington State University; participated in NEPP conservation study and in Pacific Northwest Regional Commission energy study; member of steering committee, Washington Energy Research Center and Washington Water Research Center; participated in studies dealing with water resource development and use.

Harry W. Garretson, private consultant; retired from BPA Division of Power Management; directly involved with Hydro-Thermal Power Program and Pacific Northwest-Southwest Intertie.

George W. Hinman, Director, Environmental Research Center, Washington State University; participated in NEPP conservation study and in Pacific Northwest Regional Commission energy study; participant in energy impact assessments for U.S. Department of Energy; member of several Washington State energy advisory committees.

Joel Johanson, private consultant; retired from service with the Office of Management and Budget and U.S. Geological Survey.

Henderson McIntyre, private consultant; retired from BPA Division of Power Management; participated in development of Hydro-Thermal Program, United States-Canadian Columbia River Treaty, and other regional power-planning programs.

Robert Murray, private consultant; participated in developing the NRDC alternative scenario; also contributed to the Skidmore, Owings and Merrill conservation, Oregon transition, and Seattle-Energy 1990 studies.

Department of Energy
Washington, D.C. 20545

May 11, 1978

Mr. Monte Canfield, Jr.
Director, Energy and Minerals
Division
U. S. General Accounting Office
Washington, D. C. 20548

Dear Mr. Canfield:

We have reviewed the draft report entitled "Electric Energy Options for the Pacific Northwest," transmitted to the Secretary by your letter of March 27, 1978.

The GAO has done an excellent job of assembling a variety of data on the energy situation in the Pacific Northwest. The study should be useful to the Department of Energy, regional leaders, and the U. S. Congress in understanding the various energy options and developing those most appropriate to the region.

Enclosed are comments and suggestions about specific parts of the report. Because of the volume of technical detail, and the absence of supporting data for some of the conclusions of the report, we have not been able to respond as comprehensively as we would have preferred had we more than the 30 days allotted. Representatives of the Department met with GAO representatives at Portland, Oregon, to discuss the report in more detail. Additional discussions between GAO and DOE staff may be useful in assuring greater accuracy of the data in the report and strengthened support for the conclusions reached by the GAO team.

The enclosed comments are limited to the discussion in the draft report of the situation in the Pacific Northwest and the conclusions reached by GAO. With respect to the recommendations to the Congress, we would suggest that these be reviewed in light of the passage of PL 95-91 on August 4, 1977, establishing the Department of Energy. Under this Act, the Congress has charged the new Department with responsibility for assuring coordinated and effective administration of Federal energy policy and programs. We expect that within the broad energy missions of the Department, the energy problems of the Pacific Northwest as well as the rest of the nation will be addressed. Section 102 of the Department of Energy Organization Act details the

Mr. Monte Canfield, Jr. - 2 -

purposes of the Act. It is the intent of the Department to follow these Congressional guidelines as fully as possible. In so doing, many of the problems identified by GAO will be remedied. Some of the proposals by the GAO involve actions that are highly sensitive and controversial and will require careful study by DOE and coordination with all interested parties. Where current legislative restrictions may serve to inhibit the Department from effectively carrying out the purposes of PL 95-91, it would be appropriate for GAO to clearly identify these areas so that the Congress can take corrective action.

Thank you for the opportunity to review this proposed report.

Sincerely,

Fred L. Hiser, Director
Division of GAO Liaison

Enclosure: [See GAO note.]
As stated

GAO note: The enclosure is not included here but was considered in this report.

PRINCIPAL OFFICIALS

RESPONSIBLE FOR THE ADMINISTRATION

OF ACTIVITIES DISCUSSED IN THIS REPORT (note a)

	Tenure of office			
	From		To	
DEPARTMENT OF ENERGY				
SECRETARY OF ENERGY:				
James R. Schlesinger	Oct.	1977	Present	
ASSISTANT SECRETARY FOR RESOURCE APPLICATIONS:				
George McIsaac	Oct.	1977	Present	
ADMINISTRATOR, BONNEVILLE POWER ADMINISTRATION:				
Sterling Munro	Jan.	1978	Present	
Donald P. Hodel	Dec.	1972	Dec.	1977
Henry R. Richmond	Sept.	1967	Dec.	1972
DEPARTMENT OF THE INTERIOR				
SECRETARY OF THE INTERIOR:				
Cecil D. Andrus	Jan.	1977	Present	
Thomas S. Kleppe	Oct.	1975	Jan.	1977
Kent Frizzell (acting)	July	1975	Oct.	1975
Stanley K. Hathaway	June	1975	July	1975
Kent Frizzell (acting)	May	1975	June	1975
Rogers C. B. Morton	Jan.	1971	May	1975
ASSISTANT SECRETARY OF THE INTERIOR--ENERGY AND MINERALS:				
Joan M. Davenport	Apr.	1977	Present	
William D. Bettenberg (acting)	Jan.	1977	Apr.	1977
William G. Fischer (acting)	Jan.	1976	Jan.	1977
Jack W. Carlson	Aug.	1974	Jan.	1976
King Mallory (acting)	May	1974	July	1974
Stephen A. Wakefield	Mar.	1973	Apr.	1974
John B. Rigg (note b)	Jan.	1973	Mar.	1973
Hollis M. Dole	Mar.	1969	Jan.	1973

a/The Bonneville Power Administration was transferred from Department of the Interior to Department of Energy on October 1, 1977.

b/Deputy Assistant Secretary in Charge.

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