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Draft 1992 Resource Program

Technical Report

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*This document is a product of the
Energy Resources Development
and Implementation Process:*

*Define Situation
Identify Alternatives
Select Strategies
Implement Strategies
Evaluate Performance*

Bonneville
POWER ADMINISTRATION

MASTER

January 1992

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Energy Resources Development and Implementation Process

The flow chart below illustrates how the Energy Resources Program works. Broadly speaking, the program has two primary functions—resource planning and resource management. The first three blocks in the chart cover most of the planning tasks.

What Are the Needs of Our Customers?

To define the overall situation, BPA first assesses what the energy needs of customer utilities are likely to be over a 20-year planning horizon. Projections are developed and published jointly with the Northwest Power Planning Council. Also part of this initial step are forecasts of how much energy is available from existing Federal resources. BPA then compares demand and supply estimates in a regional Loads and Resources Study, also known as the "White Book."

Define Picture/Situation

Customer/Public Involvement

LOAD FORECAST
LOAD/RESOURCE
STUDY

What Choices Do We Have to Meet those Needs?

The second step is to identify all the available alternatives for meeting customer needs. BPA develops Resource Supply Forecasts for both generation and conservation resources. These studies also consider such factors as environmental and regulatory constraints, new technologies, and public opinion. Other efforts include examining opportunities for coordinating hydro system operations with Canada and arranging power purchases and transfers with Canadian and Southwest utilities.

Identify Alternatives

Customer/Public Involvement

ANALYSIS OF
RESOURCE SUPPLY
ALTERNATIVES

How Can We BEST Meet those Needs?

Step three involves weighing the available alternatives and their consequences to arrive at the most appropriate and cost-effective resource mix for the short-term. Developing the Resource Program is a public review process in which BPA's customer utilities and other interested parties have an opportunity to influence resource decisions. The process focuses on a 2-year planning period—i.e., the 1990 Resource Program covers 1992-1993.

Select Strategies

Customer/Public Involvement

RESOURCE
PROGRAM

What Are We Doing to Meet Customer Needs?

From planning and strategy BPA then moves to step four—meeting customer power needs. Based upon the policies and directives in the Resource Program, managers draw up an overall plan to capture the conservation available in the region's homes, factories, and offices. This results in many programs and projects, ranging from about 25 to 40 in any year. In the past, BPA teams have designed and managed most conservation programs. Now utilities and other power producers are sponsoring their own programs with BPA support.

Bonneville is responsible for planning and acquiring generating resources—both conventional and renewable resources. Another part of step four is BPA's oversight function—seeing that BPA gets value from contracts for generated power.

Implement Strategies

Customer/Public Involvement

PROGRAM DESIGN
AND
IMPLEMENTATION

How Well Did We Meet those Needs?

Finally, in step five BPA looks at how well it is doing its job. It is agency policy to evaluate all programs. Evaluation provides a means of comparing initial objectives with actual results. It is essential for verifying the energy savings from conservation programs and understanding the quality of our actions to acquire the energy.

Evaluate Performance

Customer/Public Involvement

EVALUATION

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EXECUTIVE SUMMARY

The 1992 Resource Program

The Resource Program is the Bonneville Power Administration's primary process for deciding how to meet future resource needs — how much new resource development is needed by BPA, which types of resources to acquire and option, how to go about acquiring them, and how much to spend.

A New Regional Power Plan: The Resource Program's Starting Point

The Northwest Power Planning Council completed a new Northwest Power Plan in 1991. This Draft Resource Program describes how BPA proposes to do its part to meet the Council's regional resource objectives.

Major Changes in the Last Two Years

In addition to the Council's new Plan, there have been other major changes since BPA's 1990 Resource Program. Regional loads have continued to grow at healthy rates, above the Medium forecast rate. Concerns over the output of existing resources have grown. BPA has made significant progress on its first use of billing credits and a competitive bidding process. Natural gas prices have dropped, as have forecasts of future gas prices. Interregional transactions have come to the forefront as promising opportunities for meeting BPA's future resource needs.

Finally, it has become increasingly evident that a renewed and accelerated commitment to conservation is crucial to meeting future resource needs.

BPA's Resource Program Proposal

Acquire all cost-effective conservation — at least 600 average megawatts — by 2003.

This conservation is the foundation of the Resource Program.

Acquire an additional 250 aMW of generation resources to meet the most-likely range of need.

Conservation can meet much of the likely range of need. The 250 aMW of generation resource acquisitions can fill the rest. Together, the proposed conservation and generation acquisitions, plus the acquisitions already under way, can meet Medium-High load growth — or Medium load growth with a 500 aMW reduction in existing resources — through the year 2000.

Acquire 250 aMW more options to cover the outer range of needs.

To provide flexibility in the face of significant load and resource uncertainty, these options could be exercised to bring more new resources on line or secure additional power quickly, if needed.

***BPA's Resource Needs:
Healthy Growth in Loads and Risks
That Must Be Managed***

Recent Load Growth

Regional demand for electricity has grown at 2.4% per year over the last two years. During the same time period, BPA's non-DSI loads grew at 1.7% per year. Both BPA and the region could face deficits in electricity supply in the 1990s unless new resources are developed.

Future Loads Are Uncertain

Load growth is expected to average around 1% per year over the next 20 years. But loads cannot be predicted precisely. BPA and Planning Council load forecasts continue to show that loads could either decline slightly or grow at up to 2% annually over the next 20 years.

There Are Increasing Concerns About the Output of the Existing System

The likelihood of operational changes to the hydro system for the benefit of salmon migration has increased over the last two years. These changes could reduce the firm output of the hydro system, perhaps by several hundred average megawatts (aMW). Additionally, the two nuclear plants BPA relies on have experienced problems in the last year.

Two Ranges of Resource Need

Resource needs over the next ten years cannot be predicted exactly. BPA examined load and resource uncertainties and developed two ranges of resource needs:

- The most likely range (which approximates Medium-High load growth) shows resource

needs of up to 1,800 aMW by the year 2003.¹

- The outer range (approximating High load growth) shows resource needs of up to 3,000 aMW by 2003.

BPA proposes cost-effective resource **acquisitions** to cover the most-likely range of needs, and resource **options** to cover the outer range of needs.

A Major 10-Year Resource Commitment:

- ***1,380 aMW of Acquisitions***
- ***1,450 aMW of Options***

These proposed resource acquisitions build on the 1990 Resource Program recommendations (see Figure 2-1, p.5). In combination, currently planned resources and 1992 Resource Program recommendations through 2003 provide 1,380 aMW of firm power and 1,450 aMW of options that could be exercised, if needed. The 1,450 aMW of options includes 400 aMW from existing sales contracts that are convertible to exchanges.

The Biggest Challenge: How to Acquire All Cost-Effective Conservation

A Major Effort Will Be Required. The proposal to acquire all cost-effective conservation within the BPA system poses enormous challenges to BPA, its utility partners, the region's electricity consumers, the Planning Council, and others having a stake in the outcome.

The effort will be measured in part in financial terms. The 600+ aMW of conservation will cost about \$2.8 billion. But getting it done will take more than dollars. The region as a whole will have to muster the will — as well as the financing — to meet this goal.

¹Acquisitions are not recommended to cover most-likely needs through the entire ten-year period because resource lead times do not require decisions now for post-2000 acquisitions.

The magnitude of the effort cannot be overstated. Acquiring 600+ aMW of conservation is equivalent to building a new large power plant. But drawing up the blueprint for this much conservation is not as straightforward as it is for a conventional power plant, nor is the "building" process.

Meeting the Conservation Challenge Will Require Several Components

Commitment to Success. BPA, utilities, the Planning Council and many others must make a commitment.

Resolving Key Issues. Key issues include how to set appropriate prices when paying for conservation measures, risk sharing, verification of savings and many others.

Involvement of Key Parties. It is clear that *only* an open process that gives all interested parties an opportunity to participate can succeed. BPA has designed the Conservation Implementation Plan process to provide this involvement.

A Clear Strategy. Success in achieving conservation will require a clear and sensible strategy. The strategy must lay out a set of actions which will produce the needed conservation. The Conservation Implementation Plan contained in this Draft Resource Program is BPA's first cut at this strategy. Much remains to be done to make the implementation plan complete. Chapter 8 of this document describes how it will be completed, and how to get involved.

A Strategy for Generation Resources

Foster Competition Among Alternative Sources. BPA has a variety of sources to tap for additional options and acquisitions. These sources include billing credits, competitive bidding, targeted acquisitions, exercising contingency options, interregional opportunities such as purchases and exchanges from outside the Northwest, and others.

BPA proposes to explore these sources and choose the best ones by late 1993, facilitating a competitive marketplace for resources in the process. A major factor in BPA's choice of sources for acquisition will be its experience with competitive bidding and the resource contingency plan options. Commitments to new resources prior to late 1993 are not ruled out if especially attractive opportunities arise.

Interregional Opportunities Look Promising. BPA has a variety of promising opportunities to meet load growth by forging arrangements with utilities outside the Northwest. These include power exchanges, power sales convertible to exchanges, purchase options, increased coordination with Canada, extended arrangements, and others. Such arrangements have the potential to meet BPA loads cost-effectively by making fuller use of existing resources on the West Coast, thus reducing the need to build new power plants. They can create environmental benefits by reducing air emissions at certain times of year, by facilitating changes in river flows for the benefit of migrating fish, and by reducing the need to build new transmission lines. BPA plans to consider these interregional opportunities carefully as it explores alternative sources of acquisitions and options.

A 10-Year Response Plan

Previous Resource Programs have focused mainly on BPA actions in the next two-year budget period. This Resource Program addresses the period from 1993 to 2003. Over this ten-year period, BPA will inevitably face new events to which it will have to respond. BPA is preparing to respond to these developments, first, by anticipating the types of events which might require a response; and second, by determining how to adjust the actions specified in this Resource Program. In this way, BPA intends to lay the groundwork for a more efficient and effective response to the unavoidable changes in the utility environment.

Other Recommendations

Rely on Market Forces to Determine Fuel Choice. Funding for regional or demonstration fuel-switching programs or projects is not proposed. However, BPA will collect data on fuel choice trends to support the agency's continued interest in integrated resource planning and accurate load forecasting.

Confirm New Resource Technologies. Many technologies for conserving and generating electricity have great promise, but are not yet proven. BPA can improve the cost effectiveness and environmental quality of its future acquisitions by confirming these technologies now. Through the Resource Supply Expansion Program (RSEP), BPA plans to collaborate with other utilities to confirm new resources and expand the region's supply of reliable, cost-effective power.

Why these actions?

- The proposed actions are consistent with the objectives of the 1991 Northwest Power Plan and follow the resource priorities established by the Northwest Power Act.
- Developing all cost-effective conservation will keep system costs down and help minimize environmental effects and transmission system requirements.
- A mix of conservation, generation and options from a variety of sources provides the flexibility and diversity to control risks.
- Strategies for acquiring generation resources will promote efficient and environmentally sound use of existing Northwest resources and the West Coast system.

What are the potential rate and budget impacts?

- The accelerated conservation, additional generation and options proposed here are estimated to require rates roughly 0.1 mill/kWh higher than current rate projections in Fiscal Years (FY) 1994-95, and less than 1 mill higher in any given year through 2003.
- BPA capital budgets for resources will increase by a total of approximately \$77 million in the two year period of FY 1994 and 1995. Expense budgets for resources will increase by approximately \$65 million for the same period.

BPA is requesting comments on the Draft 1992 Resource Program through February 20, 1992.

The recommendations and conclusions presented in this document are preliminary. BPA is requesting public comments on the Draft 1992 Resource Program through February 20, 1992.

In addition, you are encouraged to join in a dialogue with BPA's Area Offices on how the Resource Program — and particularly the Conservation Implementation Plan — should be implemented throughout the region by local utilities. Call your Area Office to find out how to participate in those discussions.

This draft will be revised based on public comments and internal discussions, and Draft II will be released in May 1992. The second draft will allow for discussion of revised funding levels in Programs in Perspective (PIP) scheduled for July 1992. In September 1992, after the PIP discussions, the final 1992 Resource Program will be released. Chapter 1 provides additional information regarding public involvement opportunities and how to provide comments.

1. INTRODUCTION

Purpose of the 1992 Resource Program

The 1992 Resource Program will propose actions to meet future loads placed on the Bonneville Power Administration (BPA). It will also discuss and attempt to resolve resource-related policy issues.

The Resource Program assesses resource availability and costs, and analyzes resource requirements and alternative ways of meeting those requirements through both conservation and generation resources. These general resource conclusions are then translated into actions for both conservation and generation. The Resource Program recommends budgets for the Office of Energy Resources for Fiscal Years (FY) 1994 and 1995.¹ In developing the 1992 Resource Program, BPA relied on the Northwest Power Planning Council's 1991 Power Plan² to provide guidance about future resource needs and alternatives for meeting those needs.

BPA's Resource Program bears directly on an important BPA responsibility: the obligation under the Northwest Power Act³ to meet the power requirements of public and private utility and direct service industrial (DSI) customers according to their contractual agreements. Meeting these requirements is a legal obligation whose scope cannot be predicted with certainty. The amount and kinds of resources required to meet future needs depends on such factors as the load growth faced by Pacific Northwest utilities and the availability

and cost of alternative sources of power to those utilities.

BPA's Draft 1992 Resource Program is contained in four documents:

- *1992 Resource Program Summary*
- *Technical Report*
- *Technical Assumptions Appendix*
- *Conservation Implementation Plan*

This volume is the *Draft 1992 Resource Program Technical Report*, a comprehensive document that provides supporting data and analyses for Resource Program recommendations.

The *Summary* provides an overview of the resource analysis, resource program recommendations for FY 1994 and 1995, and policy recommendations concerning some of the issues related to the Resource Program.

The *Technical Assumptions Appendix* contains the raw data used for the Integrated System for Analysis of Acquisitions (ISAAC) computer model.

Finally, the *Conservation Implementation Plan (CIP)* is a reproduction of the first section of Chapter 8 of this document, for those who are primarily interested in that topic.

To obtain copies of these documents, call BPA's document request line at 1-800-622-4520.

Development of the Resource Program

Development of the Resource Program is a multiple-step process. The first step is the load forecast, which contains a range of five forecasts (Low, Medium-Low, Medium, Medium-High and

¹FY 1994 starts in October 1993.

²1991 *Northwest Conservation and Electric Power Plan*, Northwest Power Planning Council.

³"Pacific Northwest Electric Power Planning and Conservation Act," P.L. 96-501, December 5, 1980.

High). The range of forecasts reflects the uncertainties BPA faces in projecting future load growth. A range of load/resource balances is prepared by comparing the capability of existing Federal System⁴ resources to the range of forecasted loads over the next 20 years. Following this, BPA develops new resource supply forecasts, which are used to plan resource acquisitions to meet load growth.

The next step is the development of a set of criteria, called decision factors, to be used in evaluating alternative resource programs. The decision factors encompass a wide range of economic, environmental, institutional and social/political concerns, which are used to develop and evaluate alternative resource programs for FY 1994 and 1995.

A number of alternative proposals and the proposed resource program are then developed. Scenario analysis provides insights about how different resource acquisition actions would perform under varying circumstances. Next, a set of alternative strategies for acquiring and optioning generation resources are developed and subjected to decision analysis.

Finally, the alternative strategies are evaluated against the decision factors and the likely band of resource needs to identify the Draft Resource Program.

Public Involvement

The key purposes for the public involvement component of the 1992 Resource Program are to provide information to the public on Resource Program development and to gain new information from the public on issues presented by the public or entities with special interests or expertise, enabling BPA to make better-informed decisions.

⁴Federal System loads are made up of the net requirements of the region's public utilities, BPA sales to the DSIs, BPA sales to other Federal agencies, and other BPA contractual obligations to deliver power.

Technical Review Panel. To assist in developing the Draft 1992 Resource Program, BPA conducted a series of Technical Review Panel (TRP) meetings. The TRP, originally formed in 1985, is a self-selected group of representatives from BPA's utility customers and their associations, Northwest Power Planning Council staff, special interest groups, state energy offices and individual BPA customers. Seven TRP meetings were held from April through October 1991 (five in Portland at two at Area Offices), to lay out and discuss the principal issues to be addressed in the 1992 Resource Program; report on activities such as load/resource assessment, designing the resource analysis and other issues; and share early analytical results. Through these meetings, BPA gained valuable insights which helped shape this Draft Resource Program.

In response to requests from TRP members, smaller working groups were hosted by BPA to focus on scenario planning, strategy development, fuel choice and conservation. The results were discussed with the full TRP and incorporated into the Draft 1992 Resource Program.

BPA is Requesting Comments on the Draft 1992 Resource Program Through February 20, 1992

In addition to commenting on the overall direction and scope of BPA's proposed resource actions, comments are requested on the following issues:

- What will it take to acquire all-cost effective conservation? How can or should the region finance and manage the operation of a decentralized conservation power plant?
- What sources of generation resources offer best value to BPA and its customers? Why?
- Are the recommended levels of generation resource acquisitions and options appropriate?

BPA encourages your oral or written comments on the Draft 1992 Resource Program. Send written comments to:

Public Involvement Manager
Bonneville Power Administration
P.O. Box 12999
Portland, OR 97212

Or, if you prefer, a meeting to receive comments from the general public will be held on February 12, 1992 from 1 p.m. to 4 p.m. in Room 106 of BPA's Headquarters Building (905 NE 11th Avenue, Portland, Oregon).

In addition, you are encouraged to join in a dialogue with BPA's Area Offices on how the Resource Program — and particularly the Conservation Implementation Plan — should be implemented throughout the region by local utilities. Call your Area Office to find out how to participate in those discussions.

2. THE RESOURCE PROGRAM ENVIRONMENT

What Is Different Since 1990

Even in the relatively short span of two years, issues arise that change resource needs. During development of the Draft 1992 Resource Program it was clear that a number of new issues had emerged:

- Release of the 1991 Plan by the Northwest Power Planning Council provided new guidance and an opportunity to ensure consistency between the Council's plan and the Resource Program.
- Significantly lower gas prices, both current and forecasted, substantially shifted the generation resource picture.
- The listing and potential listings of several stocks of anadromous fish under the Endangered Species Act appear likely to require changes in operation of the hydro system that could reduce its capacity and firm energy output.
- A reassessment of the schedule for developing all cost-effective conservation in BPA's service area was needed to address objectives in the 1991 Northwest Power Plan.
- An exploration of using extra-regional sources through exchanges, coordinated operation and imports to meet some of BPA's future power needs.
- The need to review and/or revise existing BPA policies, such as billing credits, cost-sharing and rate design was raised by customers and others.

The Draft 1992 Resource Program builds on the resource actions that Bonneville undertook

based on final results of the 1990 planning process. These actions are now under way and include:

- Acquiring 350 aMW from Billing Credits and All Sources Bidding.
- Achieving 120 aMW of energy savings via hydroelectric system and transmission efficiency improvements.
- Acquiring 380 aMW of conservation (as outlined in the Conservation Implementation Plan's "Current Path").
- Optioning 800 aMW through the Resource Contingency Plan.

The Draft 1992 Resource Program recommends:

- Acquiring over 600 aMW of cost-effective conservation on an accelerated path by 2003.
- Acquiring an additional 250 aMW of new generation resources.
- Optioning another 250 aMW of firm power.
- Replacing options as they are exercised or their shelf life expires.

Figure 2-1 depicts how these resources fit together to provide acquisitions totaling 1,380 aMW, and options totaling 1450 aMW, through 2003. These amounts reflect a ten-year commitment to acquire all cost-effective conservation, and generation resource actions which BPA would initiate in FY 1993 through 1995. Thereafter, based on progress made in acquiring conservation, Bonneville will adjust generation targets as part of future Resource Programs.

**Figure 2-1. Currently Planned Resources and
1992 Resource Program Recommendations Through 2003**

Guidance from the Northwest Power Planning Council

The Northwest Power Act and the Planning Council's 1991 Northwest Power Plan provide the framework for BPA's resource planning. Section 4 of the Northwest Power Act authorized creation of the Northwest Power Planning Council, and assigned it the responsibility for developing, adopting and periodically updating a regional conservation and electric power plan for the region. In addition, the law established priorities for resource acquisition and gave the BPA Administrator responsibility for acquiring resources. BPA's resource acquisitions are to reflect these priorities and to be consistent with plans adopted by the Council.

The Council completed a new revision of the plan in 1991. The keynote of the new plan is the call for action *now*. In each of four resource portfolios, the resource of choice is conservation. And, in light of the environmental and transmission efficiencies gained, conservation is awarded a higher cost effectiveness ceiling (11 cents per kWh¹) than generation resources. The most challenging objective is the acquisition of over 1,500 average megawatts (aMW) of conservation and efficiency improvements in the region by the year 2000.

¹Resource costs in the 1991 Northwest Power Plan are expressed in nominal levelized life-cycle (1991) dollars, as opposed to the present-value levelized ("real") dollars in some earlier Planning Council documents. The equivalent of 11 cents per kWh (nominal dollars) is 5.5 cents per kWh (real 1991 dollars).

This is the first time the development of BPA's Resource Program has closely followed completion of the Council's plan. This schedule has allowed BPA to adopt most of the analytical assumptions used in the Plan and to focus on issues associated with implementing its portions of the Plan. The 1991 Northwest Power Plan includes four objectives that together form the foundation of BPA's Resource Program:

Council Objective 1:

Acquire All Low-Cost Resources

Acquire over 1,500 aMW of conservation and efficiency improvements in the region by the year 2000 — approximately 40% or 600 aMW in BPA's service area by 2000 (740 aMW by 2003).

Council Objective 2:

Reduce Resource Lead Times

Reduce lead times for 100 MW of hydropower projects and 750 MW of cogeneration, and back-up for 1,500 MW of nonfirm hydropower.

Council Objective 3:

Determine Cost and Availability of Resources

Confirm an additional 500 to 1,000 aMW of new cost-effective resources (new conservation technologies, biomass, geothermal, wind and solar) through research and demonstration programs.

Council Objective 4:

Actions Supporting Implementation

Review and revise utility regulatory processes and BPA policies to support implementation of the Council's goals.

The proposed resource actions and recommendations contained in the Draft 1992 Resource Program were selected in accordance with these objectives and the resource priorities of the Northwest Power Act. First, the Resource Program targets all available cost-effective conservation. Second, a commitment is being made to increase the contingency pool of cost-effective options by 250 aMW to a total of 1,450 aMW.

These options — under either pre-build or contractual arrangements — will reduce acquisition lead times. Third, BPA will continue to work with the Council, the US Department of Energy and others to develop the Resource Supply Expansion Program (RSEP) to confirm additional conservation and renewable resources (see Chapter 9). Finally, through the 1992 Resource Program, BPA has undertaken a Conservation Implementation Plan to identify and remove barriers to accelerated conservation acquisition (see Chapter 8 for more details).

BPA's Load Forecast and Load/Resource Balance

This chapter describes how BPA develops load forecasts and estimates of BPA's load/resource balance. It also summarizes and compares current forecasts with those underlying the Draft 1992 Resource Program.

Regional Economic and Load Forecasts

BPA's resource planning process began with forecasts of regional economic growth. First, five forecasts — Low, Medium-Low, Medium, Medium-High and High — were developed for employment, population, households and fossil fuel prices, using national macroeconomic forecasts, relationships between the Pacific Northwest and national economies, and input from utility and industry experts.

These forecasts of major determinants were then split into forecasts for public and investor-owned utility (IOU) service territories, and fed through a system of electric power demand and pricing models to produce electricity forecasts for both the public utilities and IOUs. The result was a range of five regional load forecasts from Low to High. Similarly, a range of DSI loads was produced; major determinants of future DSI loads are

projected aluminum prices, electricity costs and other production costs.

The long-term regional and public utility load forecasts used in the Draft 1992 Resource Program were developed jointly by BPA and Council staff in the spring of 1991. The Low, Medium-Low, Medium-High and High forecasts were prepared using the Council's electricity pricing model, as part of the development of the 1991 Northwest Power Plan. The Medium forecast was prepared at the same time using BPA's Supply Pricing Model. For the Medium forecast, the BPA pricing model better reflects detailed near-term assumptions for resource costs. These forecasts were published as the "1991 Pacific Northwest Economic and Electricity Use Forecast" and will be referred to here as the "1991 joint forecast."

An updated Medium case forecast was prepared in August 1991, incorporating more recent economic trends and historical load tracking data. The update did not differ materially from the Medium forecast prepared for the final 1991 Northwest Power Plan, and BPA elected to use the final plan forecast for this study.

Long-term forecasting methods are designed to capture underlying trends in energy use. For the Medium case only, a mid-term econometric forecast of loads for the public utilities through 1994 was substituted for the long-term forecast projections. These mid-term projections were developed to provide a better estimate of the near-term outlook for the economy and resulting loads.

For a given load forecast (actually a set of five forecast ranges), some conservation savings are incorporated as a reduction of load, while other conservation is counted as a resource used to meet loads.

Most documents, including this one, describe a "price-effects" forecast, in which price-induced conservation (actions that consumers are pro-

jected to take in response to electricity prices) is treated as a load reduction.

In addition to price-induced conservation, the 1991 joint forecast was reduced to reflect utility conservation program savings achieved to date, along with projected conservation savings from currently budgeted programs (at this time, budgets extend through FY 1994 and no programmatic savings were incorporated as load reductions after that year).

The load forecast provides a "base case" against which resource actions can be assessed. The forecast assumes that while consumers will change their consumption patterns in response to changes in electricity prices, utilities and state or local governments will not implement new or additional demand side load reduction initiatives — such as conservation programs, adoption of the Model Conservation Standards (MCS) by the states of Idaho or Montana, or cost-effective cogeneration — beyond currently budgeted levels.

Thus, the long-term "price-effects" forecasts include:

- Price-induced conservation.
- Future impacts of all current building codes and Federal appliance standards in effect at the time the forecasts were produced. These impacts include Federal appliance standards effective January 1990 and January 1993; and MCS-level state building codes (the 1990 Washington State Energy Code, which became effective in July 1991; and the 1992 Oregon Building Code, effective in January 1992).
- Conservation savings that have already been achieved, such as the weatherization of existing dwellings, construction of Super Good Cents houses; along with savings from conservation programs budgeted for FY 1991, 1992 and 1993.

**Table 2-1. Regional Firm Energy Loads
1991 Joint Forecast**

	Load Forecast (MW)					
	Historical	Low	Medium-Low	Medium	Medium-High	High
1980	16310					
1981	16310					
1982	16630					
1983	15350					
1984	16230					
1985	16670					
1986	16570					
1987	16600					
1988	17400					
1989	18200					
1990	18700					
1991	18930	18930	18930	18930	18930	18903
1992		17332	18166	19211	19746	20659
1993		17598	18455	19627	20117	21144
1994		17313	18398	19911	20447	21678
1995		17025	18358	20015	20782	22277
1996		16955	18440	20164	21133	22859
1997		16953	18567	20359	21465	23402
1998		16978	18718	20607	21830	23942
1999		16988	18857	20861	22188	24459
2000		16938	18975	21091	22511	24987
2001		16721	19118	21334	22850	25545
2002		16514	19261	21571	23155	26017
2003		16548	19420	21832	23526	26570
2004		16596	19602	22093	23915	27142
2005		16680	19834	22386	24346	27799
2006		16767	20076	22683	24785	28460
2007		16848	20312	22965	25201	29092
2008		16921	20543	23250	25603	29719
2009		17018	20791	23553	26053	30381
2010		17111	21025	23816	26476	31018
2011		17232	21305	24145	26966	31758
2012		17263	21484	24388	27358	32395

Table 2-1 and Figure 2-2 show historical total firm loads for the region from 1980 through 1990, and forecasted loads through 2011. Forecasted regional load growth over the 1991 to 2011 period ranges from -0.4% annually in the Low case to +2.6% in the High case. In the Medium-High and Medium-Low cases, loads are projected to grow annually at 1.8% and 0.6%, respectively. In the Medium case, regional firm loads are projected to grow at a rate of 1.3% annually from 1990 to 2011

— from 18,600 aMW in 1990 to 24,150 aMW by 2011.

The most likely range of loads is between the Medium-High and Medium-Low cases. There is a 50% probability that loads will be in this range. The Medium case represents the center of the distribution of projected loads. The probability of loads being between the Medium-High and High or between the Medium-Low and the Low cases is 20% each. The High and Low cases represent unlikely extremes of possible future loads, with a

**Figure 2-2. Regional Firm Energy Loads
1991 Joint Forecast**

5% probability of being higher than the High case or lower than the Low case.

This range of forecasts reflects the uncertainties inherent in projecting future economic growth, energy prices and the intensity of electric power use. As described in more detail in Chapter 5, resource plans and decisions are evaluated over this range of possible future loads so that the effect of forecast uncertainty is considered in the planning process.

The 1991 joint forecast reflects updated long-range projections of economic activity, fuel and electricity prices, and other factors influencing electricity use. Compared to the 1989 load forecasts used in developing the 1990 Resource Program, there are more optimistic projections of regional employment, slightly lower retail electricity prices and relatively unchanged fossil fuel price

projections, which generally make the 1991 load forecasts slightly higher. The exception is the High case, where savings attributable to Federal appliance standards and the adoption of the MCS in Oregon and Washington result in a slightly reduced High case forecast through 2000.

Federal System Loads

Federal System loads — the loads BPA must plan to serve — are a subset of regional loads plus contractual obligations to deliver power outside the region. Federal System loads are made up of the net requirements of the region's public utilities, BPA sales to the DSIs, BPA sales to other Federal agencies, and other BPA contractual obligations to deliver power. Net public utility requirements and DSI loads will account for over

80% of Federal System loads in Operating Year (OY) 1994.²

The net requirements of the public utilities are determined by subtracting the amount of generation resources dedicated to serving their own load from their total load forecasts. Each year, under provisions of their power sales contracts, the public utilities inform BPA of the amount of their dedicated resources for the next seven years.

The Federal System load forecast described here does not include IOU loads beyond current contractual obligations. Under the power sales contracts with the IOUs, a utility must give seven years' notice that it will place load on BPA. Only one IOU, Puget Sound Power & Light, has given such notice. Puget is now purchasing BPA power through the end of the notice period in 1998. Thus, the Federal System forecast described here includes no IOU "New Resources" rate loads beyond OY 1998.

Figure 2-3 and Table 2-2 show historical Federal System loads from 1980 through 1990, and forecasted loads through 2011. Forecasted load growth over the period from 1991 to 2011 ranges from -1.2% annually in the Low case to +2.1% in the High case. In the Medium-High and Medium-Low cases, loads are projected to grow at 1.3% and 0.1% annually, respectively. In the Medium case, Federal System firm loads grow at a rate of 0.8% annually from 1991 to 2011, from 8,700 aMW in 1990 to nearly 10,200 aMW in 2011. Federal System loads are described in further detail in the *1991 Pacific Northwest Loads and Resources Study* (BPA, December 1991).

BPA's Load/Resource Balance

BPA prepares load/resource balance estimates by comparing the capability of the existing Federal System resources to a range of forecasted loads over the next 20 years. This comparison is used to determine when and by how much projected Federal System loads are expected to exceed

existing Federal System resources. When firm resources are less than firm loads, the Federal System is in firm energy deficit. Conversely, if firm resources exceed firm loads, BPA may market the resulting firm surplus. A detailed load/resource balance analysis presented in BPA's 1991 *Pacific Northwest Loads and Resources Study*.

Hydroelectric power comprises 92% of Federal System firm energy resources, while 6% comes from nuclear projects and 2% from contractual resources. For resource planning purposes, BPA considers only the "firm energy" from the hydro system using current operating constraints. This is the maximum quantity of firm energy that can be generated by drafting the hydro system from full to empty during the "critical period," defined as the worst four years of streamflows on the mainstem Columbia River, which occurred during OY 1929 through 1932.

For the present study, BPA examined load/resource balances under a range of five load forecasts. This analysis shows that under the High, Medium-High and Medium load forecasts, the Federal System is in energy deficit throughout the planning horizon. Under the Medium-Low forecast, BPA will have surplus firm energy through OY 2003. A firm energy surplus will be available under the Low case forecast throughout the planning horizon.

Change in Loads and Resources Since the 1990 Resource Program

Since the 1990 Resource Program was completed, the Pacific Northwest economy has enjoyed stronger than anticipated economic and load growth. Reflecting this recent growth, the 1991 joint forecast projects slightly higher regional and Federal System loads than the 1989 forecast used in the 1990 Resource Program. However, in developing the 1990 Resource Program, it was decided to target future resource acquisitions based on the load-resource balance under the 1989 Medium-High forecast. This decision was made, in part, by noting that the 1989 Medium

²Operating Year 1994 is the period from July 1, 1993 to June 30, 1994.

**Figure 2-3. Federal Firm Energy Loads
1991 Joint Forecast**

forecast was below actual loads. The new 1991 joint Medium forecast projects slightly lower regional and Federal System loads than the 1989 Medium-High forecast. However, the 1991 Medium-High forecast of Federal System loads is roughly 250 aMW higher over the forecast period than the 1989 Medium-High forecast.

Existing Contractually Available Resources

BPA has long-term surplus firm energy sale and exchange contracts with Southern California Edison, the Modesto-Redding-Santa Clara Operating Agency, Burbank-Glendale-Pasadena, and Puget Sound Power & Light. These contracts provide for complete or partial termination of en-

ergy deliveries if the energy is needed instead to serve BPA's firm requirements customers.

The California resource options total 329 aMW for 1993. If BPA converts the surplus sales to exchanges, the exchange energy becomes available to BPA as a firm resource. BPA may also elect to purchase supplemental and/or option energy under the SCE contract. BPA has an annual option to determine the cost effectiveness of converting these surplus power sales to exchanges and obtaining the exchange energy instead of acquiring resources to continue the contracts as surplus power sales.

The Puget contract has a five-year termination notice provision. Discontinuing this sale at the earliest possible date, June 1998, would make an additional 75 aMW available for BPA to meet firm loads.

**Table 2-2. Federal Firm Energy Loads
1991 Joint Forecast**

	Load Forecast (MW)					
	Historical	Low	Medium-Low	Medium	Medium-High	High
1980	8274					
1981	8557					
1982	8250					
1983	6878					
1984	7182					
1985	7740					
1986	7280					
1987	7082					
1988	7801					
1989	8318					
1990	8585					
1991	8685					
1992		7657	8136	8618	9003	9422
1993		7724	8243	8891	9147	9632
1994		7521	8179	9077	9322	9888
1995		7254	8088	9054	9460	10141
1996		7247	8165	9137	9662	10419
1997		6939	7915	8893	9486	10316
1998		6966	7991	8996	9637	10540
1999		6992	8069	9110	9794	10756
2000		7104	8271	9349	10067	11107
2001		6872	8317	9427	10185	11295
2002		6625	8343	9486	10246	11390
2003		6687	8449	9626	10430	11638
2004		6855	8665	9866	10718	12003
2005		6884	8745	9965	10860	12237
2006		6995	8909	10149	11088	12560
2007		7064	9033	10290	11271	12837
2008		7083	9110	10382	11402	13067
2009		7038	9118	10404	11470	13232
2010		6929	9062	10353	11477	13333
2011		6752	8934	10240	11417	13373
2012		6767	9004	10333	11570	13625

Regional Load/Resource Balance

The generation resources for the non-Federal System — the IOUs and the public utilities — are 62% hydro and 27% thermal. The thermal resources primarily consist of IOU coal and nuclear plants and combustion turbines (CTs). Imports into the region and miscellaneous other resources make up the remaining 11%.

Figures 2-4 and 2-5 show the regional and federal load/resource balance for the five load forecast ranges. In the High, Medium-High, and Medium case load forecasts the region experiences firm energy deficits beginning in the first year, OY 1993. The region goes into firm energy deficit in 1999 in the Medium-Low case forecast, while in the Low forecast the region experiences firm energy surpluses throughout the planning horizon.

Figure 2-4. Regional Firm Energy Surplus/Deficit **Figure 2-5. Federal Firm Energy Surplus/Deficit**

Revenue Situation

BPA's future revenue outlook is an important factor in developing the Resource Program. In determining the requirements for capital investments, including resource development and acquisition, BPA must consider the agency's varying and sometimes volatile revenue stream.

Revenue fluctuations are largely driven by supply and demand conditions outside of BPA's control. Some of the factors affecting revenues include: (1) load changes driven by changing economic conditions and aluminum commodity prices; (2) the variability of weather, precipitation and streamflows; (3) the performance of thermal power plants; (4) the availability and cost of "spot market" electricity, oil and gas resources which compete with BPA's energy sales; and (5) the availability of transmission capacity.

The major element of variation in recent years has been direct service industry (DSI) revenues. With the introduction of the variable DSI rate in 1986, which tied the price of electricity to the commodity price of aluminum, BPA's revenues from its aluminum DSI customers have varied based on the same load.

On the resource side, the major historical variance in revenues has resulted from the available amount of nonfirm energy BPA has been able to market, and the price received from such sales. Both of these factors are dependent on the timing and amount of annual runoff, which is highly variable. Thermal plant performance also affects the amount of nonfirm energy BPA has to market. In addition, nonfirm energy prices depend on the prevailing fuel prices paid by California and Southwest utilities for running their gas- and oil-fired plants.

Along with Pacific Northwest resource performance uncertainty, water and weather conditions outside the region can affect BPA's sales and revenues. Higher hydro production in California limits the available capacity on the southern portions of the Intertie system, reducing the sales Northwest utilities can make.

BPA's revenue variability presents a continuing challenge to maintaining the agency's financial health. This makes it important to examine resource investments that will limit the increase in BPA's fixed costs. The financial and operating characteristics of some resources also provide greater flexibility in dealing with near-term changes in BPA's load/resource balance by matching changes in demand with corresponding changes in operating costs, thus reducing exposure to revenue instability. BPA will continue to work with its customers and others to assess its financial situation, issues and options in the development of the 10-Year Financial Plan.

3. DECISION FACTORS

For the 1992 Resource Program, five broad decision factors were selected. They were used to guide analysis and compare different acquisition strategies and sources. This chapter defines the five decision factors — efficiency, risk, reliability, environment and competitiveness.

Efficiency

The efficiency decision factor addresses the degree to which resource strategies minimize BPA's power system costs and promote efficient, least-cost use of West Coast resources. System costs, as defined in the Northwest Power Act, include all costs for installing new conservation, generation, transmission and distribution facilities; operating costs; fuel costs; utility and direct service industry (DSI) customer and retail consumer costs incurred for conservation measures; and quantifiable environmental costs and benefits.

Risk

The electric power industry operates in an uncertain and changing environment. Flexibility to deal with changes in load growth, resource availability and costs is critical. The risk decision factor is applied to identify resource strategies that offer flexibility and minimize economic, financial and deliverability risks. Economic risks include the likelihood of building unneeded resources or of being caught short and having to incur high costs to acquire expensive but quickly available resources. For the purposes of this study, financial risk considers the likelihood that revenues under-run costs. Deliverability risk considers the public acceptability of different resource types and the ability to build or operate them as planned.

Reliability

The ability to meet the future electrical needs of customers with a high degree of reliability is a key factor in the evaluation of alternative resource strategies. The reliability decision factor addresses the potential of each resource package to meet BPA's contractual obligations if load growth outstrips available resources, or if existing resources are able to meet less load than expected. This decision factor also addresses factors helpful for resolving transmission capacity constraints.

Environment

This decision factor is applied to ensure that the actions recommended by BPA are environmentally sound. In analyzing possible environmental impacts, BPA considers both quantifiable and nonquantifiable effects on air quality, wildlife habitat, fisheries, etc.

Competitiveness

The competitiveness decision factor addresses BPA's position in the energy service marketplace. "Competitiveness" includes the extent to which each strategy minimizes rate impacts, builds new, more competitive markets, uses competitive markets to find the best resources, and promotes the competitiveness of BPA's customers.

4. NEW RESOURCE SUPPLY

BPA has three sources of new resources for meeting firm load growth: conservation, generation and contracts with other utilities. Because BPA practices integrated supply and demand side planning, quantitative estimates of the supply, cost and availability of resources are needed. These estimates are used to plan the acquisition of cost-effective resources to meet firm loads and to assist in conservation program design.

The Northwest Power Act defines cost effectiveness, when applied to a measure or a resource, to mean that such measure or resource must be forecast:

- i. to be reliable and available within the time it is needed, and
- ii. to meet or reduce the electric power demand, as determined by the Council or the Administrator, as appropriate, of the consumers of [BPA's utility] customers at an estimated incremental system cost no greater than that of the least-cost similarly reliable and available alternative measure or resource, or any combination thereof.¹

For conservation and generation, these quantitative estimates are called supply curves or supply forecasts. BPA resource supply forecasts are used for resource planning, program design assistance and a variety of other studies. The issues involved in making forecasts of generation resources are relatively straightforward: timing, cost and production. Forecasting conservation resources is more complex because it requires additional assumptions about market penetration, market availability and the proper installation of measures. Replacement power costs are incurred when conservation is over-estimated. On

the other hand, if conservation is underestimated, costs will be incurred because of incorrectly timing the on-line date of new alternative resource. Therefore, BPA has taken a conservative approach to forecasting the conservation resource.

Forecasts of the supply curve for imports and/or exchanges with other entities to obtain firm energy are also complex. They rely on estimates of the load/resource balance and diversity with interconnected utilities, environmental considerations and the likelihood that appropriate firm arrangements can be concluded.

The conservation and generation sections of this chapter are excerpted from much more detailed reports. These documents, the Draft Conservation Resources Supply Document and the Draft Generation Resources Supply Document, can be obtained by calling the BPA Documents Request Line at 1-800-622-4520.

Conservation

The Northwest Power Act defines conservation as any reduction in electric power consumption as a result of increases in the efficiency of energy use, production or distribution. Conservation can be a sound regional investment because it reduces the need for costly new generation plants. Efficiency improvements are achieved by installing energy conservation measures (ECMs) that increase the productivity of electric energy.

Conservation resources are often categorized according to end use sector: residential, commercial, industrial and irrigation. The conservation potential for each sector is forecast by developing supply estimates that indicate the cost and

¹Sec. 3(4)(A), P.L. 96-501.

savings of the ECMs within each sector. The sector potential is the sum of the savings from all of the ECMs within the sector. BPA, utility and Council staff worked together in developing the conservation supply estimates used in the Resource Program.

In comparing the cost of resource alternatives, BPA uses the concept of real levelized cost.² The real levelized cost of a resource is the present value of its cost converted into a stream of equal annual payments over the life of the project and divided by the annual kWh saved or produced. Costs are expressed in a base year dollar level (e.g., 1990 dollars) and the effects of inflation are removed from the stream of costs.

A cost-effective limit for conservation resources is determined by evaluating the cost of the long-term alternative generation resources. This is the real levelized cost of adding a marginal unit of energy to the region's power grid, 39 mills/kWh.³

This cost is then adjusted to make conservation and generation resource costs comparable. Adjustments to the avoided cost of generation are needed because "conservation as a resource has several advantages that are not captured in the 7.5 cents per kWh (equivalent to approximately 39 real levelized mills/kWh) figure. Electricity that is generated from central station sources requires transmission and distribution lines, and energy is lost on its way to customers. Conservation has

neither the added expense of transmission lines nor the line loss en route. Energy savings also have fewer environmental impacts than any of the generation resources included in the 1991 Northwest Power Plan. Furthermore, many conservation programs closely track growth and decline in the economy."⁴

The plan also notes that "Failure to purchase these environmentally sound and economical resources now could force acquisition of more costly and environmentally damaging resources later."

These adjustments result in a 55 mill/kWh real levelized cost ceiling for electrical conservation measures. This 55 mill/kWh limit sets the cost limit on measures to be included in the conservation resource supply estimates, and affects the relative placement of conservation in the resource stack.

Savings

The development of conservation supply estimates takes place in two steps. First, the technical conservation resource potential is established. This potential is adjusted by various factors to produce the achievable conservation resource potential.

A technical supply estimate is the maximum cumulative amount of electric energy savings theoretically available if all consumers in an end use sector implemented all conservation measures which, from an engineering standpoint, are cost-effective to install. The technical resource supply is estimated for the entire region and also for the BPA service area.

Several adjustments must be made to this technical resource potential to estimate how much can realistically be achieved. The first adjustment is a 7.5% increase in technical savings potential because conservation displaces the generation resources whose delivery would incur transmission losses.

²The Planning Council reports both "real levelized" and "nominal levelized" costs. The Council felt that nominal levelized costs were more comparable to current rates. BPA continues to use real levelized costs because they have been the most useful summary of resource costs for BPA's purposes. However, BPA will report resource costs in both real and nominal levelized terms. BPA's real levelized costs can be roughly converted to nominal levelized costs by using the following multiplication factors:

Resource Life	Factor
20 years	1.53
30 years	1.77
40 years	1.97
50 years	2.14

For example, to convert to a nominal levelized cost for a normalized 40-year resource, multiply the real levelized cost by 1.97.

³See the 1991 Northwest Power Plan, Chapter 14.

⁴1991 Northwest Power Plan, Vol. I, p. 32.

The second adjustment is a reduction of the technical potential to the percentage of the target market which realistically can acquire the conservation measures. This adjustment acknowledges that each conservation market has a saturation point below 100%, and that some of the estimated technical potential will never be captured by conservation acquisition programs or through energy efficiency standards.

The final adjustment subtracts from the achievable conservation potential those conservation savings that BPA expects to acquire through programs before the FY 1994-95 planning period begins. This adjustment includes savings acquired through existing programs, new budgeted programs, and codes and standards in place through 1991. These three adjustments produce an estimate of the conservation savings that will realistically be available for the planning period beginning in FY 1994.

Costs

The models that produce the conservation supply estimates use incremental measure costs and a 3% real discount rate to calculate the present value of the costs of conservation savings over the term of the savings.

Administrative costs are added to estimate the total costs of providing energy savings. Administrative costs include audits, inspections and program management required to ensure effective, responsible programs. Administrative costs are calculated as a percentage of the costs of the conservation measures. For example, based on national program experience, administrative costs for commercial programs are estimated to be 30% of the cost of measures installed.

When deriving the levelized cost estimates shown in the tables in this section, a future payment stream is calculated from the present value of the sum of the measure costs, administrative costs and financing costs over 20 years with a nominal finance rate of 9.2%. The present value of this nominal payment stream is then calculated

with an 8.15% discount rate. The resulting present value is then levelized over the term of the savings with a 3% real discount rate.

BPA has evaluated conservation programs since 1982 to assure the reliability of estimates of conservation supply and costs. This information has been used to adjust the supply estimates to provide a better prediction of the outcomes of future programs. In April 1990, BPA released a separate *Issue Backgrounder* on conservation program accomplishments and the basis for their measurement that provides further discussion of this topic.

Tables 4-1, 4-2, 4-3 and 4-4 characterize the conservation resources in terms of achievable potential and the average capital and operating and maintenance (O&M) costs needed over the expected life of these savings. Costs are levelized over the time period in which savings are expected to persist. For example, savings from the weatherization of existing single-family homes are set at 50 years because the home is expected to have an average life of 50 years. The energy savings realized from weatherization are expected to continue to some degree for the life of the home.

Conservation resources are further classified as lost-opportunity or discretionary/deferrable resources. This distinction reflects the timing of resource availability. Where appropriate, the seasonal distribution of savings is also specified. Finally, program ramp rates are determined, describing the fraction of achievable potential that can be acquired annually, and reflecting ease of access to the market.

Summary Presentation of Conservation Estimates by Sector

The tables in this section summarize achievable conservation potential for 1994 to 2010 from the Medium load forecast for each of the major end uses. The total regional achievable potential ranges from about 1,600 aMW for the Low fore-

**Table 4-1. Residential Space Heat:
Achievable Conservation Resources [1]
(Medium Loads)**

	Existing Single Family	Existing Multi-Family	New Single Family [2]	New Multi-Family	New Manufact'd Houses
Supply					
Regional Supply (aMW)	70	40	117	19	150
BPA Supply (aMW)	43	13	67	6	71
Term of Savings (years)	50	50	70	70	45
Total Regional Costs [3]					
Average Capital Costs 1990\$/akW)	7849	7398	6091	7252	5903
Average Administrative Costs (1990\$/akW)	1570	1480	1218	1450	1181
Real Levelized Cost [4] (1990 mills/kWh)	42	40	29	34	33
Nominal Levelized Cost [5]	83	79	57	67	65

Source: Draft 1992 Conservation Resources Supply Document, October 1991

[1] Report of achievable potential for FY 1994-2010, which is the technical potential plus 7.5% transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rate (85% for new residential structures, 75% for existing residential structures and 85% for new manufactured housing).

[2] Includes savings (15 aMW) and costs from solar access codes.

[3] Average costs have been financed over 20 years and levelized over the term of savings.

[4] Real levelized costs assume 100% debt financing at a 9.2% nominal interest rate, levelized over the term of the savings.

[5] Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote [4].

cast, to 2,300 aMW for the Medium forecast, to about 3,100 aMW for the High forecast. (In comparison, for the 1990 Resource Program, the total achievable potential in the region under the Medium case forecast was estimated to be 1,700 aMW.) For BPA it is about 750 aMW for the Low forecast, 1,000 aMW for the Medium forecast, and about 1,400 aMW for the High forecast.⁵

Residential Sector

The residential sector is separated into three end uses: space heating, water heating and appliances. Space heating is divided into single-family, multi-family and manufactured housing. All measures that weatherize a house, such as storm windows or ceiling insulation, comprise the

space heating resource. The residential space heating sector is further subdivided into existing and new buildings. One step is to estimate the potential savings from weatherization of existing homes. There are several components of the estimated potential for new buildings. One major element is an estimate of the savings beyond the level of the Council's Model Conservation Standards (MCS). In addition, the estimates for new single-family buildings includes the savings from the adoption of local solar access building codes that require beneficial orientation to the sun and specifications for surrounding building setbacks and heights. Administrative costs are estimated to be 20% of the measure costs for all residential space heat programs. Table 4-1 summarizes the savings potential in this sector.

The residential water heating resource consists of several measures: energy-efficient water heat

⁵See BPA's Draft 1992 Conservation Resources Supply Document for a more detailed technical description of these resources and the estimation methods.

4. New Resource Supply

**Table 4-2. Residential Appliances and Water Heat:
Achievable Conservation Resources [1]
(Medium Loads)**

	Existing Lighting [2]	New Lighting	Water Heating
Supply			
Regional Supply (aMW)	7	35	614 [3]
BPA Supply (aMW)	2	18	265
Term of Savings (years)	3	10 [4]	12
Total Regional Costs [5]			
Average Capital Costs (1990\$/akW)	932	2673	2002
Average Administrative Costs (1990\$/akW)	186	535	400
Real Levelized Cost [6] (1990 mills/kWh)	45	43	23
Nominal Levelized Cost [7]	89	85	45

Source: Draft 1992 Conservation Resources Supply Document, October 1991

[1] Report of achievable potential for FY 1994-2010, which is the technical potential plus 7.5% transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rate (85% for refrigerators and freezers, and 77% for water heating).

[2] Multi-family applications only.

[3] Water heating supply has changed significantly (approximately 25% lower since the Resource Program analysis began.

[4] Bulb lifetime represents replacement up to a 10 year life to allow a consistent basis for costing a variety of technologies in different applications.

[5] Average costs have been financed over 20 years and levelized over the term of savings.

[6] Real levelized costs assume 100% debt financing at a 9.2% nominal interest rate, levelized over the term of the savings.

[7] Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote [6].

ers, heat pump water heaters with heat recovery ventilation, R-11 wraps and bottom boards for water heaters, pipe wraps, low-flow showerheads, and energy-efficient dishwashers and clothes washers. Water heating savings are shown in Table 4-2.

For the 1990 Resource Program, the residential appliance supply estimate included only refrigerators and freezers. However, national federal appliance standards setting maximum energy consumption levels for refrigerators and freezers became effective January 1, 1990, and more stringent levels have been set to become effective January 1, 1993. Currently, these standards encompass all cost effective, reliable and commercially available conservation resources for this market segment. Therefore, appliance conservation supply estimates will not be presented at this time.

A preliminary placeholder to represent the energy savings potential derived from residential lighting efficiency measures is included in the current conservation supply estimates. Compact fluorescent lighting applications in a residential setting are presently the most clearly understood among a diverse array of developing technologies. For this reason, they were chosen to illustrate an example of the energy savings possible under a certain set of conditions. Realistically, the specific technologies employed and the assumptions associated with them, such as cost, measure life and possible applications, may change dramatically in the future. See Table 4-2 for the appliance summary. Administrative costs are assumed to be 20%, for residential lighting and water heating.

**Table 4-3. Commercial: Achievable Conservation Resources [1]
(Medium Loads)**

	Existing Buildings (Discretionary)	Existing Buildings (Lost Opportunities) [2]	Total Existing	New Construction (Lost Opportunities) [3]
Supply				
Regional Supply (aMW)	316	243	559	339
BPA Supply (aMW)	149	110	259	135
Term of Savings (years) [4]	15	15	N/A	15
Total Regional Costs [5]				
Average Capital Costs (1990\$/kW)	2044	2083	N/A	1407
Average Administrative Costs (1990\$/kW)	613	625	N/A	422
Real Levelized Cost [6] (1990 mills/kWh)	26 [7]	26	N/A	18
Nominal Levelized Cost [8]	51	51	N/A	35

Source: Draft 1992 Conservation Resources Supply Document, October 1991. See Chapter 8, Implementation Plan, for program-specific conservation costs and savings by years.

- [1] Report of achievable potential for FY 1994-2010, which is the technical potential plus 7.5% transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rate (60% for all commercial buildings).
- [2] Costs for all lost-opportunity resources in existing commercial buildings are based on costs of savings in remodeled and renovated buildings, which comprise the majority of lost opportunities in existing commercial buildings.
- [3] All potential savings in new buildings are now assumed to be lost opportunities.
- [4] For use in ISAAC, the term of savings for all buildings has been adjusted to 15 years, i.e., incorporating replacement costs where necessary.
- [5] Average costs have been financed over 20 years and levelized over the term of savings.
- [6] Real levelized costs assume 100% debt financing at a 9.2% nominal interest rate, levelized over the term of the savings.
- [7] This real levelized cost may be low. The Commercial Incentives Pilot Program evaluation cost was 35 mills/kWh.
- [8] Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote [6].

Commercial Sector

The commercial sector is the fastest growing end use in the region in terms of energy consumption. This sector consists of ten building types: offices, retail, restaurants, grocery stores, lodging, colleges, primary and secondary schools, warehouses, health and miscellaneous. The most energy intensive end uses in the commercial sector are lighting, refrigeration, space heating, water heating and air conditioning. Office and retail buildings have the largest share of energy use in the sector, primarily because they account for the largest share of commercial building floor space. Restaurants and grocery buildings have

substantially higher energy use per square foot than the other building types and therefore, also account for a significant share of energy savings potential in the commercial sector.

BPA's commercial sector load forecast model provides data for forecasted floor space, energy use, and the portion of floor space using electricity for space heating and water heating. The data for measure cost and savings is derived from building prototype analyses. The cumulative electrical energy savings potential for FY 1994 through 2010 is displayed in Table 4-3.

Much of the conservation potential in existing buildings comes from retrofit measures. Existing

**Table 4-4. Industrial and Agricultural: Achievable Conservation Resources [1]
(Medium Loads)**

	Industrial	Agricultural (Irrigation)
Supply		
Regional Supply (aMW)	290	34
BPA Supply (aMW)	136	14
Term of Savings (years)	20	20
Total Regional Costs [2]		
Average Capital Costs (1990\$/kW)	1955	1555
Average Administrative Costs (1990\$/kW)	196	311
Real Levelized Cost (1990 mills/kWh) [3]	16	14
Nominal Levelized Cost [4]	32	28

Source: Draft 1992 Conservation Resources Supply Document, October 1991.

[1] Report of achievable potential for FY 1994-2010, which is the technical potential plus 7.5% transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rate (60% for all commercial buildings).

[2] Average costs have been financed over 20 years and levelized over the term of savings.

[3] Real levelized costs assume 100% debt financing at a 9.2% nominal interest rate, levelized over the term of the savings.

[4] Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote [3].

commercial buildings often undergo remodeling or renovation, which presents additional opportunities for installing energy efficient measures. Significant savings from new buildings can be obtained by including energy efficient measures beyond those required by local building ordinances at the time of construction. Statewide commercial building codes (commercial MCS) are being developed. An estimate of supply potential beyond the energy efficiency level mandated by these codes will be developed as information becomes available. Administration costs for the commercial sector are assumed to be 30% of measure costs.

Industrial Sector

The industrial sector includes specific types of manufacturing firms in Standard Industrial Classifications (SIC) 20 to 39. The industries that consume the most electricity in this sector are pulp and paper, lumber and wood products, and chemicals. The primary industrial electrical end uses are motors and lighting. Other major end uses include process heating and refrigeration.

The energy savings estimates for this sector are generated from a computer model developed by BPA. The model calculates the potential savings available 20 years from the initial year, which for this analysis was 1994. The model combines regional industrial load forecasts, data on end use consumption by each industry, and estimates of percentage savings for 53 available ECMs. The product of this model is a regional supply curve that lists the cumulative savings of these ECMs in order from the least to the most expensive. Table 4-4 displays the sum of the energy savings potential from the model: 136 aMW of industrial conservation is available to BPA at an average levelized cost of 13 mills/kWh. Administrative costs are assumed to be 20% for the industrial sector.

Two points on industrial conservation should be noted. First, BPA is in the process of developing a new industrial conservation supply curve model. This model is likely to document higher conservation savings as it will contain more ECMs and apply to a wider range of industries. Results of this new model may be reflected in the final 1992 Re-

source Program industrial conservation figures. Secondly, it should be noted that BPA is working to identify savings in and design conservation programs for the Northwest's aluminum industry, although it is not clear when this work will be reflected in the Resource Program.

Agricultural Sector

The conservation potential in the agricultural sector results from the implementation of low pressure irrigation in center pivot systems, main-line improvements and redesign of fittings. Energy-efficient motors and irrigation scheduling have been excluded as energy saving measures due to the analysis of evaluation data.⁶ Administrative costs are assumed to be 20% of capital costs for the agricultural sector. The energy savings potential for the agricultural sector is displayed in Table 4-4.

Customer System Efficiency Improvements

A significant opportunity exists to conserve energy by reducing losses on the transmission and distribution (T&D) systems of BPA and its customer utilities. These efficiency improvements are available from three principal existing sources: the hydroelectric system, the T&D system and thermal plants. Detailed information on savings potential can be found in the Draft 1992 Conservation Resources Supply Document.

BPA elected to use the 1991 Northwest Power Plan as the basis for hydropower improvement estimates. The potential is based on both turbine runner replacement and electronic governor installation at existing hydro facilities. Analysis has shown that the bulk of the regional potential may be in electronic governor replacement and that runner replacements may be more costly or difficult to acquire. BPA feels that this assumption retains a viable, inexpensive resource as an option without waiting for more definitive analysis. About 70% of the total regional potential is considered available to BPA. This assumed that BPA

has access to turbines on the Federal system or its customers' projects.

The Council and BPA participated in a series of workshops conducted by the Pacific Northwest Utilities Conference Committee (PNUCC) to examine the assumptions for T&D efficiency improvement potential to be used in the Council's 1991 plan. T&D improvements consist of regional transmission and distribution improvements and conservation voltage regulation (CVR). The Council used previous assessments as well as the results of these workshops to arrive at a consensus estimate for T&D improvements. BPA participated in the process and has elected to include the estimates in the 1992 Resource Program. The ultimate cost and time frame over which these efficiency measures could be acquired are uncertain. It is likely the resource cannot be acquired quickly, even if it is cost-effective. The bulk of this resource probably can be acquired incrementally over the next 10 to 20 years. Based on the proportion of distribution on customer utility systems, 52% of T&D and 41% of the CVR potential is considered available to BPA.

Because of the site-specific nature of thermal plant efficiency improvements, generic savings estimates have previously been unavailable. In preparing for the 1991 plan, the Council gathered preliminary information from plant owners on potential efficiency improvement projects. Because the Council's regional estimates are based on preliminary data that does not include all the thermal plants in the region, it is likely that the potential is larger than projected. In addition, BPA developed new estimates for improvements at WNP-2, and has supplemented the Council's regional estimates with update figures for WNP-2. All of WNP-2 potential is available to BPA; about 10% of the generic potential is considered to be available to BPA through existing agreements with plant owners (see Table 4-5).

⁶See BPA's Draft 1992 Conservation Resources Supply Document for a detailed explanation of evaluation results.

**Table 4-5. Customer System Efficiency Improvements:
Achievable Conservation Resources [1]**

	Conservation Voltage Reduction	Transmission & Distribution	Hydro	Thermal	WNP-2
Supply					
Regional Supply (aMW)	100	200	110	58	47
BPA Supply (aMW)	41	104	78	6	47
Term of Savings (years)	40	40	40	30	30
Total Regional Costs					
Capital Cost [2, 3] (1990\$/kW)	1424	5254	607	4808	1374
Real Levelized Cost [4] (1990 mills/kWh)	7	26	3	28	8
Nominal Levelized Cost	14	52	6	56	16

Source: Draft 1992 Conservation Resources Supply Document, October 1991

[1] CSEI supply was formerly published in BPA's Generating Resource Supply Document.

[2] Average costs have been financed over 30 years levelized over the term of the savings.

[3] Administrative costs included in capital costs.

[4] Real levelized costs assume 100% debt financing at 7.3% nominal interest rate, levelized over the term of the savings.

Generation Resources

This section summarizes the resource cost and supply assumptions for generation resources used by the BPA for the Resource Program and other planning activities. The Council completed its 1991 Northwest Power Plan in April 1991. As part of the development of the plan, the Council circulated several issue papers on the costs and availability of generation resources. BPA collaborated with the Council on many of these papers. Through the Council's public involvement process a regional consensus developed on the assumptions used for generation resources. Since 1992 Resource Program planning commenced as the Council was completing the plan, BPA elected to use the Council's generation resource assumptions. Thus, capital and O&M costs for the Resource Program, as well as availability estimates, are generally based on and consistent with the generation resource data used by the Council in the 1991 Northwest Power Plan.

Adjustments

Some adjustments have been made to the figures used by the Council. These adjustments reflect different assumptions used by Bonneville or additional information developed after the release of the Council's 1991 plan.

Resource Availability. Not all of the regional potential of a resource is available to Bonneville. Availability of generic resources to BPA was set at 25% of the regional supply, the same figure used in the 1990 Resource Program; exceptions are noted in the descriptions below.

Transmission Adjustment. The capital cost of resources is adjusted to reflect their location. These adjustments are based on the distance of the assumed site from the load centers to the west of the Cascade Mountains. Where specific sites are identified, the adjustment is based on the distance to the Puget Sound area. Where specific sites are not identified, the adjustment is based on the zone in which the resource is assumed to be located. For generic resources west of the Cascades no adjustment is made. For resources lo-

cated between the Cascades and the eastern edge of the BPA grid, an increment of \$128/kW is added to the capital cost. For resources located east of the grid a \$438/kW adder is used. These zonal factors are generic and are based on BPA estimates for construction of new transmission lines. All adjustments are explicitly shown on each data sheet. Background information regarding the adjustment calculation is contained in Bonneville's 1991 Generation Resource Supply Document.

Table 4-6. Financial Factors

	Percent
Real Escalation Rates	
Capital	1.2
O&M	0.7
Fuel	0.7
Coal	1.0
Natural Gas	3.1
Tax Rates	
Federal	34.0
State	3.7
Insurance	0.25
Gross Revenue	
Public	2.2
Private	2.1
Financial Assumptions	
Price Level	1990
Nominal Debt Interest Rate	
Public	7.3
Private	9.7
Nominal Return on Equity Rate	
Private	12.5
Real Discount Rate	3.0
Inflation Rate	5.0

Coal Gasification. In addition to the transmission adjustment, capital costs assumed by the Council were arbitrarily reduced by 10% in anticipation of updated costs which should be available for the final 1992 Resource Program.

WPPSS Nuclear Projects 1 and 3. Data for both High and Low cases is included. The High

case reflects a higher fixed O&M value, with a 1.5% instead of 0.7% annual real escalation rate. For the 1992 Resource Program analysis, an average of these values was used. Both the Low and the High case reflect variable fuel costs which are lower in real terms than was used in the 1990 Resource Program.

Financial Assumptions. Financial assumptions used by BPA may differ from those used by the Council. Table 4-6 summarizes these assumptions. When calculating levelized costs, Bonneville assumes combined 50% public/50% private ownership except where ownership is explicit (for example, WPPSS Projects 1 and 3).

Summary

Table 4-7 summarizes supply forecast information for the year 2000. This table lists all of the generation resource categories. The resource identifiers are the same as those used on the data sheets that are included in the appendices. Levelized cost is not the only criterion used in the resource mix selection process. It does, however, provide a preliminary view of the resources relative to each other.

Stand-Alone Biomass

Technical Description

Direct combustion and gasification are two technologies used to convert biomass into electrical energy. Biomass energy conversion technologies and power plant systems are very similar to those used in coal combustion or coal gasification. Like coal, biomass can be burned in a fluidized bed reactor, incinerated in a waterwall steam boiler, or gasified. (See the Coal and Municipal Solid Waste sections below for more information on these conversion technologies).

Direct combustion burns the biomass fuel and transfers the combustion heat directly in a boiler

Table 4-7. Generation Resources: Cost and Availability

Resource	Real Levelized Costs (mills/kWh)	Nominal Levelized Costs (mills/kWh) [1]	Regional Supply (aMW)	BPA Supply (aMW)
Hydro-1W	21	40	36	9
Hydro-1E	22	44	55	14
WNP-3L	34	65	806	806
WNP-1L	35	67	813	813
Hydro-2W	35	67	41	10
Hydro-2E	37	72	62	15
Cogen-1W	38	74	240	60
Cogen-2W	39	76	29	7
Cogen-1E	39	76	240	60
CCCT-1	39	76	See Text	
Cogen-2E	40	78	29	7
MSW	41	80	30	30
WNP-3H	42	82	806	806
WNP-1H	43	83	813	813
Hydro-3W	46	90	50	13
Wind-1	47	92	29	7
Hydro-3E	48	94	76	19
Geothermal	51	107	350	88
SCCT-1	52	101	See Text	
Cogen-3W	53	103	563	141
Cogen-3E	54	105	563	141
Coal-2T	55	106	750	188
Coal-1T	55	106	1800	450
Hydro-4W	58	112	36	9
Cogen-4W	58	113	269	67
Coal-3T	58	113	750	188
Cogen-4E	59	115	269	67
Hydro-4E	60	116	53	13
Coal-5T	61	118	750	188
Coal-4T	62	120	750	188
Wind-2	64	123	381	95
Wind-3	72	140	253	63
Biomass	75	145	23	23
Solar	86	166	480	120

[1] Nominal levelized costs are calculated according to resource life. The following are multiplication factors:

Resource Life	Factor
20 years	1.53
30 years	1.77
40 years	1.97
50 years	2.14

to make steam. Because biomass moisture content may be highly variable, pre-drying is often prescribed so the fuel can be introduced to the boiler within an acceptable range of moisture content.

Like coal, wood can be gasified, producing CO and H₂, the primary constituents of syngas. When gasified, biomass yields a syngas with a much lower BTU content than coal. Biomass syngas can be introduced as a fuel directly into a gas turbine or internal combustion engine that is coupled to a generator. The gas needs to be cleaned, both to reduce sulfur and to eliminate the tars and lignins that plague biomass gasifier piping and contaminate the syngas.

The primary source of biomass fuel is mill and logging residues, but landfill byproducts such as methane, agricultural residues from fields, and municipal solid waste are other possible sources. (Municipal solid waste is dealt with in a separate section.)

Wood sources tend to have a high ash and moisture content. The higher the moisture content, the lower the heating value, because boiling off water absorbs some of the heat of combustion. Compared to coal, though, biomass fuels are relatively clean-burning, with much lower concentrations of sulfur and nitrogen, therefore producing lower SO_x and NO_x emissions.

At many mills, wood residue is burned to fire a boiler and generate steam for a turbine generator. In some instances, cogeneration is an attractive option for producing both electricity and process steam at these sites. (Cogeneration is covered in a subsequent section.)

Fuel preparation is a problem compared to liquid or gas combustion fuels, or even pulverized coal. "Hog fuel" or chipped and split chunks of wood can be fed to boilers or gasifiers. Sometimes more thorough preparation, such as drying and pelletizing, is done to ensure more uniform combustion or gasification. Various types of grates and hoppers are used to supply the burner or reactor continuously with fuel.

Operating Characteristics

Biomass power plant technology is available and widely used. The most critical requirement for operating a biomass plant is the assurance of a stable fuel supply. As long as an adequate supply of fuel is available, biomass-fired steam-cycle plants may be operated as baseload systems. Since they are steam boilers, they are not amenable to load-following applications.

The size of a plant is a function of location and the fuel transportation required. Plants in the 20 to 50 MW range are the most feasible. Larger plants require transportation of fuel over longer distances, which rapidly degrades the economics of a facility. For a plant with access to a reliable fuel supply, availability should run in the 70% to 80% range. Heat rates are somewhat high (15,000 Btu/kWh) because of the moisture content of the fuel. If biomass gasifiers are coupled to engines or combustion turbines, all the syngas fuel produced must be used as it is generated.

Costs

Cost data for a stand-alone biomass fired steam boiler is presented in Table 4-8. These estimates, including the cost of fuel, are derived from the draft 1991 Northwest Power Plan. Estimates for a gasification plant are not available. However, such a plant would not be competitive with a natural gas fired facility due the low Btu content of the fuel.

Environmental Characteristics

Environmental impacts of air emissions from biomass combustion are relatively less severe compared to some fossil fuels. Still, the impacts are substantial. Pollutants include CO₂ and some CO, NO_x, SO_x, particulates and hydrocarbons. NO_x and SO_x emissions are on the order of 50% and 25%, respectively, of those for coal combustion per MWh. CO and hydrocarbon emissions are controlled by using better burners and adjust-

ing the air/fuel ratio to complete combustion. Particulates can be reduced with baghouse filters, scrubbers and precipitators. As long as the amount of biomass fuel used is replenished by the same amount at the same rate by new growth, the net contribution to atmospheric CO₂ is zero.

**Table 4-8. Stand-Alone Biomass:
Cost and Achievable Potential
(FY 1991-2010)**

Biomass	
Plant Characteristics	
Operating Life (years)	30
Unit Size (MW)	22.5
Equivalent Availability (%)	80%
Anticipated Capacity Factor (%)	80%
Heat Rate (Btu/kWh)	15000
Costs (1990 \$)	
Capital (\$/kW)	1677
Fixed O&M (\$/kW/yr)	44.00
Variable O&M (mills/kWh)	3.7
Fixed Fuel (\$/kW/yr)	0
Fuel (\$/MMBtu)	2.60
Lead Times (Years)	
Preconstruction	2
Construction	3
Levelized Real Cost (mills/kWh)	
Public Financing	72
Private Financing	77
Levelized Nominal Cost (mills/kWh)	
Public Financing	141
Private Financing	150
Supply Forecast (aMW)	
Regional	90
BPA	90

Aside from combustion pollutants, there are environmental concerns associated with gathering, transporting and processing biomass resources and disposing of wastes.

Removing forest or agricultural residues after timber cutting or crop harvesting can impact soils. Since the harvesting cycle for agricultural residues

is more frequent than for forests, the soil impacts may be concentrated in a shorter time span.

Dust from wood stockpiles can be a problem, and there are always difficulties in transporting large quantities of residue from source to plant. Excessive use of roads and undesirable traffic through populated areas can also be a problem.

Cooling water requirements for turbine condensers can be significant, imparting thermal pollution to the water source, whether lake or stream. Biomass has a relatively high ash content and the residue must be disposed of properly in landfills.

Supply Forecast

Logging residue is the most likely fuel for a stand-alone biomass plant. Mill residue is consumed for other products or to produce steam for mill use. Cogeneration applications are already common for large mills. About 15 to 30 trillion Btus of logging residue is available on a regional basis at a average cost of \$2.60/MMBtu. This would be adequate for 100 to 300 MW of stand-alone generation. The developable resource, however, would be limited by competition with cogeneration applications, which would also be a more efficient use of the fuel. Therefore, for planning purposes, 90 aMW is assumed to be available to the region and BPA.

Coal Gasification

Technical Description

Several advanced coal technologies offer better heat rates (higher thermal efficiencies) and greatly reduced emissions compared to the conventional steam cycle coal plant. BPA and the Council assume that future coal plants in the Northwest will reflect advanced technology having the best environmental characteristics.

Coal gasification technology thermally decomposes solid coal into a high-quality fuel that can

Table 4-9. Coal Gasification: Derivation of Fuel Costs

	Coal-1T	Coal-2T	Coal-3T	Coal-4T	Coal-5T
Surrogate Site	Colstrip	Creston	Boardman	Thousand Springs	Western OR/WA
Assumed Coal Field	Colstrip	East Kootenay	East Kootenay	Uinta	East Kootenay
Costs (1990 \$/MMBtu)					
Minemouth	0.52	0.95	0.95	1.06	0.95
Track Upgrade	0.00	0.00	0.00	0.00	0.00
Rail Haul	0.00	0.35	0.50	0.30	0.71
Rolling Stock	0.00	0.04	0.05	0.03	0.08
Total	0.52	1.34	1.50	1.39	1.74
Real Escalation	1.0%	1.0%	1.0%	1.0%	1.0%

be burned in a combustion turbine. In gasification, the coal is partially oxidized, producing mostly CO and H₂, which are combustible gases. A subsequent acid process removes the sulfur from the gas stream and converts the reactants to hydrogen sulfide, which is easily removed. Gasification provides a clean, combustible gas, referred to as "syngas," that is almost entirely sulfur-free.

One of the most efficient coal combustion systems is a combined cycle plant that uses a combustion turbine as the topping cycle and a steam cycle plant as the bottoming cycle, with a gasifier as the fuel processor. The 100-MW Coolwater plant near Barstow, California has successfully demonstrated this design using an oxygen-blown gasifier. Compared to an air-blown gasifier, the Btu content of syngas from oxygen-blown gasifier is higher.

A combined cycle plant like Coolwater could be developed in stages. The first phase would be a combustion turbine, initially using natural gas or distillate oil as the fuel source. The second phase would add a steam cycle plant to take advantage of the exhaust heat from the gas turbine to extract steam for a steam turbine. Lastly, a gasification plant could be added and syngas from coal would become the final energy source.

Operating Characteristics

A coal gasification facility would be designed as a baseload generator, with optimum performance at design load. Part load operation is less efficient, and these plants are not designed for short term peaking operation. The thermal inertia of getting boilers, turbines and condenser up to design temperature inhibits quick response to variations in load. Availability is in the 75% to 85% range, and capacity factors generally exceed 65%; capacity factor is assumed to equal availability for planning purposes. Coal gasification plants have heat rates under 9,500 Btu/kWh.

Costs

Cost estimates for coal fired coal resources are derived from documentation prepared for Bonneville's 1990 Resource Program and updated to reflect current costs and assumptions. The coal resource is described as five blocks, each block representing a different site. These sites represent five potential areas in the Northwest that could support coal development. Although specific sites are identified, they represent surrogates for five different areas and should be considered as generic sites. Along with each site is a corresponding fuel source. These were selected as

**Table 4-10. Coal Gasification: Cost and Achievable Potential
(FY 1991-2010)**

	Coal-1T	Coal-2T	Coal-3T	Coal-4T	Coal-5T
Plant Characteristics					
Operating Life (years)	30	30	30	30	30
Unit Size (MW) [1]	420 (428)	420 (357)	420 (357)	420 (357)	420 (357)
Equivalent Availability (%)	70%	70%	70%	70%	70%
Anticipated Capacity Factor (%)	70%	70%	70%	70%	70%
Heat Rate (Btu/kWh)	9490	9455	9455	9490	9455
Costs (1990 \$)					
Capital (\$/kW)	2817	2209	2492	2546	2493
Fixed O&M (\$/kW/yr)	70.10	65.00	65.00	69.70	64.20
Variable O&M (mills/kWh)	0.9	0.8	0.8	0.9	0.8
Fixed Fuel (\$/kW/yr)	0	0	0	0	0
Fuel (\$/MMBtu)	0.52	1.34	1.50	1.39	1.74
Lead Times (Years)					
Preconstruction	2	2	2	2	2
Construction	5	5	5	5	5
Levelized Real Cost (mills/kWh)					
Public Financing	50	50	54	57	57
Private Financing	60	59	62	66	65
Levelized Nominal Cost (mills/kWh)					
Public Financing	97	98	105	111	110
Private Financing	116	115	121	128	126
Supply Forecast (aMW)					
Regional	1800	750	750	750	750
BPA	450	188	188	188	188

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

the most inexpensive fuel sources based on existing mining and transportation costs. Fuel costs are summarized in Table 4-9.

The capital and operating costs for the gasification technology are the same for each site and are based initially on the estimates published in the 1991 Northwest Power Plan. Capital costs are based on estimates originally developed in 1985. Several improvements in both combustion turbine and gasification technologies have occurred since that time, and estimates are currently being updated to reflect these changes. The capital costs reported in Table 4-10 reflect a 10% reduction from the estimates reported in the 1991 plan. This adjustment was made in anticipation of lower capital costs which are expected to be reflected in the revised estimates.

Environmental Characteristics

Because of combustion characteristics of gasifiers, NO_x emissions are inherently low and SO_x, carbon monoxide and particulate emissions are dramatically reduced compared to conventional coal technologies. Solid wastes are also less hazardous. Coal gasification is the cleanest method available of all the coal conversion technologies.

Mining, transportation and fuel handling problems are similar for both conventional and advanced coal technologies.

Supply Forecast

Table 4-10 summarizes the availability of the coal resource at each of the five surrogate sites.

These estimates are from the 1991 Northwest Power Plan and are consistent with Bonneville's assumptions in the 1990 Resource Program.

Cogeneration

Technical Description

Cogeneration is the sequential production of more than one form of energy output from one energy source. Cogeneration is particularly well-suited to process industries, such as pulp and paper and lumber and food processing, where large quantities of steam or heat are used for drying or to process materials and where plant electric loads are high. Typically, high pressure, high temperature steam can be used first in an electricity generation process, then bled off from a turbine for process heat.

Cogeneration is not new. Before large central generation plants came into vogue in the 1930s, as much as 50% of the electricity generated in this country came from cogenerators. Historically, most cogeneration plants involved large units in industrial facilities, from 5 to 50 MW.

Today, cogeneration plants are as diverse as the industries and commercial applications where they are found, and the technology employed is as varied as the kinds of fuels used. In wood industry plants, for example, wood waste must be disposed and is used as an energy source. But a whole variety of fuel types can be used in cogeneration. The breakdown of fuels for proposed cogeneration projects nationwide is as follows: natural gas, 58%; coal, 19%; and biomass waste and other fuels, 23%.

Following the encouragement of independent power production under the Public Utilities Regulatory Policy Act of 1978 (PURPA), smaller packaged system units fueled with natural gas have entered the market. These modules may be rated from 4 to 20 MW, and are suitable for hospitals, schools, prisons, hotels and other small commercial

and institutional applications. Rather than the traditional boiler/turbine arrangement of larger cogeneration systems, these packaged units may employ reciprocating internal combustion engines. They are likely to use heat recovery of the exhaust gases to serve secondary energy needs for hot water, drying or space heating, as well as for refrigeration and space cooling. These cooling applications use some of the heat recovery to drive absorption chillers.

Cogeneration technologies have reached commercial maturity and can be operated reliably with high availability and high capacity factors. As electricity prices increase, a threshold is reached where it makes economic sense to operate a cogeneration plant. At mills where process heat as well as electricity is needed, and wood residue is both a waste problem and a fuel opportunity, cogeneration can be an attractive solution. The option may not be as straightforward at a hospital or a university. Fuel sources must be stable in both price and availability to induce potential cogenerators to generate their own electricity.

Operating Characteristics

Cogeneration is particularly suited to sites that have a relatively constant thermal load requiring a stable fuel supply. For this reason, cogeneration makes a good baseload technology.

Costs

Regional estimates of cogeneration prepared by BPA and the Council used the output of the Cogeneration Regional Forecasting Model (CRFM) as the principle source. This model matches cogeneration technologies with facility types for subregions in the Northwest. The program performs a cost/benefit analysis for a subset of the configurations appropriate for each facility type. The objective is to find the configuration, operating mode and system size that maximizes the internal rate of return as seen by the project sponsor. This process yields a distribution for cogeneration supply as a function of internal rate of return. This is then converted to a quantity of

**Table 4-11. Cogeneration (East): Cost and Achievable Potential
(FY 1991-2010)**

	Cogen-1E	Cogen 2-E	Cogen-3E	Cogen-4E
Plant Characteristics				
Operating Life (years)	40	40	40	40
Unit Size (MW) [1]	25 (33)	10 (12)	10 (12)	10 (12)
Equivalent Availability (%)	80%	80%	80%	80%
Anticipated Capacity Factor (%)	80%	80%	80%	80%
Heat Rate (Btu/kWh)				
Lead Times (Years)				
Preconstruction	2	2	2	2
Construction	2	2	2	2
Levelized Real Cost (mills/kWh)				
Price	39	40	54	59
Levelized Nominal Cost (mills/kWh)				
Price	76	78	105	115
Supply Forecast (aMW)				
Regional	240	29	563	269
BPA	60	7	141	67

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

cogeneration at different sellback prices. The price a utility has to pay for cogeneration is treated as a cost from the supply forecast perspective.

For planning purposes the cogeneration potential was divided into four price blocks. Each block represents a quantity of cogeneration potential at a given price as defined by the CRFM. These four blocks were then divided into two groups, one east and one west of the Cascades. The group east of the Cascades includes the transmission adjustment described earlier.

Environmental Characteristics

Environmental effects of cogeneration depend primarily on the type of fuel used. Plant emissions for biomass, coal, natural gas or other fuels would be similar to any combustion facility using these fuels. Compared to large central power stations, though, emissions would be of much smaller scale and very much localized. Emissions may be less concentrated and more dispersed, but are likely to be found within large population

areas, whereas large central power plants are often remote from population centers.

Because cogeneration plants satisfy thermal energy as well as electricity needs with a single energy source, there is less overall pollution than if separate energy sources were used for these purposes. Cogeneration fuel sources tend to maximize the use of the available energy. On the other hand, multiple small units may be less efficient than a large single unit for the same level of production. This may be the case for installations that produce excess electricity beyond the amount matched to the secondary thermal load for a site. In this case, the byproduct thermal energy made available through cogeneration is not used as efficiently.

Another issue, sometimes overlooked, is that developing small scale electricity supplies for buildings such as packaged cogeneration units may miss the opportunity to concentrate on energy efficiency in buildings. Gains in energy efficiency are also likely to reduce pollution because less fuel combustion is required to meet an equivalent level of electrical service.

**Table 4-12. Cogeneration (West): Cost and Achievable Potential
(FY 1991-2010)**

	Cogen-1W	Cogen 2-W	Cogen-3W	Cogen-4W
Plant Characteristics				
Operating Life (years)	40	40	40	40
Unit Size (MW) [1]	25 (33)	10 (12)	10 (12)	10 (12)
Equivalent Availability (%)	80%	80%	80%	80%
Anticipated Capacity Factor (%)	80%	80%	80%	80%
Heat Rate (Btu/kWh)				
Lead Times (Years)				
Preconstruction	2	2	2	2
Construction	2	2	2	2
Levelized Real Cost (mills/kWh)				
Price	38	39	53	58
Levelized Nominal Cost (mills/kWh)				
Price	74	76	103	112
Supply Forecast (aMW)				
Regional	240	29	563	269
BPA	60	7	141	67

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

Supply Forecast

The CRFM model contains a database of facilities which could potentially install cogeneration equipment. These range from refineries and paper mills to hospitals and commercial buildings. The model attempts to match various cogeneration technologies with each facility. Additional economic assumptions are made regarding fuel prices and the price at which the facility could sell electricity back to the utility.

As with the cost analysis, the model's objective is to select systems that maximize the developer's internal rate of return and yield a supply curve for cogeneration. Assumptions are made regarding penetration rates (actual decisions to install the cogeneration equipment) at different levels of return. The penetration curve reduces the distribution of supply to an expected value for developed cogeneration and the results are aggregated to the regional level. The final result is a generic estimate of cogeneration potential. However, there is no site or project-specific information in the output. Tables 4-11 and 4-12 show the cost and availability of cogeneration, using a 50/50

east/west division based on the relative distribution of potential cogeneration facilities.

Combustion Turbines and Displaceable Resources

Technical Description

Combustion turbines (CTs), also called gas turbines, are based on the technology used in jet engines. Large CTs designed for utility applications, known as frame machines, are configured for heavy duty use. Weight is not a primary consideration. In the basic CT design, a compressor packs large amounts of air into a combustor at high pressure. Fuel is added to the air and burned in the combustor, releasing heat energy and producing a high temperature, high pressure exhaust gas. This gas is expanded through a turbine, which powers the compressor and generator.

Natural gas or distillate oils are the primary fuels used in combustion turbines. Gasified fuels, such as the syngas derived from coal, are also potential fuel candidates. (Gasified coal is covered elsewhere in this report.) The heat rate (Btu/kWh) for simple cycle gas turbines is about the same as for steam turbine generation. Combustion turbine technology, however, is still improving and more efficient machines are being developed.

The inefficiency of a combustion turbine can be seen in the high temperatures of the gases discharged from the turbine. There is significant available energy in the exhaust gases which can be directed to a heat recovery process. One way to take advantage of this available energy is to use steam injection (which also has the benefit of reducing NO_x emissions). In a steam-injected turbine, hot exhaust gases are recirculated to heat pressurized water into superheated steam. The steam is then injected into the combustor of the turbine and mixed with compressed inlet air. The additional inlet steam helps drive the turbine.

CT efficiency can also be improved by using multi-stage compressors with inter-cooling between stages, and by operation at higher turbine inlet temperatures. Currently, turbines operate at temperatures around 2000 °F, but improvement in heat tolerant materials can increase this limit to more than 2300 °F.

The high thermal energy in the turbine exhaust makes CTs ideal in cogeneration applications where high grade process heat is used in addition to electricity. Another way to take advantage of the energy in the exhaust gases is to use the combustion turbine as the "topping cycle" in a combined cycle plant.

A combined cycle power plant couples a combustion turbine with a steam cycle plant to generate power more efficiently. Electricity is first generated from the combustion turbine. The exhaust gases from the CT then become the heat source for raising water to steam in a steam cycle system. The combustion turbine cycle is referred to

as the "topping cycle" and the steam turbine cycle as the "bottoming" cycle.

Combined cycle plants are designed to maximize the thermal efficiency of a power plant by using the available energy in the combustion turbine's high temperature exhaust gases. The key to the combined cycle is the heat recovery steam generator system, which takes the place of the steam cycle boiler. Typical steam conditions in a heat recovery steam generator are 900-1000 °F and 1000-1500 psi. Instead of rejecting heat to the environment at gas turbine temperatures of more than 1000 °F, the combined cycle eliminates heat at the steam cycle condenser temperature, which is the temperature of available cooling water, around 50-70 °F.

Combustion turbine technology is proven and widely used. CTs are simple, reliable and easy to site. They can be installed with a minimum of site renovation and preparation because they are so compact and do not require additional equipment such as cooling towers or elaborate fuel processing subsystems.

Operating Characteristics

Combustion turbines can be operated to meet both capacity and energy loads. CTs can respond quickly to demand changes; however, maximum efficiencies are obtained when operating at design capabilities. Because of high fuel costs, CTs tend to be used at a constant rate for a limited period of time. CTs can be fired up quickly and have proved effective in meeting "needle peak" loads and fluctuations due to extreme weather conditions.

CT availability factors are in the 80% or 90% range. They are candidates for meeting baseload needs and can also be used for firming. Simple CTs operate at heat rates of 11,000 to 12,000 Btu/kWh. Combined cycle applications operate at heat rates of 7,500 to 8,500 Btu/kWh. CTs used to "firm up" or supplement nonfirm hydro may operate at capacity factors from 15% to 40%. When operated to meet short-duration capacity

**Table 4-13. Combustion Turbines:
Cost and Achievable Potential
(FY 1991-2010)**

	SCCT	CCCT
Plant Characteristics		
Operating Life (years)	30	30
Unit Size (MW)	139	420
Equivalent Availability (%)	84%	83%
Anticipated Capacity Factor (%)	84%	83%
Heat Rate (Btu/kWh)	11480	7620
Costs (1990 \$)		
Capital (\$/kW)	788	894
Fixed O&M (\$/kW/yr)	2.20	5.80
Variable O&M (mills/kWh)	0.2	0.4
Fixed Fuel (\$/kW/yr)	0	0
Fuel (\$/MMBtu)	1.72	1.72
Lead Times (Years)		
Preconstruction	2	2
Construction	2	2
Levelized Real Cost (mills/kWh)		
Public Financing (see text)	51	38
Private Financing (see text)	53	40
Levelized Nominal Cost (mills/kWh)		
Public Financing (see text)	99	74
Private Financing (see text)	103	78
Supply Forecast (aMW)		
Regional	See Text	
BPA	See Text	

needs, CTs operate at relatively low capacity factors on the order of 5%.

Combined cycles can be designed and operated to phase in the CT first, with the steam cycle portion added later. Commercial combined cycle technology is available and likely to be put into service as fuel costs increase.

Costs

Table 4-13 shows capital and operating costs for both single cycle and combined cycle combustion turbines. These costs are based on the General Electric MS7001F combustion turbine. Both the single and combined cycle configurations

have dual fuel capability as well as 14 days of oil storage capability.

Since CTs would normally be run to displace other higher cost resources, capacity factor is not an accurate measure of their performance. If CTs were run in a baseload mode, their capacity factor would equal their availability. The levelized costs shown in Table 4-13 reflect this baseload operation.

Environmental Characteristics

CTs using natural gas are relatively clean burning. Only NO_x emissions tend to be a problem, because of high combustion temperatures, but significantly less so than in coal combustion. NO_x can be controlled with water or steam injection into the CT combustor, eliminating up to 80% of the NO_x. In this case, water use and visible steam plumes become an environmental concern, but water use can be minimized by

reusing the condensed exhaust steam for steam injection.

If oil fuels are used, there is some sulfur dioxide pollution. Exhaust gas SO_x can be mitigated with scrubbers, which adds to CT costs. As in all combustion technologies, significant amounts of CO₂, a "greenhouse" gas, and waste heat are produced. Simple cycle CTs release waste heat directly to the atmosphere, so cooling water is not required.

Since CTs tend to be sited close to where transportation and transmission lines meet, effects on urban environments need to be considered. As with jet planes at airports, CT noise can be a problem. Typical noise levels at 1,200 feet

from operating CTs run at 65 to 70 dB. Silencing packages can reduce this to a rated 51 dB at 400 feet.

Environmental impacts for combined cycle plants are the combined impacts of steam power plants and combustion turbines, net of the improvement in efficiency for the combined processes as compared to separate ones.

Supply Forecast

The amount of power available from the Northwest hydro system varies from year to year. "Firm energy" is defined as the amount of energy the system could produce during a recurrence of critical water conditions. In most years, the hydropower system generates more than this amount. Any generation in excess of firm energy is called "nonfirm" energy. The Federal System produces between 2,600 and 3,000 aMW of nonfirm energy in an average water year. Over the past ten years, BPA has sold an average of over 1,000 aMW outside the region and 5,550 aMW within the region as nonfirm power, in addition to serving the DSI "top quartile."⁷ Available nonfirm energy can be used in conjunction with another resource to "firm it up" and serve BPA's firm loads.

Use of nonfirm energy in conjunction with other resources can be accomplished a number of ways. These include coordination with Canadian utilities; additions of displaceable firm resources, such as CTs, to the system; load management techniques; supplemental energy contracts with the Pacific Southwest; or adding reservoir capacity to the existing Federal System. The cost of any strategy in meeting BPA loads depends on the value and availability of nonfirm, and the feasibility and costs associated with the strategy.

The Draft 1992 Resource Program estimates that 1,600 aMW nonfirm could be converted to firm energy through a combination of 1,050 aMW

of Pacific Northwest CTs and 550 aMW of extra-regional resources. The latter would consist of contractual arrangements with out-of-region parties, specifically utilities in California and the Southwest. BPA could arrange to purchase energy from the Pacific Southwest when water conditions in the Federal System are insufficient to meet BPA's firm loads. BPA might pay a small reservation charge for this privilege, and then pay the costs the Pacific Southwest would incur to produce and transmit energy when needed by BPA. Since the costs for obtaining power from the Pacific Southwest are uncertain, the analysis assumes that those costs would equal 32 mills, the cost of building a CT in the Pacific Northwest.

The quantity of combustion turbines installed is not inherently limited. Typical constraints include the ability to site and fuel supply availability. These constraints will pose less of an impediment for the first increment of turbines than for subsequent installations.

Geothermal

Technical Description

Geothermal energy taps the heat available below the earth's surface. Heat, water and permeable rock in combination are the needed for a hydrothermal power generation resource. Generally, wherever tectonic plates adjoin there is the potential for geothermal resources. At these points, the earth's mantle is relatively thin and fault systems give way to earthquakes and volcanos; and magma protrudes close to the surface, bringing geothermal heat with it. High temperature gradients found in drilling, hot springs and geysers, as well as certain kinds of geologic formations and geochemistry, provide evidence of possible hydrothermal systems. The biggest problem with developing geothermal energy is finding the resource.

⁷Under its power sales contracts, in limited circumstances BPA has the right to curtail service to one-quarter of the DSI load for short periods.

Drilling to depths as much as 10,000 feet is often required in order to locate a production well and bring geothermal steam or fluid to the surface where it can be processed through a power plant. Prospecting for high quality geothermal reservoirs is a risky and expensive business.

There are three principal types of geothermal conversion technologies used in power generation: dry steam, flash and binary cycle plants. In dry steam systems the geothermal resource is a gas at temperatures in excess of 350 °F. High pressure geothermal steam is drawn up through wells as a gas and goes directly through a turbine; then it condenses to a liquid and is injected back into the reservoir.

In flash systems, the geothermal resource is found as a pressurized liquid brine at temperatures greater than 350 °F. Because the resource is a fluid under high pressure, it must be "flashed" (depressurized to a gas state) before it can be processed through a turbine. When geothermal fluid flashes, only a portion of the liquid becomes steam, while the rest remains as a high pressure liquid. Depending on the temperature and pressure of the brine as it leaves the wellhead, geothermal fluid may be flashed twice in sequence to maximize the quality or proportion of steam possible from the fluid.

Binary systems extract heat from geothermal fluids that have relatively low temperatures, less than 300 °F. A binary system must use another working fluid besides the geothermal brine (such as Freon) that has a low boiling point compared to water. A binary system includes a geothermal loop, a working fluid loop and a cooling loop, but all three are separate and do not mix. The geothermal loop imparts heat to the working fluid in an evaporator where the working fluid boils to a gas. The hot gas expands through a turbine-generator. Finally, the cooling loop runs through a heat exchanger and condenses the working fluid. Binary systems have used geothermal resources with temperatures as low as 177 °F.

Resource temperature and pressure dictate the choice of technology employed at a particular

geothermal site. Geothermal energy is being used worldwide with a high degree of success. In California, at the Geysers field alone, about 2000 MW of on-line capacity taps a dry steam geothermal reservoir. Other active geothermal regions in the U.S. include the Basin and Range geologic province covering parts of Utah, Nevada and Idaho; and California's Imperial Valley.

Typically, geothermal plants are sited in 20 to 50 MW units, but modular systems as small as 5 MW have been developed. One advantage of small-scale modular units is that they can help evaluate a reservoir's characteristics while generating power.

Operating Characteristics

Geothermal power is a baseload energy source, with high availability and high capacity factors ranging up to 95%. The high capacity factors observed at plants in California, Nevada and Utah are due in part to a combination of redundant equipment, conservative nameplate ratings and contractual incentives.

Costs

The Council's Staff Issue Paper 89-36, "Geothermal Resources," developed a range of costs based on geothermal conversion technologies at sites with defined geothermal resources. Costs would be expected to vary depending on site specific conditions. Table 4-14 shows the cost data used by BPA and the Council for the geothermal resource. These costs are based on the representative Basin and Range plant used in the 1991 Northwest Power Plan.

Environmental Characteristics

Depending on the kind of conversion technology and the size of the facility, geothermal resource development can have significant environmental impacts. Some of impacts may apply only to binary, flashed or dry steam systems, but not all three. Plant size, siting and operation and

maintenance practices also affect the magnitudes of these impacts can be mitigated and geothermal energy can provide a reliable, relatively clean generation alternative.

Geothermal energy conversion requires processing large quantities of fluids and gases. Dry steam systems (and flash steam systems, to

**Table 4-14. Geothermal:
Cost and Achievable Potential
(FY 1991-2010)**

	Geothermal
Plant Characteristics	
Operating Life (years)	30
Unit Size (MW) [1]	25 (27)
Equivalent Availability (%)	90%
Anticipated Capacity Factor (%)	90%
Heat Rate (Btu/kWh)	0
Costs (1990 \$)	
Capital (\$/kW)	3107
Fixed O&M (\$/kW/yr)	13.00
Variable O&M (mills/kWh)	6.5
Fixed Fuel (\$/kW/yr)	0
Fuel (\$/MMBtu)	0.00
Lead Times (Years)	
Preconstruction	2
Construction	2
Levelized Real Cost (mills/kWh)	
Public Financing	48
Private Financing	55
Levelized Nominal Cost (mills/kWh)	
Public Financing	92
Private Financing	107
Supply Forecast (aMW)	
Regional	350
BPA	88

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

some extent) introduce non-condensable gases — particularly hydrogen sulfide (H₂S) — into the environment. H₂S can accumulate in low pockets and threaten plant species and wildlife. Carbon dioxide, another non-condensable gas, is also

and kinds of expected impacts. However, many discharged into the atmosphere in significant amounts, but the concentration of CO₂ is about 3% per kWh of that emitted by a coal plant. Other contaminants from geothermal steam pose a less serious hazard compared to hydrogen sulfide.

Large quantities of cooling water are needed to operate the cooling system. Condensed steam can be used as a coolant, augmented by additional water supplies. Water needs for power generation, particularly in arid areas, may conflict with local agriculture, mining or other uses.

Water quality can be a problem at a geothermal site. Brine coming to the surface from supply wells and returning through injection wells has the potential to contaminate local water tables. Most geothermal fluids are highly saline and contain trace toxic elements such as boron, mercury, lead, ammonia and arsenic. Manganese and iron also may be found, which makes water acidic. Also, there is the potential for leakage into shallow aquifers or accidental release of brine into streams or lakes.

Like any major construction activity, geothermal site development has a major impact on local communities. There is heavy road use, land erosion, disruption of local ecosystems and noise. Some of these effects are transitory, while others continue during plant operations. Energy production may require only about 20 to 100 acres for a 50 MW plant, but the exploration, drilling, construction and operation facilities may encompass several hundred acres.

Another concern in geothermal operations is the maintenance of the geothermal reservoir. Normally, reinjection of the brine helps recharge fluids into a geothermal reservoir and prevent subsidence of the wellfield. Injection, on the other hand, also may induce seismic activity due to high local pressures from the reentrant fluid.

Aesthetics are a major concern. The visual impact of a wellfield and power plant facilities may be objectionable, especially in pristine areas such as the Cascade Range where many potential geothermal sites exist.

Alternatives to using water for wet cooling include dry cooling towers, which are large and expensive, and reuse of geothermal steam after it condenses as a cooling water source. Slant drilling to locate several wells from one pad reduces land impacts. Loud noises caused by steam release at wells can be muffled to avoid hearing injury to field workers. Risks associated with hazardous wastes can be minimized by good safety practices and accident prevention in transportation and handling. Some wastes can be incinerated and rendered harmless.

In general, geothermal steam or brine chemistry, the conversion technology used, and the characteristics of the geothermal reservoir will dictate the primary environmental concerns associated with a particular plant. Each site poses its own environmental problems which must be dealt with on a site-specific basis.

Supply Forecast

The technology of geothermal energy is well established and demonstrated. However, it can only be applied where a recoverable geothermal heat source exists. The only demonstrated use of geothermal energy in the Northwest is a now defunct binary cycle demonstration plant at Raft River, Idaho.

The most likely locations in the Northwest for geothermal development are the Basin and Range province (southeastern Oregon and southern Idaho) and the high Cascades of southern Oregon. Table 4-14 shows 350 aMW of regional geothermal resource to be available. This is based on the representative Basin and Range plant used in the 1991 Northwest Power Plan.

Hydroelectricity

Technical Description

Water power is one of the oldest, simplest forms of power. In its modern manifestation, the

potential energy of water is released as it drops a significant elevation through a turbine to generate electricity. Water is piped to the turbine through a penstock, starting at the forebay, or entrance to the penstock. Available energy is proportional to the elevation difference between the forebay and the turbine blades. This height is often referred to as the "head."

Hydroelectric projects either have dams associated with them to store water and create head, or are "run-of-river" plants that take a portion of a river's flow out at a high elevation, drop it through a penstock and turbine, and release it at a lower level. Most of the potential projects in the Puget Sound area, for example, are small run-of-river designs.

Planners make a distinction between firm and non-firm energy generated by the hydro system. Firm energy is energy that is available under critical water conditions, determined by examining the flow records available for the river or stream and assessing historical low flows. This determines how much flow and hence energy can be anticipated. Nonfirm energy is produced by water flows above the critical flows. Since firm energy is reliable, it has a higher value than nonfirm. Precipitation and stream flows vary greatly from year to year, so non-firm energy availability, on the other hand, tends to be quite variable.

Operating Characteristics

To determine the operating characteristics at a particular site, information on the local hydrology must be examined. If not provided by the developer, planning models are used to estimate flows based on data such as drainage areas above the site, precipitation records and information on local groundwater conditions. Hydrologic conditions vary greatly over the region, even within basins and sub-basins. In the west, winter storms produce immediate high flows, while in the east, flows lag behind precipitation, coming predominantly from melting snow in the spring. Elevation also affects the shape of project output.

**Table 4-15. Hydro (East): Cost and Achievable Potential
(FY 1991-2010)**

	Hydro-1E	Hydro-2E	Hydro-3E	Hydro-4E
Plant Characteristics				
Operating Life (years)	50	50	50	50
Unit Size (MW) [1]	10 (11)	10 (11)	10	10
Equivalent Availability (%)	48%	36%	37%	36%
Anticipated Capacity Factor (%)	48%	36%	37%	36%
Heat Rate (Btu/kWh)	0	0	0	0
Costs (1990\$)				
Capital (\$/kw)	1188	1457	1959	2344
Fixed O&M (\$/kW/yr)	23.00	29.00	39.00	48.00
Variable O&M (mills/kWh)	0	0	0	0
Fixed Fuel (\$/kW/yr)	0	0	0	0
Fuel (\$/MMBtu)	0.00	0.00	0.00	0.00
Lead Times (Years)				
Preconstruction	3	3	3	3
Construction	3	3	3	3
Levelized Real Cost (mills/kWh)				
Public Financing	20	33	43	53
Private Financing	25	42	54	67
Levelized Nominal Cost (mills/kWh)				
Public Financing	38	63	83	103
Private Financing	49	81	105	131
Supply Forecast (aMW)				
Regional	55	62	76	53
BPA	14	15	19	13

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

Costs

The cost projections for projects in the database are either supplied by potential developers or calculated by the Hydropower Analysis Model (HAM), contained within the Pacific Northwest Hydropower Data Base and Analysis System (NWHS) model. This algorithm uses individual developer estimates if available from permit and license applications. When consistent estimates are not available, the model develops a cost estimate from the physical characteristics contained in the application. All of the cost estimates are then aggregated into generic cost categories (see Tables 4-15 and 4-16).

Environmental Characteristics

None of the projects considered in the projection of potential are located in the Council's Protected Areas. This screens out any projects that might have an impact on anadromous fish populations.

A hydroelectric project that has an impoundment (the capability to store water) associated with it would generally have a more severe impact than a run-of-river project. This would especially be true for large impoundments, above 100 acres.

**Table 4-16. Hydro (West): Cost and Achievable Potential
(FY 1991-2010)**

	Hydro-1W	Hydro-2W	Hydro-3W	Hydro-4W
Plant Characteristics				
Operating Life (years)	50	50	50	50
Unit Size (MW) [1]	10 (11)	10 (11)	10	10
Equivalent Availability (%)	48%	36%	37%	36%
Anticipated Capacity Factor (%)	48%	36%	37%	36%
Heat Rate (Btu/kWh)	0	0	0	0
Costs (1990\$)				
Capital (\$/kW)	1060	1329	1831	2216
Fixed O&M (\$/kW/yr)	23.00	29.00	39.00	48.00
Variable O&M (mills/kWh)	0	0	0	0
Fixed Fuel (\$/kW/yr)	0	0	0	0
Fuel (\$/MMBtu)	0.00	0.00	0.00	0.00
Lead Times (Years)				
Preconstruction	3	3	3	3
Construction	3	3	3	3
Levelized Real Cost (mills/kWh)				
Public Financing	18	31	41	51
Private Financing	23	39	52	65
Levelized Nominal Cost (mills/kWh)				
Public Financing	35	59	79	99
Private Financing	45	75	100	125
Supply Forecast (aMW)				
Regional	36	41	50	36
BPA	9	10	13	9

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

Supply Forecast

Tables 4-15 and 4-16 summarize the projected potential for the hydroelectric resource. This procedure used to generate estimates of potential uses the Pacific Northwest Hydropower Supply Model. This model uses data from the NWHS on cost, capacity and output, combined with regional environmental information from the Northwest Environmental Data Base. The Protected Areas identified by the Council defines those areas which should not be developed due to anadromous fish impacts.

The procedure used to develop estimates of potential for this study involves several steps:

- Sites located in Protected Areas were screened out of the analysis.

- The remaining projects could have environmental problems that may preclude development. In addition, the technical characteristics of many sites have not been fully explored, leading to the possibility that development may not be feasible for engineering, environmental or economic reasons. To account for these factors, probabilities of completion were assigned based on the stage at which the project stands in the regulatory process (from permit pending to license granted), the layout of the project (diversion to canal), the status of the waterway structure (existing to undeveloped), and the value of the environmental resources at the site which would be affected by development.

- These probabilities (ranging from 20% to 95%) were applied to the capacity and energy potential of each project to obtain a probable contribution. The probable contributions of individual projects are then summed to obtain the regional potential.

This method produces a statistical estimate of the expected developable hydropower without the need to determine if specific individual projects should be developed — a determination that would be inappropriate given the limited information available on specific projects and stream reaches.

It is important to remember that even though a specific project is included in the estimate of potential it does not mean the site will or will not be developed. This methodology is intended to provide a macro assessment of resource potential. The presence or absence of a specific project has a minor effect on the overall projection for the small hydro resource.

Municipal Solid Waste

Technical Description

Municipal solid waste (MSW), more commonly known as garbage, can be burned without sorting in a "mass burn" facility. A common technology for mass burn is the European waterwall incinerator. In this design, MSW fuel is pushed onto a sloping reciprocating grate by a hydraulic ram. After the fuel is introduced into the incinerator, it passes through a drying zone, a combustion zone and finally a burnout zone. The waterwall is the heat transfer surface in the incinerator where water is heated to steam at 835 °F and 900 psia which drives a turbine-generator.

Flue gases, coming out of the incinerator, pass through a lime scrubber to remove the SO₂, HCl and other gases, then through a baghouse to eliminate fly ash containing heavy metals, furans, dioxins and other toxic compounds. Bottom ash

off the incinerator grate and captured fly ash are disposed of in a lined ash monofill. The MSW fuel in this case contains 25% ash and 4500 Btu/lb. The low heating value is due to high moisture and low grade fuel quality; both lignite coal and biomass have higher Btu content.

Mass burning is the most common MSW technology and is currently being used in Japan, at hundreds of sites in Europe, and at a few in the United States. An alternative to raw MSW is refinement of the combustible materials by removing undesirable components such as metals, plastics and excessive moisture. This higher quality fuel is referred to as refuse-derived fuel or RDF.

The key to a RDF plant operation is the front-end waste separation process. In one design, flailing, trommell screening, magnetic separation of metals and size reduction prepare a fuel that contains about 15% ash and 5900 Btu/lb. At some sites, the major problem with RDF is securing an assured supply of the fuel. RDF is also used to supplement other fuels, such as hog fuel wood burners.

Gasification may be another option for burning MSW. Gasification first converts a fuel into a product rich in H₂ and CO called syngas. H₂ and CO gases are the main constituents that have significant heating value; they can be burned cleanly in a boiler or gas turbine. SO_x and other pollutant compounds can be filtered or scrubbed from the syngas, and diverted away from the combustion burners. The advantages of gasification is that it separates the fuel processing from the actual combustion and provides a clean-burning fuel.

Operating Characteristics

Most MSW plants in the United States are sized between 40 and 60 MW. Expectations are for smaller sized plants in the region of about 10 MW, operating between 65% and 80% capacity. There is a plant near Salem now operating at 12 MW. Forecasters estimate as much as 380 MW

may be regionally available by 2000. By design, MSW plants — whether mass burn, RDF or gasification — will be baseload operations. Consistency and availability of fuel are key factors in determining plant availability and capacity factors.

**Table 4-17. Municipal Solid Waste:
Cost and Achievable Potential
(FY 1991-2010)**

Plant Characteristics	Municipal Solid Waste
Operating Life (years)	30
Unit Size (MW) [1]	10 (12)
Equivalent Availability (%)	80%
Anticipated Capacity Factor (%)	80%
Heat Rate (Btu/kWh)	0
Costs (1990 \$) - see text	
Variable (mills/kWh)	41
Lead Times (Years)	
Preconstruction	2
Construction	3
Levelized Real Cost (mills/kWh)	
Price	41
Levelized Nominal Cost (mills/kWh)	
Price	81
Supply Forecast (aMW)	
Regional	30
BPA	30

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

Costs

Table 4-17 shows the price of energy from a hypothetical 10 MW MSW plant. This price reflects the region's long-term avoided cost. The price of electricity is a function of the tipping fee charged to haulers for receiving wastes. The cost of electricity is determined by the avoided costs of the utilities serving the area where the plant is located and the tipping fee is then determined. If the fee is higher than other disposal alternatives,

then the MSW plant would not be economic to build.

Environmental Characteristics

MSW plants are primarily garbage reduction sites, helping communities with an alternative to a growing environmental problem. In this respect, MSW plants are an environmental credit. But the pollutants from air emissions are significant. In some locales, there has been vociferous campaigning against MSW plant siting. Municipalities burning solid waste have been concerned primarily with toxic emissions, especially the dioxins and furans that originate from plastics.

Dioxins are very stable, and may be taken up through the food chain and absorbed in animal fatty tissue. The Environmental Protection Agency has classified dioxins as "probable" human carcinogens. One form of dioxin, 2,3,7,8-tetrachlorodibenzo-p-dioxin, is potentially one of the most potent human carcinogens. However, studies of operating MSW plants linking furans and dioxin deposits to local emissions are inconclusive.

Because of the diversity of materials comprising the fuel, there is also the potential to discharge trace amounts of metals such as arsenic, cadmium, nickel, mercury, cadmium and other chemical compounds such as fluorides and polychlorinated biphenyls (PCBs). Sixty percent of the cadmium and mercury discharge from MSW plants comes from nicad, alkaline and mercury batteries.

Some pre-sorting of waste would help to cut ash residue and diminish emissions of HCl, HF, CO, NO_x and heavy metals. Refuse-derived fuel eliminates some unacceptable garbage. Many of the compound chemical pollutants can be eliminated by exposing them to high burn temperatures of 1800 to 2000 °F in baghouses for several seconds and using electrostatic precipitators.

RDF would be a better environmental choice than mass burn MSW simply because the fuel

source is better controlled to eliminate unacceptable elements such as plastics and metals.

Ash byproducts, which may be toxic in concentrated amounts, must be disposed of in a lined landfill. If this is not done carefully, leachates from ash deposits can contaminate water tables or streams and lakes.

There are also technologies being developed that can degrade HCl and may be useful in the future to provide better control of MSW air pollution. These include electron beam radiation and selective catalytic converter technologies.

Supply Forecast

MSW plants are built principally to help alleviate local waste disposal problems. In order for a plant to be viable, many factors, including tipping, fees, electricity avoided costs, disposal alternatives and community support, must all be lined up in favor of the plant. These plants have historically required long lead times and have met with public opposition. Because of these factors and the relatively low avoided costs in the region, significant development is not expected for planning purposes. However, Table 4-17 shows 30 aMW assumed to be available.

Solar

Technical Description

Solar Thermal. Solar thermal plants are similar to other thermal generation plants — they convert heat energy into electricity through a turbine-generator. Solar energy is highly variable both during the day and between seasons. It is not available at night and is greatly diminished during cloudy weather. Because solar radiation is widely dispersed, it must be gathered and concentrated to be useful in a solar thermal system. This requires large arrays of panels with controls and mechanisms to reflect and focus the incident light and direct it to a heating unit. Solar thermal sta-

tion heating units have high absorptivity for trapping and retaining incident radiation and then transferring the energy to a working fluid.

Collectors for solar thermal generators are characterized by large surface areas for capturing sunlight and specific geometric shapes for concentrating the radiant energy. There are three main types of collectors: central station receivers, line-focus parabolic troughs and point-focus parabolic dishes. In central station receivers, movable mirrors, called heliostats, track the sun and reflect its energy to a central receiver mounted on a tower.

The best example of a central receiver station is the 10 MW plant in Barstow, California which has operated since 1982. The system has 1,818 individual tracking heliostats with 766,000 sq ft of reflective surface. In its operating history the plant has produced 11.7 MW peak power, with a 10% capacity factor and a maximum annual output of 8816 MWh.

Parabolic in-line troughs are the solar thermal power technology most used by utilities. The reflective trough is bent into a parabolic shape for its entire length, and concentrates the sun's energy along a line parallel to the trough. Along this line, receivers are run to capture the concentrated energy. Because many of these systems are designed to be stationary, elaborate tracking mechanisms and controls are not needed. Troughs are typically oriented north-to-south and lie horizontally. This configuration tends to offer the best tradeoff between maximizing capacity and keeping first costs and maintenance costs down. If energy is to be maximized instead of capacity, other orientations — such as tilting or tracking the troughs toward the sun — can be considered.

Receivers for in-line parabolic troughs are a specially coated pipe inside a glass vacuum tube. One company, Luz International, which operates the world's seven largest solar thermal plants, uses a synthetic oil as a heat transfer fluid. The oil reaches 753 °F and runs through a heat exchanger to superheat the steam that drives a

turbine-generator. With this design, solar thermal conversion efficiency has improved to about 29%.

Point-focus parabolic dish systems are single dish units focusing the solar energy to a single focal point where the receiver is located, like a flashlight reflector in reverse. Unlike in-line troughs, the parabolic reflector must track the sun continuously on two axes. One axis allows for tracking east to west during the day; the other axis allows for tracking north to south as the sun's declination changes with the seasons. Because of this system's requirement for accuracy and reliability to work effectively, fabrication is difficult and expensive.

Some point-focus systems have external heat engines, such as a reciprocating Stirling, that absorb heat directly and turn generators. Others have a system of fluid lines connecting each receiver and carrying a heat transfer fluid, which in turn is used in a turbine-generator. Compared to the in-line parabolic reflectors, the point-focus systems can concentrate much more energy. As of 1987, there were four point-focus reflector pilot projects testing various engine and generation technologies.

Photovoltaic. Photovoltaic cells (PVs) use the photoelectric effect to convert the sun's radiation directly into DC power. In PV cells, sunlight strikes a semiconductor material, typically treated silicon, and frees up electrons which generate DC current. The DC power is then conditioned through an inverter with controls to produce AC current.

There are two main types of PV systems: flat-plate and concentrating. Flat-plate systems are usually deployed as groups of cells in stationary panels. Thus, the incident sunlight upon the cells varies markedly throughout the day and seasonally as the angle of the sun's rays changes. Concentrating systems, on the other hand, track the sun throughout the day and are outfitted with lenses to concentrate the sunlight.

PV cells are usually grouped together into waterproof modules that range from 0.1 to 2.0 m², and are laid out side by side in banks to form

arrays. A typical PV cell produces less than 2 amps at about 0.6 volts (about 1.2 watts). Commercial PV flat-plate cells can achieve about 12% efficiency in converting sunlight into electrical energy. Concentrating systems have reached better than 26% efficiency using a single-crystal silicon material. Multiple thin-film layered cells currently under development can theoretically reach 42%.

Although the costs of producing PVs are coming down and efficiencies are going up, the technology is still very expensive. Single-layer thin film cells, the least costly to manufacture, also have very low conversion efficiency, about 4% to 6%. For this technology to reach wide market acceptance, analysts estimate that efficiencies would have to reach a threshold conversion efficiency of 15%; laboratory versions have reached 12%. As more and more PVs are manufactured — only 30 MW were produced in 1988 — costs will fall even further. Expectations are that costs will drop from a current 55 cents/kWh down to 8 cents/kWh by 2010.

Photovoltaics are a proven technology and there are many current applications, such as calculators, range fences, and remote lighting and signaling stations. Flat-plate PVs have low operating and maintenance costs, minimal environmental impacts, a free energy source, and very high reliability. Concentrating PVs have lower reliability because they are mechanically more complex and subject to failure.

Operating Characteristics

Solar Thermal. A solar thermal system's capacity is dependent on the sun. Solar insolation has a daily peak in early afternoon, and of course is not available at night. There is also seasonal variation due to the change in the sun's declination, which is greatest in early summer. Transient cloud cover also affects the amount of energy available from the sun.

Luz's systems use natural gas as a backup fuel to boost peak or maintain capacity during cloudy

periods and late in the day. In Luz's California plants, the proportion of energy contributed by gas in a solar energy system is constrained to no more than 25%. If solar thermal plants were used to supply capacity, as Luz's plants are in California, the situation is analogous to gas-fired systems firming nonfirm hydro in the Pacific Northwest. A fossil fuel used as a backup opens up the question of whether this fuel wouldn't be better used in other applications, such as space heating. Without a fuel backup, a solar thermal station's capacity factor is diminished significantly.

For eight of Luz's Solar Electric Generating Stations, typical capacity factors range from 25% for a 13.8 MW plant to 36% for a larger 80 MW plant. First costs range from \$4500/kW to \$2800/kW for these same plants. There are about 6000 to 8000 sq m of collector area per MW of capacity. Luz has an installed capacity of over 160 MW at six sites, with almost another 500 MW planned. Luz plants operate in latitudes and climates

where the available insolation is much higher than that available in the Pacific Northwest. The most promising locale for solar generation plants are areas east of the Cascades.

Photovoltaics. As with solar thermal, a PV system's capacity is dependent on the sun. Solar radiation is very dispersed and varies significantly

with latitude and climate. The average daily total solar radiation in Phoenix is about twice that of Seattle. Consequently, the most promising PV sites in the region are also east of the Cascades. Although about 1 kW of solar radiation falls on a square meter at noon on a sunny day, a typical PV array can generate only about 120 W/m². A

50 MW power installation would require about 90 acres of PV cells. This is peak capacity and diminished performance would occur under cloudy skies and early or late in the day. PV system capacity factors for future concentrating PV plants may reach as high as 33%.

Costs

The cost estimates in Table 4-18 reflect the solar thermal technology. Photovoltaic facilities are more costly.

Environmental Characteristics

Solar Thermal. Although the energy source for solar thermal systems is free and environmentally

benign, plant siting and operations do have some environmental impacts. All turbine-generators require some cooling to condense working fluids, whether the fluid is steam in central station systems or Freon in a closed loop system. Dry cooling with air may be the heat sink of choice, but even this air must be conditioned, usually with a cooling tower or cooling pond. Ultimately some

Table 4-18. Solar: Cost and Achievable Potential (FY 1991-2010)

Plant Characteristics	Solar
Operating Life (years)	30
Unit Size (MW)	80
Equivalent Availability (%)	28%
Anticipated Capacity Factor (%)	28%
Heat Rate (Btu/kWh)	0
Costs (1990 \$)	
Capital (\$/kW)	2764
Fixed O&M (\$/kW/yr)	16.00
Variable O&M (mills/kWh)	0
Fixed Fuel (\$/kW/yr)	0
Fuel (\$/MMBtu)	0.00
Lead Times (Years)	
Preconstruction	2
Construction	2
Levelized Real Cost (mills/kWh)	
Public Financing	75
Private Financing	97
Levelized Nominal Cost (mills/kWh)	
Public Financing	145
Private Financing	187
Supply Forecast (aMW)	
Regional	480
BPA	120

makeup cooling water is required to cool the air. In hot, dry climates where solar thermal plants are most likely to be located, water for cooling comes at a premium.

Because of the very diffuse nature of solar radiation, large sections of land are required for developing solar thermal sites, which has a localized effect on the land taken out of use.

If natural gas is used as a back up energy source, the impacts of natural gas combustion must be considered. Lastly, the working fluids used in engines and turbine-generators such as oils or freons must be managed and contained to prevent inadvertent escape into the environment.

Photovoltaic. The only significant environmental impacts of PVs are in the industrial processing of the PV materials, where such chemicals as gallium arsenide and cadmium sulfide are used; and in the large surface areas of land required to set up a PV plant.

Because of the very diffuse nature of solar radiation, large sections of land are required for developing PV sites, which has a localized effect on the land taken out of use.

Supply Forecast

The best potential solar site with measured insolation in the Northwest is the Whitehorse Ranch in southeastern Oregon. However, because of its latitude, it receives only 70% of the solar energy of the best sites in the Pacific Southwest. Although the cost of solar generation is significantly higher than other resources, the physical resource is available in the portions of the Northwest in enough quantity to include it as an available resource for planning purposes. Table 4-18 shows 480 aMW available based on Council projections. Because of the high cost of the resource and the higher avoided cost of Pacific Southwest utilities, it is likely that development will occur in that area before it occurs in the Northwest.

Wind

Technical Description

Wind turbines convert the kinetic energy of wind into electrical energy by transferring the momentum of air to the rotation of wind turbine blades. There are a great many wind turbine designs, but the most common is the horizontal axis turbine, which has the axis of blade rotation oriented perpendicular to the ground like an airplane propeller. The turbine axis is connected directly to a gear box, which is connected to a generator. Gears step up the blade RPM to a rate nearly matching the 1800 RPM needed to synchronize a generator, which is connected through switch gear to a utility grid. In the horizontal axis design, the rotor blades, turbine, gears and generator are all mounted on a horizontal axis set atop a tower and contained within a housing as a single unit.

Engineers have devised two principle means to regulate blade speed for controlling power output: variable pitch and stall regulation. With variable pitch, a wind machine's blades adjust so that the turbine begins generating at a cut-in speed, then rises to a rated power output, and finally holds this level until the wind reaches a cut-out speed. With stall regulation, blades are aerodynamically designed to lose their lift at a certain rotation speed. Turbine housings are also designed with passive or active yaw control to swivel on the vertical axis and align the turbine in the direction of the wind.

The power generated from a wind stream is proportional to the cube of the wind velocity; as the wind speed doubles, available output increases by a factor of eight. Because the amount of energy extracted from wind is extremely sensitive to wind speed, optimum siting of individual turbine units requires a substantial amount of data describing how wind speeds are distributed over the site and over time. There is even significant variation of wind strength as height varies above ground. Winds aloft tend to

be more stable than near the ground. Potential sites must have average wind speeds in excess of 12 mph to be considered worth developing.

Wind machines are generally grouped together into arrays at a site called a wind farm or wind park. A typical arrangement is to place turbine units in rows about 10 rotor diameters apart, and adjacent turbines within the rows about three rotor diameters apart, although optimum siting must take into account terrain and the interactive effects among turbines. Wake disturbance and turbulence from one wind machine can severely limit the energy extracting potential of other machines downwind. Array losses due to energy extraction by upwind turbines can drop energy production as much as 15% to 20%.

Wind power has undergone substantial development since the early 1980s, and the technology has now reached the status of a mature industry. In California today, there are about 17,000 wind turbines operating with an installed capacity of 1500 MW at three principal sites, which is about 90 to 95% of the installed capacity in the world. The California experience has been a proving ground for the developing wind industry. Initial problems with fatigue failure and reliability are now being addressed with better aerodynamic and structural designs and improved controls.

Operating Characteristics

Wind power is dependent on the availability of wind. Despite wind's unpredictability, this renewable resource does exhibit certain patterns. One type of wind regime results from air pressure differentials between seaward and continental climates. For example, at sites in the Columbia Gorge, winds peak in the spring and summer when cooler air on the west side of the Cascades moves eastward to displace warmer air inland. At other sites, such as those at the southern Oregon coast and along mountain ridges in Montana, winds are driven by storms which tend to occur in winter.

Although wind cannot be counted on for peak loads, it can displace some capacity load. Turbine units with good mechanical design and regular maintenance show equivalent availability factors better than 92%, but they vary widely in output. Typical capacity factors for on-line units range from 10% to 35%, depending on the average wind speed. Today, wind machines tend to be scaled at 150 to 600 kW, are lighter in weight and have improved efficiency compared to their predecessors.

Costs

The cost of electricity from a wind facility is a function of the conversion technology as well as the wind resource present at the site. The costs shown in Table 4-19 reflect capital and operating costs from the 1991 Northwest Power Plan, with capacity factors ranging from 18% to 31%.

Data which became available after the completion of the Council's Plan indicates that wind costs continue to drop as the technology improves. In some locations, costs in the 32 mill range have been achieved. BPA will incorporate changes in projected resource costs in its supply estimates and resource development and acquisition decisions. For more information see Appendix D of the Draft 1992 Generation Resource Supply Document.

Environmental Characteristics

Although wind energy is environmentally benign, there are some distinct environmental impacts. Wind turbines generate audible noise, which can be objectionable to nearby residents, and electromagnetic noise which can interfere with television reception.

Wind sites may pose a hazard to both birds and aircraft. Some sites may be in the path of migratory birds. Secondary impacts could be caused by constructing transmission systems to bring electricity from wind sites to grid connection points. Siting impacts can be mitigated with good planning.

**Table 4-19. Wind: Cost and Achievable Potential
(FY 1991-2010)**

	Wind 1	Wind 2	Wind 3
Plant Characteristics			
Operating Life (years)	40	40	40
Unit Size (MW) [1]	20 (23)	30	30
Equivalent Availability (%)	31%	26%	18%
Anticipated Capacity Factor (%)	31%	26%	18%
Heat Rate (Btu/kWh)	0	0	0
Costs (1990 \$)			
Capital (\$/kW)	1236	1577	1239
Fixed O&M (\$/kW/yr)	16.00	17.00	17.00
Variable O&M (mills/kWh)	12.1	12.4	12.0
Fixed Fuel (\$/kW/yr)	0	0	0
Fuel (\$/MMBtu)	0.00	0.00	0.00
Lead Times (Years)			
Preconstruction	1	1	1
Construction	2	2	2
Levelized Real Cost (mills/kWh)			
Public Financing	44	58	66
Private Financing	51	69	79
Levelized Nominal Cost (mills/kWh)			
Public Financing	85	112	128
Private Financing	99	134	153
Supply Forecast (aMW)			
Regional	29	381	253
BPA	7	95	63

[1] Unit sizes shown in parentheses reflect adjustments made for modeling purposes.

Supply Forecast

In 1985, BPA completed a five year resource assessment (WIND REAP) of over 300 wind sites in the Pacific Northwest. Of these, 39 were identified as having potential for future commercial development. Since BPA's assessment was completed, several thousand turbines have been installed in California. This combination of potential sites and substantial experience with integration of wind turbines into an electrical grid forms a basis for including wind energy as an available resource to the Northwest. Table 4-19 summarizes the supply potential. These estimates are based on the 1991 Northwest Power Plan.

WPPSS Nuclear Projects 1 and 3

Technical Description

WNP-1 is a 1250 MW nuclear project located on land leased from the U.S. Department of Energy (DOE) at the Federal Hanford Reservation about ten miles north of Richland, Washington. The plant design is based on a pressurized water reactor made by Babcock and Wilcox (B&W 205). Westinghouse designed the turbine generator. A project of similar design in Germany is complete and operates at full power.

WNP-3 is a 1240 MW nuclear project near Satsop, Washington, 16 miles east of Aberdeen in

**Table 4-20. Nuclear (WNP-1 and WNP-3): Cost and Achievable Potential
(FY 1991-2010)**

	WNP-1		WNP-3	
	Low WNP-1L	High WNP-1H	Low WNP-3L	High WNP-3H
Plant Characteristics				
Operating Life (years)	40	40	40	40
Unit Size (MW)	1250	1250	1240	1240
Equivalent Availability (%)	65%	65%	65%	65%
Anticipated Capacity Factor (%)	65%	65%	65%	65%
Heat Rate (Btu/kWh)	0	0	0	0
Costs (1990\$)				
Capital (\$/kW)	1430	1430	1137	1137
Fixed O&M (\$/kW/yr)	84.59	109.21	90.26	116.53
Variable O&M (mills/kWh)	5.4	5.4	5.4	5.4
Fixed Fuel (\$/kW/yr)	0	0	0	0
Fuel (\$/MMBtu)	0.00	0.00	0.00	0.00
Lead Times (Years)				
Preconstruction	0	0	0	0
Construction	7	7	7	7
Levelized Real Cost (mills/kWh)				
Public Financing	35	43	33	42
Private Financing	N/A	N/A	34	43
Levelized Nominal Cost (mills/kWh)				
Public Financing	67	83	65	81
Private Financing	N/A	N/A	66	83
Supply Forecast (aMW)				
Regional	813	813	806	806
BPA	813	813	806	806

Grays Harbor County. It is a pressurized water reactor called a System 80, produced by Combustion Engineering, Inc. The Palo Verde 1 and 2 nuclear plants in Arizona, which came on-line in 1985 and 1986 respectively, are of the same design.

Operating Characteristics

Nuclear plants are best operated in baseload mode at their rated MW output. Like all steam cycle plants, nuclear plants have a large startup inertia and cannot respond quickly to significant changes in load demands.

Costs

As a result of the public input received during the review of its Draft 1990 Resource Program,

BPA recommended deferral of another comprehensive study of the future of WNP-1 and WNP-3 until significant new information becomes available or conditions change sufficiently to warrant a new study. Both cost-to-complete and O&M cost assumptions would be reviewed as part of such a study.

Detailed cost-to-complete construction estimates were prepared for WNP-3 by the Washington Public Power Supply System and its contractors in 1984. In 1986, the Supply System updated the 1984 estimates in support of Bonneville's 1987 Resource Strategy. Operation and maintenance (O&M) cost estimates were also reviewed in 1986. The Council reviewed O&M costs for nuclear power plants for the 1991 Northwest Power Plan. The Council reported that although O&M costs have escalated rapidly from 1974 to

1984, escalation has peaked and declined in more recent years. The Council assumes that the real rate of operating and maintenance cost escalation will decline from 3.5% annually in 1986 to 0% (real) by 2000.

Table 4-20 shows high and low cost estimates for both WNP-1 and WNP-3. These high and low estimates were developed to show the uncertainty surrounding the projected fixed operating costs. The low cases reflect no real escalation applied to the fixed O&M estimates. The high cases reflect real escalation based on WNP-2 and Trojan experience between 1986 and 1990.

Environmental Characteristics

The environmental impacts of nuclear energy fall into the categories of mining uranium ore and fuel processing, plant construction, electricity production and waste disposal.

Uranium is mined in open pits. Exploration, drilling and blasting in mining operations can disrupt the local environment and contaminate groundwater. Land reclamation problems are similar to those of coal mining, but on a much smaller scale because the energy content of uranium ore has a much higher density than that of coal. Miners must take precautions to avoid the risk of inhaling radioactive material. Radioactive uranium tailings can contaminate water supplies and be borne on the wind, and must be disposed of properly.

The primary impacts from operations at a nuclear plant are the release of heat and moisture from the plant cooling system, cooling tower drift, and airborne radioactive materials (heat released in large clouds of condensed steam from cooling towers is a common effluent from large thermal generation plants).

Radioisotopes are fission products formed as a result of uranium and plutonium fission in the reactor. These include actinides and activation products. Actinides are the isotopes of elements having atomic weight of 89 and greater. Activa-

tion products include radioisotopes formed by the neutron flux during reactor operation.

The containment structure of a nuclear reactor is designed to withstand severe natural forces, especially seismic activity. The containment is designed to contain any released radionuclides in the event of a loss in reactor cooling, even if pipes break. There is the potential for the core to overheat, but redundancy is built in to back up the primary cooling system.

Gaseous radioactive effluents include fission product isotopes of the noble gases, krypton, neon and argon — the primary source of direct, external radiation emanating from a plant's effluent plume — and carbon-14 and radioiodines. These products can be controlled through filtration and by collecting and allowing them to decay to acceptable radiation levels before they are released. Particulates, such as the fission products of cesium and barium and activated corrosion products such as cobalt and chromium, are controlled in high efficiency filters.

Besides airborne gases and particulates, there may be some release of waterborne radioactive materials, including fission products such as nuclides of strontium, activation products such as sodium and manganese, and tritium.

Experience designing, constructing and operating nuclear power plants indicates that the average annual release of these kinds of radioactive materials and effluents typically will be a small percentage of the limits specified by federal safety regulations. All aspects of nuclear power plants are continuously monitored.

Other potential water-related effects of nuclear power plant operation include thermal discharge, water consumption and release of waterborne chemical pollutants. Makeup water in cooling towers tends to concentrate the mineral salts and other contaminants already in the water. These are controlled with continuous "blowdown" to introduce fresh coolant. Blowdown can be environmentally damaging but the effluent can be treated to remove impurities.

The failure of the U.S. government to site a facility for radioactive waste disposal, however, continues to be a problem. Waste is classified as high-level, transuranic or low-level. High-level waste has high concentrations of beta- and gamma-emitting isotopes and significant concentrations of transuranic materials, including plutonium. Spent fuel is the only reactor product that falls in this category. Reactors produce about 400 ft³ per year of spent fuel. In a typical commercial reactor, about 15% to 25% of the fuel is replaced each year.

Transuranic wastes have low levels of beta and gamma emissions but significant concentration of transuranic isotopes. Transuranic waste are produced during reactor operation but contained within fuel elements unless the cladding is breached.

Finally, low-level wastes are characterized by low beta or gamma emissions and relatively insignificant concentrations of transuranic materials. These wastes may become radioactive during normal operations. Low-level wastes include clothing, paper, spent ion-exchange resins, filters and evaporator concentrates from isolated parts of the reactor building. Generally, these wastes are disposed of by allowing them to decay and diluting them to acceptable concentrations.

Although operational and safety risks can be addressed, long-term disposal of nuclear wastes remains an unresolved problem. In 1982, Congress passed the Nuclear Waste Policy Act, making the federal government responsible for the ultimate disposal of high-level nuclear wastes, which includes the spent fuel from power plants. There have been delays due to state resistance and management problems, and the siting and use of a long-term repository still remains a problem.

Supply Forecast

The scoping process for the 1992 Resource Program determined that WNP-1 and WNP-3 would be treated as available resources for plan-

ning purposes, the same assumption used in BPA's 1990 Resource Program. Prior to a decision to take specific action regarding either WNP-1 or WNP-3, it is anticipated that there will be a complete review of cost data and a regional consensus will be developed through a public involvement process.

Contractual Resources

This section provides background information on BPA customer needs, BPA resources, and how marketing activities can complement the Resource Program. It focuses on products and services BPA could purchase or sell outside the Pacific Northwest. It then proposes a series of actions to position BPA in the West Coast electricity market.

The Pacific Northwest appears to be energy constrained with excess summer capacity, while California and the Pacific Southwest appears to be summer capacity constrained with excess ability to produce energy in the winter. In addition to firm purchases and exchanges, California utilities plan to add over 10,000 MW of capacity by the year 2001 to serve summer peak load. This includes over 7,000 MW of demand-side management (DSM) and 3,500 MW of qualifying facilities (QF) and independent power producer (IPP) supplied capacity. Summer capacity from the Pacific Northwest is an alternative to the QF and IPP capacity on which the California utilities are currently planning.

BPA can position itself to take advantage of its unique situation within the West Coast electricity market by pursuing a limited number of "win-win" extraregional transactions that are mutually beneficial. Specific actions include:

- Consider firm option energy contracts with California utilities to satisfy firm energy resource needs (i.e., option and supplemental energy in the SCE contract).

- Evaluate and include benefits from surplus marketing opportunities created by resource acquisitions (i.e., include the opportunity cost of additional summer capacity provided by resource acquisitions).
- Consider joint ventures to meet both California and Pacific Northwest needs for capacity and energy.
- Continue Canadian Coordination and Northwest Partnership activities.

Summary of California Customer Needs

The California Energy Commission (CEC) Final 1990 Electricity Report (ER 90) projects a California statewide need of 10,800 MW of capacity by 2001. Under CEC assumptions, DSM is expected to supply approximately 7,300 MW, of which conservation programs are expected to supply 4,200 MW. In addition, QFs and IPPs are expected to supply 3,500 MW of capacity.

Table 4-21 summarizes the utility plans by service areas. The California-Oregon Transmission Project (COTP) Intertie ownership assumes IOU participation in this table, which is now unlikely, and without IOU participation the ownership shares are uncertain. The third column lists planned Pacific Northwest purchases by California utilities. In total, California is relying on 1,690 MW of resource-deferring spot capacity from the Pacific Northwest, which in the worst case is supplied by BPA at the Emergency Capacity Rate of \$1.21 per kW-week. In addition, by 2003 California utilities are planning to import nearly 3,000 MW of Pacific Northwest capacity in purchases and exchanges over the existing and the Third AC Interties. Thus, under the ER 90 scenario, California expects to be receiving 4,700 MW of summertime capacity from the Pacific Northwest by 2003.

The California market for Pacific Northwest nonfirm energy will probably soften in the future. Gas prices will likely stay low and gas will be in abundant supply to the utilities and IPPs as new interstate gas line capability becomes available.

All-source bidding will probably emerge to replace the current QF bidding process. More Requests for Resources by California utilities will, among other things, require quantification of environmental costs and likely include set-asides for renewable resources. California will continue to encourage QFs and IPPs as part of the state's generation resource mix. New interconnection agreements among California parties may provide new or expanded transmission access that may lead to marketing opportunities.

Pacific Gas & Electric (PG&E)

Due to its abundant resources and its intention to pursue a DSM program aggressively, PG&E has limited needs for new generation for the rest of the decade. PG&E expects to add approximately 1,300 MW of DSM by 1994, increasing to 2,893 MW by 2001. Except for 700 MW of spot capacity purchases from the Pacific Northwest and seasonal exchanges with Washington Water Power, Puget Sound Power & Light and Seattle City Light, the first cost-effective generation is the repowering of Hunters Point units 1 and 2 on the San Francisco peninsula in 1999. Because transmission corridors into this area are limited, it would appear a QF could not compete under the operating constraints. As a result, the CEC recommends that the California Public Utility Commission (CPUC) consider the repowering project to be nondeferrable by a QF in the Biennial Resource Plan Update (BRPU) process, or that the CPUC include modifications to the QF solicitation so the winning bids match the heat rate and performance characteristics of the facilities.

At a March 1991 conference, "Meeting California's Energy and Environmental Needs in the 1990s," Greg Rueger, senior vice president of PG&E, stated that PG&E's energy needs are expected to increase by 2,072 aMW by the year 2000. Of this, 1,230 aMW is increased demand and the remaining 842 aMW is from declining geothermal output (450 aMW), declining imports from the Pacific Northwest (108 aMW), and needed standby reserves (280 aMW). He stated

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Table 4-21. Summary of ER90 California Customer Plans

	Intertie Ownership	Planned PNW Imports Including Spot Capacity [1]	Additional Capacity Needs and Plans
PG&E Service Area [2]	1872 MW existing 426 MW COTP	700 MW spot (1991-2009) 296-376 MW imports (1991-2003) [3]	254 MW deficit in 1992 increasing to 4353 MW in 2003. Plan to meet with uncommitted DSM and 397 MW of combined cycle CTs in 2003.
Other Northern California-MID, NCPA, Redding, Santa Clara and TID	25 MW existing 470 MW COTP	323 MW COTP imports in 1993, increasing to 433 MW in 2003 [4]	Near-term deficits of 177 MW and 237 MW in 1991-92. Long-term deficits of 100 MW in 1995 increasing to 572 MW by 2003. Will serve with unspecified generic additions.
SCE Planning Area [5]	1812 MW existing 401 MW COTP	400 MW spot (1991-2009) 941-951 MW imports (1991-2003) 85 MW generic exchange (2000-2003)	445 MW deficit in 1997 increasing to 3600 MW in 2003. Plan to meet with uncommitted DSM, repowering and replacements of existing resources and 400 MW of new combined cycle CTs in 1990, an additional 760 MW in 1996 and an additional 714 MW by 2003.
LADWP Service Area	1016 MW existing	410 MW spot (1991-2009) 105 MW imports (1991-2003)	No deficits until 243 MW in 2002. Plan all-resources RFP for up to 600 MW phased in from 1996.
BGP	299 MW existing	72 MW import (1991-2003) 80 MW spot (1991-2003) 29 MW PGX exchange (1991-2003) 29 MW PGX purchase (1991-1992)	No significant deficits.
SDG&E Service Area	266 MW existing	100 MW spot (1991-2009) 69-115 MW imports (1991-2003)	100 MW deficit in 1991 increasing to 2041 MW in 2003. Plan to meet with uncommitted DSM, repowering and replacement of existing generation plus 83 MW of CTs in 2002 and 100 MW of geothermal in 2003.
SMUD	200 MW existing 207 MW COTP	143 MW COTP imports in 1993 increasing to 196 MW in 2003 96 MW imports	Deficit of 525 MW in 1996 increasing to 668 MW by 2003. Will serve with unspecified other additions.

[1] *Spot Capacity* — These are short-term purchases of either reliability capacity used exclusively for summer capacity needs, or short-term summer purchases, exchanges or load factoring of both energy and capacity. Spot capacity must meet three tests: be demonstrated to be available from the Pacific Northwest, have a transmission path available, and be demonstrated as more cost-effective than a combustion turbine.

[2] Includes WAPA.

[3] Includes TCL-WAPA (74 MW), Long Fib-WAPA (45 MW) and PGE-WAPA (65 MW).

[4] Includes MSR at 139 MW.

[5] Includes Southern California Edison and Resale Cities.

that PG&E plans to meet its need by repowering Hunters Point (274 aMW), QF/IPP purchases (1,022 aMW), California-Oregon Transmission Project and hydro upgrades (57 aMW), and customer energy efficiency improvements (719 aMW). At the same conference, PG&E vice president Robert Haywood stated that the utility plans to add 4,000 MW of capacity by the year 2000. Of this, 2,500 MW is expected to be customer efficiency improvements, 500 MW from PG&E system efficiency improvements, and 1,000 MW of capacity for energy exchanges with the Pacific Northwest "with no money changing hands."

Northern California Small Municipal Utilities

The northern California municipals include the Northern California Power Agency, Santa Clara, Lassen, Modesto Irrigation District (MID), Turlock Irrigation District (TID) and Redding. At present, MID, TID and Redding need 172 MW of new peaking resources to maintain their reserve requirements. Assuming the COTP is completed in 1993 and each participant uses its share, by 2001 NCPA will require 83 MW of new resources, increasing the total northern municipal requirement for new energy resources to 425 MW. Since the CEC only identifies the municipals' need for new resources, and recommends desirable attributes of new additions, ER 90 contains a small amount of dispatchable load management by MID and Redding, and recommends that the municipals evaluate cost-effective DSM programs prior to committing to new generation acquisition.

Sacramento Municipal Utility District (SMUD)

When SMUD closed its Rancho Seco nuclear plant, it entered into two power sales contracts with PG&E and SCE to replace the lost power. Since entering into these two contracts, SMUD has decided they are too expensive. As a result, SMUD is pursuing an aggressive DSM program and new bids for sales and generation. Through its DSM program, SMUD expects to reduce its capacity growth to zero and its energy growth to

less than 1% per year. Without DSM, SMUD's average rate of growth is projected to be 2.3% for peak and 2.2% for energy. If the utility meets its DSM target, in 2001, SMUD will be serving one quarter of its total system requirements with new DSM programs.

To replace the two contracts with PG&E and SCE, SMUD has issued an RFP for purchases and new generation. The solicitation seeks a diversity of resources that in addition to meeting load can provide system support and dispatchability. ER 90 further recommended SMUD consider adding natural gas units to increase its resource diversity. SMUD is currently seeking 200 MW of long-term purchases from the Pacific Northwest or Canada. SMUD claims that DSM has eliminated substantial diversity between their winter and summer peaks and thus creates a need for year-round baseload power.

Southern California Edison (SCE)

SCE has enough capacity resources to meet expected peak demand and reserve margin requirements through the end of the decade, although much of their gas/oil fired generation is located within the South Coast Air Quality Management District (SCAQMD). On June 24, 1991, SCE accepted the SCAQMD NOx emission limitation which is expected to cost \$700 million. In addition to existing and committed resources, SCE's peak requirements will be met through DSM programs, repowering of two Huntington Beach units in 1996 (followed by two more in 1999 and 2000), and Pacific Northwest spot capacity purchases. DSM is expected to contribute 2,000 MW by 1994 increasing to 3,250 MW by 2001. By 1996, SCE will repower two existing generators by replacing old steam boilers with new combustion turbines and heat recovery steam generators which will add a net capacity of 760 MW. The two additional repowerings, each 407 MW, were determined cost effective in 1999 and 2000, respectively. ER 90 recommends the CPUC designate at least one repowering, or 407 MW, to be set aside for bidding by renewable resources in the CPUC's BRPU process. Pacific

Northwest spot capacity purchases add an additional 400 MW annually throughout the planning period to the SCE capacity resource plan.

Starting in the year 2000, utility-owned geothermal resources are expected to become more cost-effective than new gas-fired resources. The additional geothermal fields, located in the Coso and Imperial valleys, could contribute up to 1,200 MW by 2005. Because geothermal resources may be the most cost-effective resource choice, ER 90 recommended that additional repowerings beyond the two recommended above be delayed until ER 94, which will determine the resource choices of the mid-2000s.

Southern California Small Municipal Utilities

The southern municipals are commonly referred to as the "resale cities." They include Anaheim, Azusa, Banning, Colton, Riverside and Vernon. Unlike the northern municipals, which desire more independence from PG&E, the resale cities will continue to depend on SCE for part of their needs. In 1994, SCE's obligation to the resale cities will be 173 MW. By 2001 the SCE obligation will increase to 561 MW. Each of the resale cities has a power sales contract with SCE which declines steadily to zero by 1999. However, any resource shortfall the resale cities may experience becomes an obligation on SCE to serve or develop resources to meet their needs. Under a recent business arrangement between the resale cities and SCE, the resale cities can replace partial requirements with new resources or additional DSM, and reduce the SCE system requirements by that amount. SCE is at some risk because it must provide resources and the resale cities have the choice to buy or not purchase from SCE. The 561 MW of capacity resource needs required by 2001 assumes the resale cities use their share of the COTP.

Los Angeles Department of Water and Power (LADWP)

Of LADWP's existing capacity resources, 40% are from gas fired units located within the South

Coast Air Quality Management District (SCAQMD). Consequently, LADWP is required to improve air quality through air emission reductions. LADWP requested CEC assistance in its reduction assessment and evaluation of LADWP's total need for new resources. To comply with SCAQMD regulations, LADWP intends to refurbish and add pollution control equipment to 15 of its 16 in-basin gas units, and repower the sixteenth unit. In addition, LADWP is encouraging two fuel switching strategies — electrification of its industry and the use of electric vehicles.

Although LADWP's resource plan does not show a capacity need until 1998, 410 MW of Pacific Northwest spot capacity will be acquired throughout the planning period. LADWP issued and then backed away from an all-resources RFP in late 1990 to acquire 100 MW in 1996, increasing the megawatts to 600 MW by the year 2000. LADWP now intends to meet their load growth with DSM. In addition, LADWP is investigating the development of geothermal leases for the late 1990s. These leases could produce up to 150 MW.

Burbank, Glendale and Pasadena (BGP)

BGP's capacity resources are adequate until 2004. Pacific Northwest spot capacity will provide 80 MW throughout the planning period. BGP and BPA have tentatively agreed to an additional 40 MW long-term exchange, subject to final BPA approval, regional review and environmental assessment.

San Diego Gas and Electric (SDG&E)

SDG&E needs additional capacity resources starting in 1991 just to meet its minimum reserve requirements. SDG&E plans to return to service two of its gas fired units and exercise a short-term contract with Arizona Public Service to meet its reserve requirements until 1993. At that time, upgrades to its existing units, repowerings or new combined cycles will become cost-effective. Throughout the planning period SDG&E plans to

purchase 100 MW of Pacific Northwest spot capacity.

BPA Resources

The 1990 Whitebook forecasts the end of the BPA energy surplus. BPA is currently soliciting proposals to acquire 300 aMW of firm energy in addition to about 50 aMW of billing credits. The firm energy bids included proposals for 41 conservation projects totaling 116 aMW and 62 generation projects totaling about 5,200 aMW.

The December 1990 Whitebook forecasts a continued BPA surplus of 30-, 50- and 70-hour-per-week capacity under 1929-30 water conditions. The Whitebook does not give information on less than 30-hour-per-week capacity. For instance, California utilities currently rely on "spot capacity" purchases from the Pacific Northwest to defer resource additions, most likely combustion turbines and QFs.

Spot capacity is defined as "short-term purchases of either reliability capacity used exclusively for summer capacity needs, or short-term summer purchases, exchanges or load factoring of both energy and capacity. Spot capacity must meet three tests: be demonstrated to be available from the Pacific Northwest, have a transmission path available, and be demonstrated as more cost effective than a combustion turbine."

When purchasing spot capacity, California utilities first attempt to purchase nonfirm, second look for surplus firm, third seek load factoring or storage services, and as a last resort they purchase Emergency Capacity from BPA.

From California's perspective, reliability-type spot capacity is a firm peaking resource, has no energy related capital cost, is cheaper than a combustion turbine, and is not deferrable by a Standard Offer Qualifying Facility contract. Its attributes cannot be supplied by a qualifying facility because this is an extremely low cost, short-term, high volume amount of electricity which is only available due to the existence of substantial seasonal and resource diversity between the

Pacific Northwest and California. It provides environmental benefits by deferring the need for new generation construction by drawing on the hydro-storage backed capacities of the Pacific Northwest.

The California utilities have no firm contractual arrangements, yet they rely on spot capacity in the following amounts for capacity planning for the next 12 years:

PG&E	700 MW
LADWP	410 MW
SCE	400 MW
BGP	80 MW
SDG&E	100 MW
<i>Total</i>	<i>1690 MW</i>

During the ER90 process, BPA assured the California parties in testimony that BPA can fill the Intertie (up to 6,000 MW) for a few hours almost any time in the summer as long as the energy is returned under mutually acceptable terms.

The California utilities use spot capacity only to serve their "needle peaks" and, therefore, not often. For example, PG&E estimates on average they would use it 22 hours per year. During the ER90 process the CEC staff estimated that spot capacity for six weeks per year had an annualized cost of \$6.06 per kW-year and would displace a combustion turbine at around \$38 per kW-year. At these rates the annual savings for 1,690 MW is around \$54 million.

Between 30-hour-per-week capacity and spot capacity which may be called on only a few hours per year, there is undoubtedly a whole range of capacity products and services BPA could market to California and the Southwest. The biggest question at the current time is how much of what type of capacity service will BPA have to market after review of the hydro operations strategy in the SOR.

To the extent that BPA acquires additional summer capacity as a byproduct of the Energy Resource Acquisition and Billing Credits processes, it could add to BPA's forecasted summer capacity surpluses. However if resource acquisi

**Table 4-22. Summer Capacity Surpluses:
June, July, August, and September**

	70 Hours Per Week (MW)	50 Hours Per Week (MW) [1]	30 Hours Per Week (MW) [1]	Spot (MW) [2]
Federal System 2001-2	1909	2754	3512	6000
Less Operations and Fish Migration	-800	-800	-800	
Plus Resource Acquisitions	+300	+300	+300	
Net Surplus, Federal System	1409	2254	3012	6000
Regional System 2001-2	558	1359	2159	6000
Less Operations and Fish Migration	-800	-800	-800	
Plus Resource Acquisitions	+300	+300	+300	
Net Surplus, Federal System	58	859	1659	6000
Federal System 2010-11	600	1400	2201	6000
Less Operations and Fish Migration	-800	-800	-800	
Plus Resource Acquisitions	+300	+300	+300	
Net Surplus, Federal System	100	900	1701	6000
Regional System 2010-11	-1062	-262	539	6000
Less Operations and Fish Migration	-800	-800	-800	
Plus Resource Acquisitions	+300	+300	+300	
Net Surplus, Federal System	-1562	-762	39	6000

[1] 50-hour and 30-hour summer/fall values from 1990 Whitebook under 1930 water, medium loads, assuming existing regional contracts including PP&L capacity sale and no resource acquisitions.

[2] Spot capacity is supplied on heavy load hours during a single day and returned on light load hours the following night. Spot capacity values are from BPA testimony to the CEC in the ER90 proceedings. California utilities rely on 1,690 MW of spot capacity from the Pacific Northwest to defer resources.

tions increase nighttime minimum generation, then these acquisitions could actually reduce BPA's ability to deliver summer capacity by reducing the ability to accept nighttime returns.

The following Summer Capacity Surpluses table gives rough estimates of the Federal and regional capacity surplus. The estimates shown are for 10 years and 20 years from now. Each column assumes only the supply of that particular product and no supply of the other products. As the length of delivery in hours per week decreases, more capacity is available.

A certain amount of capacity is needed to support BPA operations and fish migration efforts. The 800 MW estimate is a rough estimate and may well turn out to be low; better estimates should be forthcoming from the SOR and may be much higher. Acquisitions that include capacity generally add to the estimated 30-, 50- and 70-

hour-per-week capacity surpluses, and in 10 or 20 years may add much more than the 300 MW rough estimate used here. However, baseload additions may not add as much capacity as expected since they tend to be "must-run" projects and thus reduce the amount of energy which BPA can accept at night. The inability to accept nighttime energy returns is often the factor that limits the amount of daytime capacity which BPA can deliver.

It is more informative to consider the regional surplus rather than BPA's surplus, since the other regional entities have preference to Federal capacity. In ten years the region is expected to have significant surpluses of all but 70 hours per week capacity. In 20 years only spot capacity is expected to be significantly surplus.

BPA Needs

BPA is currently in the process of acquiring 300 aMW of firm energy from competitive bid and about 50 aMW of firm energy from Billing Credits.

BPA's needs for additional firm energy will grow as the firm energy needs of its customers grow. These needs could be served through increasing system efficiency, conservation, additional generation and contractual arrangements to purchase firm energy when needed. Contractual arrangements with California utilities to purchase firm energy — if, as and when needed — will likely become more attractive as the most cost-effective system efficiency and DSM alternatives are exhausted.

SOR Operational Changes

Changes in the regulated flow of the Columbia and Snake Rivers are being considered to enhance downstream fish migration. The actual flow regime that will finally be implemented is very uncertain. The Water Budget is likely to increase creating more generation in the spring and potentially extending into the summer months through August. Proposals to operate Columbia and Snake River reservoirs at lower levels will reduce the capacity available in the spring and summer. The direction that these changes will take is somewhat predictable, but the magnitude of the changes is very uncertain at this time.

Contract Opportunities

BPA has existing contracts with SCE and with Burbank, Glendale and Pasadena (BGP). The SCE contract is much larger and will be discussed here. The BGP contract has some similar features but is much smaller.

At BPA's option, the BPA-SCE contract can be a surplus power sale or a long-term capacity-for-energy exchange. The contract is currently in the power sale mode with BPA purchasing energy from several Northwest and Canadian sources over the next four years at rates which are substantially less than the rate BPA receives from SCE.

In either mode, BPA has the right to obtain 71 aMW of option energy delivered in 13 weeks or less ending no later than April 15 each year. The cost of this option energy is 115% of incremental generation cost. This option energy arrangement can be discontinued on five years' written notice by either party.

In the exchange mode, BPA would receive 41 aMW of exchange energy in the winter in the early years, decreasing to 28 aMW by 2008, in exchange for providing 250 MW of capacity to SCE in June through October. When in a power sale mode, the possibility of switching the contract from a power sale to an exchange gives BPA a contingency option, which is like an insurance policy against deficits. The exchange energy is a firm energy resource which is available to BPA throughout the 20-year life of the contract and can be used to satisfy BPA's critical water firm energy planning constraint.

In addition in the exchange mode, the SCE contract entitles BPA to 32 aMW (increasing to 46 aMW) of supplemental firm energy from November 16 through April 15 each winter. As with option energy, supplemental energy costs 115% of incremental cost; however, it is available throughout the 20-year contract life. As with option energy, supplemental energy is a firm energy source which can be used to satisfy BPA's critical water firm energy planning constraint.

Joint Ventures

Two types of joint ventures could produce win-win situations: (1) BPA could join with Pacific Northwest utilities to sell or exchange capacity and/or energy or both with California utilities where BPA supplies Intertie; and (2) BPA could purchase the winter output of resources while a California joint venture partner owned/purchased the summer output of the same resource.

At the present time, BPA is involved in at least one such arrangement where BPA is purchasing the Pacific Northwest Generating Co. (PNGC) share of the Boardman coal plant in the fall, winter and spring and granting PNGC firm Intertie

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access to market the plant's output south in the summer.

As the amount of surplus capacity available in the region is reduced over time, the limiting and therefore valuable service is not the Intertie but the amount of capacity that can be exported. BPA needs to determine whether its wheeling rates will capture the opportunity costs of the Intertie, especially as wheeling rates increase with Third AC costs. If wheeling rates adequately capture the opportunity cost of the Intertie, then BPA should look favorably on joint ventures where BPA is not impacted in the nonfirm market, fish migration is helped or at least not hurt, and BPA gets the proposed wheeling rate for the Intertie.

With regard to joint ventures where BPA acquires only the winter portion of a resource's output, BPA should encourage California and Northwest utilities and/or resource developers to bid these arrangements in BPA's Resource Acquisition Processes. These bids could then be evaluated side by side with the other resource proposals.

Alternatively, BPA and a California joint venture partner may want to issue a Joint Request for Resource Proposals where third party utilities and other developers could bid to supply generation resources or DSM.

5. ANALYSIS AND DEVELOPMENT OF RESOURCE STRATEGIES

Overview of Approach and Analysis

The Draft 1992 Resource Program proposes a course of action to meet the needs of BPA's utility customers over the next ten years. It augments the commitments of the 1990 Resource Program in light of observed and anticipated changes in Bonneville's operating environment, and provides the flexibility to cope with significant uncertainties in loads and resource availability.

This chapter describes the range of uncertainty this Resource Program must address, and the analyses supporting the actions proposed for BPA to take in the FY 1993-1995 period to address this uncertainty.

The steps in the analysis are summarized as follows:

Step 1: Identify Key Issues for 1992 Resource Program. Even in the relatively short span of two years, issues arise that can change the analysis needed to guide Resource Program decisions. A number of issues affecting the 1992 Resource Program have emerged:

- Implementing the Northwest Power Planning Council's 1991 plan.
- Assessing the impact of significantly lower gas price forecasts.
- Preparing for the potential generation losses from the hydro system due to prospective anadromous fish listings under the Endangered Species Act.
- Reassessing the potential for cost-effective conservation in the Pacific Northwest.

- Exploring the cost effectiveness of extraregional sources for the import and exchange of power.
- Incorporating competitiveness into BPA's resource planning criteria.

Step 2: Conduct Scenario Analysis. A group of BPA's middle managers used a structured process called CATALYST to develop scenarios incorporating key uncertainties for the 1992 Resource Program.

Subsequently, a series of analyses were conducted to explore how effective different actions (strategies) would be in different operating environments (scenarios). The Resource Policy Screening Model (RPSM) was used to see how the different strategies for Pacific Northwest resource development performed over the range of scenarios. To provide additional insights on the implications of uncertainties on West Coast power markets, the Power Market Decision Analysis Model (PMDAM) was used.

Step 3: Identify Decision Factors. Next, decision factors (described in Chapter 3) were developed for evaluating alternative resource strategies. These five factors — efficiency, risk, reliability, environment and competitiveness — were also used to evaluate different sources or approaches to implementing Resource Program recommendations.

Step 4: Identify Alternative Strategies. The next analytical task was the identification of a series of plausible alternative strategies that would guide the recommendations in the Draft Resource Program. Each strategy was defined by two characteristics: base levels of resource acquisitions, including over 600 aMW of conser-

vation by 2003, and a specific level of additional generation resources and options.

Step 5: Analyze Alternative Strategies. The alternative resource strategies were modeled using the Integrated System for the Analysis of Acquisitions (ISAAC). This analysis provides insights into deciding how much — and when — generation resources should be acquired and/or optioned.

Step 6: Evaluate Alternative Strategies. The strategies were then evaluated according to the five decision factors. This evaluation addresses both the quantitative and qualitative dimensions of the decision factors. Quantitative measures of efficiency, risk, reliability, environment and competitiveness were developed. Qualitative evaluations were based upon information and insights from a variety of sources.

Step 7: Develop Draft 1992 Resource Program Proposal. After the decision factor evaluation was completed, one of the strategies was selected as the preliminary Resource Program proposal and efforts began to develop it more fully, including implementation plans for acquisitions and options.

Scenario Analysis

Introduction

Scenario planning has been used extensively to help utilities develop resource plans with sufficient flexibility to deal with an uncertain future. This method acknowledges the unpredictability of the future and develops and rehearses appropriate responses to change. The possible approaches for conducting a scenario analysis differ greatly. Previous studies have varied in the number of scenarios examined, their reliance on planning models, and the measures of performance used to summarize each scenario. The literature sug-

gests that there is no single best way to conduct a scenario analysis.

Early in 1991, a group of managers from throughout BPA discussed issues relating to the 1992 Resource Program using scenario planning techniques. To assist the group in analyzing possible futures and strategies for BPA, the Planning staff used the CATALYST process from the Electric Power Research Institute (EPRI) as the framework for the discussions. This is a structured method for a group process of generating and evaluating scenarios and strategies. Scenarios represent "environmental" factors beyond BPA's control that influence the desirability of various resource acquisition strategies. Strategies represent different acquisition targets or methods of acquiring those resources. To explore the implications of these scenarios for the 1992 Resource Program, analysis was subsequently conducted using the Resource Policy Screening Model (RPSM) and the Power Market Decision Analysis Model (PMDAM).

The modeling of scenarios differed from previous scenario studies in three important ways. First, BPA analyzed multiple *strategies* as well as multiple scenarios, which required a large number of simulation studies. Second, several explicit and quantified measures of utility performance were used during each simulation. Results can be evaluated year by year in each scenario to review changes that would have to take place if utilities implement a given strategy in the face of rapidly unfolding changes. For the 1992 Resource Program, the effects on regional system costs and electric rates were selected to summarize two of the more important measures of utility performance. Third, emphasis is given to conservation and non-utility generation resources. This emphasis turns out to be important because these two resources play a significant role in the ability of utilities to respond flexibly in any given scenario.

The CATALYST Process

There were four general steps in the BPA CATALYST group process: (1) discussing and selecting candidate strategies; (2) generating a limited set of challenging scenarios based on major uncertainties in the planning environment; (3) walking through each scenario for each strategy to identify impacts and likely reactions; and (4) reflecting on what was learned when looking at all the results together.

Three "macro" strategies were used to represent a range of resource preferences: (1) continuation of the 1990 Resource Program with some updating for the 1991 Northwest Power Plan; (2) a conservation emphasis strategy; and (3) a thermal emphasis strategy. These strategies are called the High, Blitz and Moderate Conservation Strategies, respectively.

The group brainstormed a lengthy list of uncertainties BPA may confront over the next decade, including fuel prices and resource costs; nuclear, IOU and DSI issues; California and Canadian issues; environmental constraints; resource performance; and legislative and regulatory changes. Five key uncertainties (economic growth, natural gas prices, resource performance, environmental constraints on hydro, and new technologies) were selected as building blocks for the scenarios, and high, expected and low values were estimated through group discussion.

Combinations of these uncertainties were discussed in order to develop five scenarios. The specific values for each uncertainty factor in combination were used as the drivers to generate a description of the scenarios in which BPA would need to operate.

1. Base Case Scenario. The world generally evolves according to the 1990 Resource Program and the Council's 1991 Northwest Power Plan except that hydro capacity is lost due to environmental constraints. New technologies are forthcoming as expected.

2. Base Case/Resource Change Scenario. The same as Scenario 1, but with low gas prices

(so thermal resource opportunities would improve).

3. Demand Boom/Resource Bust Scenario. Economic growth is robust, new resources do not perform as planned, natural gas prices are high, new technologies are not realized, and the Federal hydro system gets hit with severe environmental constraints.

4. Demand Boom/Resource Change Scenario. Uses the same economic and hydro system assumptions as in Scenario 3, new resources perform above expectations, gas prices are low, and new technologies develop as planned.

5. Demand Low/Resource Stable Scenario. Economic doldrums, conservation performs as planned, gas prices are as currently forecast, hydro impacts are low, and new technology is as planned.

To fill in the 15 cells of the CATALYST impact matrix (five scenarios and three strategies), each utility strategy was described for three distinct periods: (1) the initial period where the utility's actions are fixed (1990-93); (2) a second period in which it is assumed that the utility would diagnose the emerging scenario and initiate appropriate action (1994-97); and (3) a period when the new actions start to have an effect in dealing with the effects of the scenario on the system (1998-2000).

From each strategy, participants explored how they thought the utility would respond in each scenario. As a first step, the High Conservation Strategy was explored under each of the scenarios to see how BPA's current approach would fare. Then the Blitz Conservation and Medium Conservation strategies were explored. Aggressive conservation and contingency plan options of 800 aMW were key ingredients in BPA's ability to respond to increased resource requirements. Strategy costs and megawatts were difficult to quantify within the group process in the time available.

The CATALYST process concluded with the group stepping back to look at the broad implica-

tions of the scenario/strategy combinations. For example, the Blitz Conservation Strategy under the Base Case scenario did not look very different from the High Conservation Strategy. Also, the High Conservation Strategy under the Demand Low/Resource Stable scenario appeared to be an easy adaptation for BPA and the region. The utilities would have the time to explore new technologies and refine acquisition methods with less pressure than under the other scenarios.

The CATALYST session brought together diverse experience and perspectives and achieved a much broader awareness of issues — and the magnitude of their impacts — than could have been envisioned by the Resource Planning staff alone. The next step was to follow up by analyzing the CATALYST scenarios and strategies to quantify impacts over a 20 year planning period. This exercise explored some of the longer-term implications and provided better definition of the tradeoffs for the proposed strategies. Two different models were used for this purpose. The Resource Policy Screening Model focused on the robustness of several strategies across the different scenarios. The Power Market Decision Analysis Model (PMDAM) explored the impacts of a single base case resource strategy across the scenarios, but looked at implications not only for the Pacific Northwest region, but for entire West Coast power system as well.

Scenario Analysis Using the Resource Policy Screening Model

Description of the Screening Model

The Resource Policy Screening Model (adapted from BPA's Conservation Policy Analysis Model) was used for the quantitative analysis of scenarios and strategies. The Screening Model simulates the Pacific Northwest electric power system, including electric consumption, system expansion, system operation and ratemaking for BPA and its

customers over a 20-year period. It permits integrated analysis of energy supply and demand policy options.

Particular strengths of the Screening Model for the scenario analysis are: (1) it is an integrated model which tracks outcomes for decision variables constantly and consistently throughout the period; (2) it simulates conservation and non-utility generation (e.g., private cogeneration) as responses to both market conditions ("price induced") and utility incentive programs; (3) it allows scenarios to play out in order to watch how particular events unfold; and (4) it accounts for particular customer groups so that individual impacts can be isolated.

Some of the model's weaknesses for the scenario analysis are: (1) it has only annual energy accounting, so it cannot monitor seasonal hydro-system operations, power marketing conditions or capacity limitations; and (2) it is not set up to perform risk analysis or decision analysis.

The model requires explicit specification of each scenario and strategy, including the load forecast, initial wholesale and retail rates, gas prices, regional power resource characteristics data, forecasts of the aluminum industry, conservation supply curves, generation resource costs, and other data. The Screening Model relies largely on other models for its inputs and parameters, including BPA's load forecasting models, resource supply curves, hydroelectric generation information, etc.

Electricity end use detail and explicit modeling of consumer behavior enable a wide range of demand side policy analysis. Conservation acquisitions and resources are treated as market responses rather than resources whose delivery a utility can guarantee at an exact level. While conservation programs offer incentives and specify which efficiency measures are eligible, it is the response to programs being offered that results in

Table 5-1. Scenario Input Assumptions for the Screening Model

Scenario	Base Case	Demand Boom/ Resource Bust	Demand Boom/ Resource Change
Economic Growth	1.28% per year	2.47% per year	2.47% per year
Conservation Supply	Current estimates	77% of current estimates	136% of current estimates
Gas Price Escalation	+3.1% per year	+5.3% per year	+0.3% per year
Gas Supply Limit	3 GW	1.5 GW	4.5 GW
Hydro Constraints			
Dry	-1.0 aGW	-2.0 aGW	-2.0 aGW
Average	-0.2 aGW	-0.4 aGW	-0.4 aGW
Wet	0 aGW	0 aGW	0 aGW
New Technology	+400 aMW	0 aMW	+400 aMW

reduced loads.¹ The Screening Model does not anticipate conservation savings, but instead adjusts the forecast of resource needs after the savings occur on the system. If resource requirements exceed what programs can deliver, the model automatically acquires generation resources, either by bidding or by building utility-owned generation (the default case). The response to utility requests for generation resources under bidding depends on the utility's avoided cost for generation and the quantity needed.

Screening Model Methodology

The Screening Model was used to examine specific, fixed scenarios originating in the CATALYST process. The scenarios were generated in the model by specifying key drivers in the model provided in Table 5-1. All of the scenarios differ in at least one key aspect from BPA's expected future. The data agrees with ISAAC data where possible. For example, load growth in the Demand Boom scenarios comes from the joint BPA/Council high load forecast. Some data is unique to these scenarios, such as the size of

hydro system energy losses resulting from environmental constraints.

The *Base Case* scenario differs from current expectations only in that it assumed hydro system loss to competing water uses. Economic growth driving the Medium load forecast takes place and regional conservation programs perform as anticipated. However, the hydro system's operation is reduced somewhat due to environmental constraints. New technologies, represented by renewable resources in the model, expand the portfolio of resources available at less than 35 mills/kWh.

Both BPA and the Council expect natural gas supplies for the region to be limited. Consequently, the model is constrained by an overall limit on new gas availability. When that limit is reached, the avoided cost for utility generation rises, increasing the available supply of cogeneration that bidders can provide. The gas price for generation resources is set at \$2.09/MMBtu in 1991 and escalates above inflation, according to the scenario.

Under the *Demand Boom/Resource Bust* scenario, gas price rises at 5.3% above inflation and supply is limited. Conservation programs do not perform as well as anticipated, suffering a 23%

¹See Andrew Ford and Jay Geinzer, "The BPA Conservation Policy Analysis Models," U.S. DOE document no. BP-24760-1, Bonneville Power Administration, April 1986.

decrease in savings acquired for a given level of expenditures. Lastly, new technologies fail to provide low cost resources. This scenario tests the limits of the region's ability to cope with acquisition challenges.

Under the *Demand Boom/Resource Change* scenario, assumptions concerning conservation program performance, gas supplies and the development of new technologies are much more favorable than in the preceding cases. This scenario explores the extent to which attractive resource options can offset prolonged, high regional demand.

It is assumed that both BPA and IOU planners adopt similar strategies, derived from CATALYST results. The principal controls in the model to select conservation acquisitions are incentive levels and budget limits. The response by end users to programs influences what, if any, generation acquisitions must be made to meet projected load growth. Only if the bidding process falls short of need do utilities acquire their own generation (lower cost resources first). Since BPA cannot own generation resources, for modeling purposes "utility owned" generation for BPA mimics the cash flow requirements of a project developer.

The target driving the *High Conservation Strategy* is acquiring 1199 aMW of regional net savings by the year 2000 under the Base Case scenario. Incentives are set at 90% of measure cost in the residential and commercial sectors, and somewhat less (63%-82%) in the industrial and agricultural sectors. The annual spending limit set for programs in existing residential and commercial buildings is \$450 million. All conservation measures up to 56 mills/kWh are eligible for programs. The 56 mill cap applies to all strategies tested and was based on the limits in the Council's 1991 Northwest Power Plan. Finally, the 10% Northwest Power Act credit for conservation and BPA environmental cost adders were included in the total regional cost result for each strategy.

The target driving the *Blitz Conservation Strategy* is acquiring 1551 aMW of regional net sav-

ings by the year 2000 under Base Case assumptions. The objective is to acquire as much savings as possible, and the spending limit is effectively removed. Residential and commercial incentives remain at 90%, while industrial and agricultural incentives are raised to the 70%-90% range.

The *Moderate Conservation Strategy* targets more cost-effective measures by scaling back from the High Conservation incentive plan. Because of the structure of the Screening Model, this causes utilities to acquire more gas resources when needed. This matches the CATALYST definition of a strategy emphasizing more thermal resources at the onset. Lower incentives mean end users bear a greater share of costs, so they will reduce market response the most where end user payback periods are greatest (close to the 56 mill/kWh cap). Lower incentives result in lower program participation rates. Incentives were reduced to 60% in the residential sector, 45%-60% for commercial, and 50%-65% for industrial and agricultural programs. The spending limit for existing residential and commercial buildings is set at \$75 million. All the same measures are eligible, so programs operate across virtually all end uses and acquire regional net savings of 612 aMW by 2000 under Base Case assumptions.

Finally, a bidding only strategy, labeled *NUG Only* (Non-Utility Generation), was added for comparison purposes to focus on this non-traditional resource.

Results from the Screening Model

Summarized Scenario Results. The analytic results for three of the five scenarios — Base Case, Demand Boom/Resource Bust and Demand Boom/Resource Change — are presented below. Aside from the Base Case scenario, the two high growth scenarios were selected for this analysis due to uncertainties the region is facing, given higher load growth.

The Demand Boom/Resource Bust scenario represents a world of limited resources with higher prices, while the Demand Boom/Resource

Change scenario represents a world of abundant resources at lower prices. Analysis was also completed for the Base Case/Resource Change and Demand Low/Resource Stable scenarios. They are not reported here since they represent more gradual changes in the resource planning environment in which there is time to respond without severe dislocations. The high demand scenarios were deemed to have the most relevance in reflecting current system challenges.

The two primary figures of merit used to judge the different strategies are: (1) the discounted present value of total regional cost; and (2) average electric rates over the years from 1988 to 2010. The results of each strategy are compared to a Reference Strategy for each scenario. The Reference Strategy acquires utility generation resources only, with no non-utility generation or conservation, but is subject to the same economic growth, resource availability and resource cost assumptions.

Regional costs include all monetary costs incurred by utilities and consumers in the region. They are calculated by adding total utility revenues to the annual customer spending on conservation. The results include the Regional Power Act 10% conservation cost credit and the effect of external impacts on the environment. Environmental costs are assigned to generation technologies in mills/kWh escalated at 1% real, accumulated over the course of the run and added onto the total regional cost.²

The rate results represent the combined effect of regional rules on recovering a flow of nominal dollar expenditures by utilities. The results in this study use existing methods for recovering conservation costs; for example, the costs for BPA's share are allocated across all electricity sales. Conservation tends to raise rates since comparable costs are spread over smaller loads. However, another cost recovery method, such as an

energy service charge on the savings, could yield different results.

Base Case Scenario. Table 5-2 shows the total regional cost and rate impacts relative to the Reference Strategy for the Base Case scenario. Total regional costs are lowest under either the Moderate or High Conservation strategies. The least desirable option in terms of total regional cost reduction is the NUG Only strategy. The Moderate or High Conservation strategies acquire resources at cost-effective levels commensurate with needs in the Base Case scenario with moderate hydro system losses, given the Regional Act credit and environmental costs. The unrestrained Blitz strategy goes overboard, both in terms of the amount acquired and the level of utility and consumer payments; it is just too expensive for the circumstances.

The four test strategies in Figure 5-1 tend to generate rate trends that are similar in shape, and they contrast with the Reference Strategy. The test strategies primarily acquire conservation and non-utility generation. The Reference Strategy primarily acquires utility generation. The rate impacts of these resources are very different over time due to utility rate-basing rather than expensing, and the exclusion of the other, cheaper resources. The Reference Strategy starts increasing after 2005 due to accelerating construction of utility generation. The NUG Only and Moderate Conservation strategies generate nearly identical rates through most of the period; the impact of conservation on rates is moderated due to its smaller size and modest incentive levels. The High Conservation and Blitz Conservation strategies generate higher rates throughout the period due to successively higher levels of spending on conservation and end up approximately 3 mills and 5 mills higher than the lowest rates, respectively, by the year 2010.

These results are applicable to the single, fixed Base Case scenario. There is no accounting for how uncertainty in resource requirements and/or resource performance would affect the choice of a final strategy. For example, if one embarked on

²Data derived from "Draft Estimates for Environmental Cost - Planning Purposes," Bonneville Power Administration, June 1991.

the Moderate Conservation strategy, it could look timid or extravagant later depending on which scenario unfolded.

Demand Boom/Resource Bust Scenario.

This scenario was designed to place maximum stress on the electric supply system by combining high growth, low resource availability and high resource prices. Total regional cost impacts relative to the Reference strategy for the Demand Boom/Resource Bust scenario are provided in Table 5-3. Total regional costs are lowest under all three conservation strategies due to the desperate need for resources. Environmental costs are high because of the resource constraints on both conservation and gas supply; the model must ultimately turn to coal because of constraints on preferred resources. The least desirable outcome in terms of total regional cost reduction is the NUG Only strategy, since higher gas prices work against many non-utility generation resources. The Reference Strategy is severely constrained due to gas shortages and high gas prices.

Average regional rate results for the four strategies, including the Reference strategy, are shown in Figure 5-2. The rates for the NUG Only and the Moderate Conservation strategies are virtually identical. The rapid increase in rates in the early part of the period is due in large part to the necessity of recovering from severe hydro system loss and keeping up with higher growth rates. The Reference strategy increases the most rapidly because gas supplies expire by about 1994 in this scenario, and utilities proceed to rate-base plants after this time. In the four other strategies it is more common for NUG coal plants to be constructed and expensed, which has a more advantageous impact on rates in this scenario. Rates in the Blitz and High Conservation strategies suffer from an acquisition of large amounts of conservation at higher prices throughout the period.

Demand Boom/Resource Change Scenario.

This scenario couples high growth, abundant

resources and low resource prices. This tends to have the opposite effect in a high growth situation as the Demand Boom/Resource Bust scenario. Total regional cost results relative to the Reference strategy for the Demand Boom/Resource Change scenario are provided in Table 5-4. More natural gas is available for non-utility generators in this scenario than in the Demand Boom/Resource Bust scenario. As a result, environmental costs are lower for all conservation strategies than for the reference case, and the fallback resource to cover the insufficiency of conservation is a cleaner resource. In addition, the environmental costs for the High and Blitz Conservation strategies are sufficiently low that these two plans result in the lowest regional cost. Total regional costs are lowest under High Conservation strategy; however, the Blitz Conservation strategy produces only slightly less desirable effects. The least desirable plan in terms of total regional cost reduction is the NUG-Only strategy. This is in part due to a windfall the region receives from the added availability of conservation and new technologies.

Average regional rate results for the four strategies including the reference case are shown in Figure 5-3. The Reference strategy rates rise continually throughout the period. The NUG Only and Moderate Conservation strategies both generate similar rate impacts. The High and Blitz Conservation rates are approximately 4 and 6 mills/kWh higher, respectively, than the lowest rates by the year 2010. The much reduced rate benefit results from more conservation available for purchase and the reduced cost of alternative resources, namely gas.

Flexibility: What Does It Take?

Another benefit of scenario analysis is the insights from working through severe challenges to the system which may fall outside of the bounds of conventional analysis. In this study the Demand Boom/Resource Bust scenario poses

**Figure 5-1. Base Case Scenario: Average Regional Rates
(1990 Mills/kWh)**

**Table 5-2. Base Case Scenario:
Regional Cost and Rate Impacts
(Billions 1990\$)**

	Reference Strategy	NUG-Only Strategy	Moderate Conservation (High Gas) Strategy	High Conservation Strategy	Blitz Conservation Strategy
Regional Cost (monetary)	120.6	118.6	117.6	119.2	121.6
Northwest Power Act Credit	-0.4	-0.4	-0.9	-2.5	-3.6
Environmental Cost	6.7	7.1	6.9	6.7	6.6
Total Regional Cost	126.9	125.3	123.6	123.4	124.6
Regional Cost (% Benefit)		1.3%	2.6%	2.8%	1.8%
Regional Rates (% Benefit)		2.2%	1.6%	-2.7%	-6.2%

**Figure 5-2. Demand Boom/Resource Bust Scenario:
Average Regional Rates
(1990 Mills/kWh)**

**Table 5-3. Demand Boom/Resource Bust Scenario:
Regional Cost and Rate Impacts
(Billions 1990\$)**

	Reference Strategy	NUG-Only Strategy	Moderate Conservation (High Gas) Strategy	High Conservation Strategy	Blitz Conservation Strategy
Regional Cost (monetary)	161.9	147.8	145.8	148.2	149.3
Northwest Power Act Credit	-0.7	-0.6	-1.3	-3.4	-4.4
Environmental Cost	9.3	9.8	9.5	9.1	8.9
Total Regional Cost	170.5	157.0	154.0	153.9	153.8
Regional Cost (% Benefit)		7.9%	9.7%	9.7%	9.8%
Regional Rates (% Benefit)		9.6%	9.6%	6.1%	4.4%

**Figure 5-3. Demand Boom/Resource Change Scenario:
Average Regional Rates
(1990 Mills/kWh)**

**Table 5-4. Demand Boom/Resource Change Scenario:
Regional Cost and Rate Impacts
(Billions 1990\$)**

	Reference Strategy	NUG-Only Strategy	Moderate Conservation (High Gas) Strategy	High Conservation Strategy	Blitz Conservation Strategy
Regional Cost (monetary)	147.0	138.5	135.2	135.9	137.5
Northwest Power Act Credit	-0.6	-0.6	-1.3	-3.5	-4.6
Environmental Cost	7.5	7.5	7.1	6.7	6.6
Total Regional Cost	153.9	145.4	141.0	139.1	139.5
Regional Cost (% Benefit)		5.5%	8.4%	9.6%	9.4%
Regional Rates (% Benefit)		6.9%	6.5%	2.5%	-0.4%

**Figure 5-4. Non-Utility Generation Capacity Requests
(aMW)**

nearly catastrophic challenges. The modeling provides a quantitative portrayal of how the utility system responds. It raises the added question of whether the region is prepared to respond as well as represented in the model.

One indicator of stress on the system monitored in the Screening Model is the rate of capacity additions. In the Demand Boom/Resource Bust scenario, the analysis assumes that a large hydro loss occurs without warning in 1993, causing BPA and the region to respond with a suddenly higher rate of acquisitions. These resource needs are first put out for bid, and if they cannot be satisfied, utilities are forced to acquire generation resources on their own. Figure 5-4 shows that for the Demand Boom/Resource Bust scenario with the High Conservation Strategy, the

region requests 2,400 MW of generation through bidding in 1993. This compares to only 700 MW in the Base Case scenario with its smaller hydro impact. That level of acquisition could severely strain the region's administrative and financial ability to replace the generation in a timely, cost-effective basis. Figure 5-4 also shows a rapid run-up in electric rates to begin paying for this lump of new resource additions. Ironically, the early and rapid rate increases actually alleviate the crises somewhat by moderating load increases.

The stress on system and institutional resources to meet the Demand Boom/Resource Bust scenario is tremendous. How much "insurance" should be purchased to prepare for it? Currently, BPA plans to acquire resource options

to protect such risks, but the optimal level is unknown. The CATALYST group felt this scenario had a very low probability of occurrence. At the same time, they felt that the Demand Low/Resource Stable scenario was more likely. Ideally, a resource strategy would include actions at a reasonable cost which position the agency to respond to whichever scenario emerges.

Finally, would the planning and tracking systems in the region be able to distinguish between changes in long-term trends (along the lines of the Demand Boom/Resource Bust and Demand Low/Resource Stable scenarios) and a change in the short to medium-term business cycle? Interpreting short-term changes as long-term trends could easily lead to substantial over- or under-investment in resources.

Flexibility is composed of three elements: the ability to respond rapidly to a perceived threat; the availability of alternative actions that will have immediate effect when decisions are made; and the timely ability to discern that action is necessary. Preparation for each of these includes, respectively: expedited processes for making and implementing decisions; the acquisition of resource options and other mechanisms to shorten the lead time for specific remedies; and an "early warning system" that would monitor specific sources of potential surprise for utility managers. The early warning system should probably concentrate on risks to existing resources (or larger resources that are scheduled to be on-line soon) from any source, including physical, contractual, regulatory or legislative. It is less likely that the performance of smaller resources or changes in demand would lead to rapid, permanent changes requiring immediate action.

The 10-Year Response Plan is intended to structure the discussion and actions to minimize the risks from low probability, high impact events.

Implications for the 1992 Resource Program

Before attempting to summarize the study findings, the following model constructs should be recalled:

- Models consist of assumptions and input data, such that the relative merit of resource strategies is very much a function of the assumed cost and availability of each alternative, and these estimates can change every year.
- The scenario results apply to each scenario individually and do not suggest an overall strategic acquisition plan.

Some key implications can be drawn from the modeling analysis of the CATALYST scenarios. The following insights are robust over all the scenarios and strategies investigated, but they should be considered carefully in the overall planning environment for BPA and the region:

- Conservation and Non-Utility Generation are competitive as attractive resource acquisitions.
- Blitz conservation creates greater rate impacts. As incentive levels for conservation are increased at the high end of the supply curve, these generous incentives go to all participants and attract higher cost measures. This compound effect results in a greater rate impact for ever smaller increments of savings.
- Gas prices and gas availability are key drivers in how the future looks over all scenarios. This fact suggests efforts are warranted to increase the availability, reliability and price stability for this key resource.
- The diversity assumed in the cost of non-utility generation (the mix of low and high cost projects) gives it a near-term advantage over utility-owned CTs. This assumption should be monitored.

- The desire for policy and management flexibility is a key insight from all scenario analyses. Judging what comprises an appropriate level of flexibility is elusive. It is clear that a short response time is a key variable in flexibility. It can also lead to over-reaction to short-term changes.

Finally, in the coming months before the final 1992 Resource Program is produced, final estimates for many of the key variables in this study will be available, e.g., demand growth, resource costs and availability, performance risks, etc. As these discussions proceed and revised estimates emerge, sensitivity analyses will be done to test these results.

Scenario Analysis Using the Power Market Decision Analysis Model (PMDAM)

Description of PMDAM

In addition to the analysis conducted using the Screening Model, a scenario analysis of the West Coast power market was conducted using BPA's Power Market Decision Analysis Model (PMDAM). This model was developed for the analysis of marketing strategies and decisions concerning long-term power sales contracts. These contracts are complex because they may specify when, where, how much and at what price power is to be delivered over 20 years or more.

PMDAM assumes each utility party will act in its own interest and attempt to find the least-cost plan to serve its native load customers. The model optimizes short and long term decisions among the parties that are beneficial and result in an economic balance (equilibrium of supply and demand) at agreed prices. The model computes both market quantities and market prices.

At the operating level, the model determines the hourly, daily, monthly and annual balance of native loads, generation resources, contract loads and contract resources. At the planning level, PMDAM determines the planning balance for resources and contracts for each party. The

planning objective is to meet firm capacity and firm energy reliability criteria while minimizing each party's fixed and variable costs. Generation resource acquisitions are simulated for each party, as are decisions to sell and purchase power on a long-term basis.

PMDAM explicitly represents uncertainty through some of the key variables that affect model outputs that are important to decision-making. Loads, generation plant availability and hydro inflows are currently treated as uncertain variables. Uncertainty is modeled as being resolved over the planning horizon.

The PMDAM simulates the West Coast wholesale power markets. The model's five regions are British Columbia, the Pacific Northwest, Northern California, Southern California and the Inland Southwest.

PMDAM Methodology

Scenario analysis was conducted using PMDAM to determine the implications of the various scenarios to the entire West Coast power system, and thereby provide insights about the desirability of developing power sales, exchange or purchase contracts as a source of acquisitions or options in the 1992 Resource Program. A single strategy, corresponding to the Base Case strategy defined in the CATALYST process, was analyzed for all five scenarios. This strategy was referred to as the High Conservation Case in the Screening Model Analysis. The input assumptions in each scenario are differentiated by changes in load growth, conservation penetration rates, gas price, ESA/SOR outcomes and new technology impacts. The assumptions for each of the five scenarios are summarized in Table 5-5.

Five different PMDAM runs were conducted. The resource and contract acquisition results are presented below.

Results of PMDAM Analysis

In the descriptions of results that follow, absolute magnitudes of resource and contract acquisitions are specified for Scenario 1 (the Base

Table 5-5. Scenario Input Assumptions for PMDAM

Variables	Economy/ Load Growth	Conservation	Gas Price	ESA/SOR Impacts [1]	New Technology
1. Base Case	medium	current supply curves	current forecast	500 aMW firm 750 MW capacity	400 MW at less than 35 mills
2. New Opportunities	medium	current supply curves	lower by 20%	500 aMW firm 750 MW capacity	400 MW at less than 35 mills
3. Demand Boom/ Resource Change	high	faster penetration rates	lower by 20%	1000 aMW firm 1500 MW capacity	400 MW at less than 35 mills
4. Demand Boom/ Resource Bust	high	slower penetration rates	higher by 20%	1000 aMW firm 1500 MW capacity	0 MW at less than 35 mills
5. Demand Low/ Resource Stable	low	current supply curves	current forecast	500 aMW firm 750 MW capacity	400 MW at less than 35 mills

[1] Capacity loss due to ESA/SOR occurs for the January through July period.

Case). All other results are expressed as changes from these base case numbers.

Scenario 1: Base Case. The results show BPA would meet its entire Year 2000 load growth with conservation (600 aMW) and contracts. There would be no need for any additional generation resources. Annual firm energy purchases from California by the year 2000 would be approximately 1400 aMW. Pacific Northwest to Pacific Southwest summer capacity sales would be approximately 3800 MW, while British Columbia to Pacific Southwest flow-through sales would be an additional 1500 MW. Pacific Northwest fall and winter capacity sales to the Pacific Southwest would be approximately 1100 MW. Pacific Northwest fall capacity sales to British Columbia would be 75 MW, and Pacific Northwest winter capacity sales to British Columbia would be approximately 420 MW.

Scenario 2: New Opportunities Case. In the New Opportunities case there are relatively minor changes on resource and contract acquisitions. Resource acquisitions remain the same at approximately 600 MW. These consist of an additional 90 MW of cogeneration and 140 MW less conservation. Annual firm energy purchases

remain the same. Pacific Northwest to Pacific Southwest summer capacity sales increase by approximately 100 MW, while British Columbia to Pacific Southwest flow-through sales decrease by approximately 200 MW. Pacific Northwest fall and winter capacity sales to the Pacific Southwest decrease by approximately 150 MW. Pacific Northwest fall capacity sales to British Columbia increase by approximately 150 MW. Pacific Northwest winter capacity sales to British Columbia increase by approximately 400 MW.

Scenario 3: Demand Boom/Resource Change Case. In the Demand Boom/Resource Change case, BPA has approximately 1700 aMW of additional firm energy load by the year 2000. Resource acquisitions (nameplate) increase by more than 2200 MW. These consist of 1000 MW combined cycle combustion turbines, 630 MW gas turbines, 320 MW cogeneration, 270 MW of additional conservation. Annual firm energy purchases from California increase by approximately 450 aMW. Pacific Northwest to Pacific Southwest summer capacity sales increase by approximately 500 MW, while British Columbia to Pacific Southwest flow-through sales increase by approximately 1000 MW. Pacific Northwest fall and winter capacity sales to the Pacific Southwest decrease

by approximately 700 MW. Pacific Northwest fall and winter capacity sales to British Columbia increase by approximately 300 MW.

Scenario 4: Demand Boom/Resource Bust Case. In the Demand Boom/Resource Bust scenario, BPA has approximately 1700 aMW of additional firm energy load by the year 2000. Resource acquisitions increase by more than 2300 MW. These consist of 1280 MW of nuclear, 250 MW coal, 380 MW cogeneration, 240 MW gas turbines and 170 MW of additional conservation. Annual firm energy purchases from California increase by approximately 800 aMW. Pacific Northwest to Pacific Southwest summer capacity sales remain constant, while British Columbia to Pacific Southwest flow-through sales increase by approximately 1100 MW. Pacific Northwest fall and winter capacity sales to the Pacific Southwest decrease by approximately 1000 MW. Pacific Northwest fall and winter capacity sales to British Columbia decrease by approximately 200 MW.

Scenario 5: Demand Low/Resource Stable Case. In the Demand Low/Resource Stable case, BPA has approximately 1250 aMW less firm energy load by the year 2000. Resource acquisitions decrease by 130 aMW (all conservation). Annual firm energy purchases from California decrease by 1500 aMW. Pacific Northwest to Pacific Southwest summer capacity sales remain constant, while British Columbia to Pacific Southwest flow-through sales decrease by approximately 1100 MW. Pacific Northwest fall and winter capacity sales to the Pacific Southwest increase by 900 MW, while exports to British Columbia decrease by 400 MW, reflecting winter heating load reductions.

The results of these comparisons are presented in Table 5-6.

Conclusions

For all cases, the results indicate that by the year 2000 it is economic for BPA to acquire conservation and firm energy option contracts from

the Pacific Southwest. All scenarios studied acquired conservation ranging from 400 to 800 MW. Firm energy contracts range from 2150 aMW of imports in Scenario 4 (High Demand) to 100 aMW of exports in Scenario 5 (Low Demand). These imports satisfy Pacific Northwest firm energy reliability criteria. These contracts have high variable operating costs, but are fully displaceable.

The fall and winter capacity market is in a transition period. Prior to the year 2000, the Pacific Northwest is a net exporter of fall and winter capacity to the Pacific Southwest and British Columbia. By the year 2000, British Columbia and Pacific Northwest become net importers of fall and winter capacity under high loads (Scenarios 3 and 4). In the base case, the Pacific Northwest and British Columbia become net importers by the year 2014. Summer capacity sales to the Pacific Southwest stay strong throughout the study horizon.

In the year 2000, the Pacific Southwest summer capacity market remains strong under all scenarios, ranging from 4000 MW in the Low demand case (Scenario 5) to 6900 MW in the High demand case (Scenario 3). Swings in summer capacity sales are primarily met by additional resource development in British Columbia.

Use of Scenario Analysis Results in the 1992 Resource Program

The scenario analyses provide a number of insights that were useful in developing the 1992 Resource Program. Both models emphasize the relative cost effectiveness of overbuilding compared to underbuilding, and underscored the economic advantages of flexibility. These results helped guide the development of resource strategies to provide a cushion of acquisitions beyond firm needs and insurance in the form of options, particularly those involving inter-regional transactions.

Table 5-6. Summary of Scenario Analysis From PMDAM [1]

Scenarios	Base Case	New Opportunities	Demand Boom/ Resource Change	Demand Boom/ Resource Bust	Demand Low/ Resource Stable
Acquisitions	600 aMW	same	+2200 aMW	+2300 aMW	-130 aMW
Firm Energy Purchases (from California)	1400 aMW	same	+450 aMW	+800 aMW	-1500 aMW
Summer Capacity Sales (PNW to PSW)	3800 MW	+100 MW	+500 MW	same	same
Flow-Through Sales (BC to PSW)	1500 MW	-200 MW	+1000 MW	+1100 MW	-1100 MW
Fall and Winter Capacity Sales to PSW	1100 MW	-150 MW	-700 MW	-1000 MW	+900 MW
Fall and Winter Capacity Sales to BC	495 MW	+400 MW	+300 MW	-200 MW	-400 MW

[1] Values expressed as change from Base Case in year 2000.

Formulation of Alternative Generation Resource Strategies

Resource Strategies

The next step in the development of the Draft 1992 Resource Program involved constructing alternative strategies to be subjected to extensive analysis using BPA's decision analysis model, ISAAC. These strategies represent distinct sets of actions Bonneville could take in FY 1993-1995 to ensure that loads are met in the face of both demand and supply uncertainties. Each alternative strategy:

- Adds to the set of resource acquisitions and options defined in the 1990 Resource Program (350 aMW of billing credits and bidding, 800 aMW of Contingency Plan options and 70 aMW of hydro efficiencies).
- Includes 47 aMW of efficiency improvements at WNP-2.
- Assumes implementation of the Council's goal of acquiring at least 600 aMW of cost-effective conservation.

Before describing the ISAAC analysis, it is important to describe two of its assumptions: the ordered portfolio or "stack" of resources used in the analysis, and the aggressive conservation acquisitions underlying all the generation resource strategies.

The 1992 Resource Stack

In developing conservation and generation supply estimates, BPA used the assumptions regarding resource cost and availability developed jointly with the Council. In a few cases, however, minor adjustments were made to incorporate new data or refinements to the analytical tools shared by BPA and the Council. For conservation supply estimates, adjustments were made in three areas: water heating, residential lighting and the commercial sector. For generation supply estimates, adjustments were made in transmission costs, coal gasification costs, and operation and maintenance costs for WNP-1 and WNP-3.

BPA uses the conservation and generation supply estimates to develop the 1992 resource stack, or menu of supply and demand options available for meeting electrical loads. The result-

Figure 5-5. New Resources Stack

Also potentially available, but not included here, are Canadian Entitlement; Canadian Coordination; contract recall; exchange energy; supplemental energy from current SP contracts; and other intersystem opportunities.

(1) Nominal levelized costs are roughly twice the real levelized costs shown here.

(2) The costs of cogeneration vary considerably: some may be more expensive than the nuclear estimates shown here. For the purpose of this diagram, all 550 aMW have been grouped together.

final resource stack used in the Draft 1992 Resource Program analysis. These considerations include:

Conservation cost advantage. The Northwest Power Act mandates a 10% cost advantage to conservation resources as compared to other resource types (renewables, cogeneration and thermal generation). To account for this advantage when determining the order of the resource stack, the levelized costs of conservation resources are reduced by 10%. Therefore, conservation resources are "moved up" in the resource stack relative to generation resources.

System considerations. Levelized costs represent the cost of a resource operating in a stand-alone mode; that is, without considering how the resource might operate in the context of the larger power system.

However, many resources

ing resource stack is based on resource cost effectiveness, and contains the amount of each resource available to BPA in aMW and the real levelized cost of each resource in mills/kWh.

BPA's resource stack is ordered initially on the basis of levelized cost, from lowest- to highest-cost (see Figure 5-5). However, several other considerations go into determining the order of the

have system cost advantages (including lead time, unit size, dispatchability, and ratio of fixed to variable costs) that are not captured by calculation of stand-alone levelized costs. These system cost advantages are important and are taken into account in ordering the resource stack.

Environmental costs. Environmental externalities are the economic costs and benefits not

Table 5-7. BPA Resource Stack

Resource	Real Levelized Direct Cost (mills/kWh, 1990\$) [1]	Environmental Costs	Total Real Levelized Cost	BPA Supply (1994-2010)		
				Total Nominal Levelized Costs [2]	Medium Loads	High Loads
Conservation (Nondisc):						
New SF Res (2000-2010)	28.4	0.0	28	56	58	135
New MF Res (2000-2010)	33.8	0.0	34	67	6	7
Hydro Eff Improvements	3.1	0.0	3	6	78	78
WNP Eff Improvements	5.0	0.0	5	18	47	47
Conservation:						
Conserv Voltage Reg	7.0	0.0	7	14	41	41
Solar Access	12.1	0.0	12	24	9	19
Irrigation	14.2	0.0	14	28	14	14
Non Aluminum Industrial	16.2	0.0	16	32	146	181
New Commercial	17.3	0.0	17	34	135	218
Hydro 1 West	20.7	1.0	22	43	9	9
Conservation:						
Comm Disc Existing	25.1	0.0	25	49	149	187
Manuf Housing WX	25.2	0.0	25	50	12	12
Comm Lost Op Existing	25.6	0.0	26	50	110	116
T & D Eff Improvements	28.0	0.0	28	55	104	104
Hydro 1 East	22.5	1.0	24	46	14	14
Thermal Eff Improvements	28.4	0.0	28	56	6	6
Conservation:						
New SF Res (1994-1999)	28.4	0.0	28	56	58	135
Water Heat	29.4	0.0	29	58	264	344
New Manuf Housing	32.7	0.0	33	64	71	69
CTs & Displaceable Purch [3]	32.0	1.4	33	66	1500	1500
Conservation:						
New MF Res (1994-1999)	33.8	0.0	34	67	6	7
Multi Family Res Wx	39.1	0.0	39	77	9	9
Hydro 2 West	34.7	1.0	36	70	10	10
SCE Option Energy [4]	37.0	1.6	39	76	71	71
Conservation:						
Single Family Res Wx	41.4	0.0	41	82	43	43
Hydro 2 East	37.0	1.0	38	75	15	15
Conservation:						
New Res Lighting	42.6	0.0	43	84	10	21
Cogen 1 West	38.0	1.8	40	78	60	60
WNP3 [5]	37.8	2.0	40	78	806	806
Conservation:						
Existing Res Lighting	44.7	0.0	45	88	2	2
Cogen 2 West	39.0	1.8	41	80	7	7
WNP-1 [5]	38.8	2.0	41	80	813	813
Cogen 1 East	39.1	1.8	41	81	60	60
Cogen 2 East	40.1	1.8	42	83	7	7
Wind 1	47.4	0.5	48	94	7	7
Hydro 3 West	46.2	2.0	48	95	13	13
Hydro 3 East	48.4	2.0	50	99	19	19
Geothermal	51.4	1.0	52	103	88	88
Municipal Solid Waste	41.0	12.6	54	106	30	30

Table 5-7. BPA Resource Stack (continued)

Resource	Real Levelized Direct Cost (mills/kWh, 1990\$) [1]	Environmental Costs	Total Real Levelized Cost	Total Nominal Levelized Costs [2]	BPA Supply (1994-2010)	
					Medium Loads	High Loads
Cogen 3 West	53.0	1.8	55	108	141	141
Cogen 3 East	54.1	1.8	56	110	141	141
Coal 1 (E. Montana)	54.7	2.5	57	113	450	450
Coal 2 (E. Washington)	54.7	2.5	57	113	188	188
Hydro 4 West	57.7	2.0	60	118	9	9
Cogen 4 West	58.0	1.8	60	118	67	67
Coal 3 (E. Oregon)	58.2	2.5	61	120	188	188
Cogen 4 East	59.1	1.8	61	120	67	67
Hydro 4 East	60.1	2.0	62	122	13	13
Coal 5 (W. Wash/Oregon)	60.8	2.5	63	125	188	188
Wind 2	63.5	0.5	64	126	95	95
Coal 4 (Nevada)	61.7	2.5	64	126	188	188
Wind 3	72.4	0.5	73	144	63	63
Biomass	74.9	3.7	79	155	113	113
Solar 2	85.7	1.0	87	171	120	120

[1] Year 2000 real levelized cost in 1990 mills/kWh. Levelized costs for generating resources assume 50% private and 50% public financing. Levelized cost for conservation resources assume 100% debt financing at a 9.2% nominal interest rate.

[2] Nominal levelized costs have been normalized to a 40-year operating life. Financing assumptions are the same as those used for real levelized costs. (Real levelized costs multiplied by 1.9 equal nominal costs).

[3] Medium gas prices (start at 13.1 mills in 1990 and increase by 3.1% per year).

[4] Assumes remains as a sale only

[5] O&M costs are an average of high and low estimates for WNP-1 and WNP-3.

directly borne by the entity causing the environmental effect. BPA is required by the Northwest Power Act to include quantifiable environmental externalities in determining a resource's total system cost for BPA's planning and acquisition activities. The Draft 1992 Resource Program is BPA's first resource plan that explicitly incorporates quantified environmental externalities into system costs.

In the development of the resource stack, environmental costs are added to the stand-alone levelized costs of all resources available to BPA. Therefore, resources with relatively low environmental costs move up the stack compared to resources with the same levelized cost but higher environmental costs.

The ISAAC model is used to deal explicitly with load uncertainty, dispatchability and the other sys-

tem considerations previously noted. This model is run several times to determine the most cost-effective order of the resources in the stack. Cost effectiveness is determined by finding the resource stack that gives the lowest present value of total system costs (including environmental costs) under 100 "games" of load and water uncertainty. The resulting resource stack, shown in Table 5-7, is the menu of available resources used for the ISAAC analysis.

Cost-Effective Conservation

BPA is proposing to acquire at least 600 aMW of conservation by the year 2003 — a major long-term investment and commitment to developing conservation as the Pacific Northwest's resource of first choice. The 1990 Resource Program

called for "a stable and steadily increasing conservation program" acquiring at least 200 aMW of conservation by 1997. The Draft 1992 Resource Program extends that commitment through 2003 and recommends accelerating the rate of conservation acquisition. Conservation continues to be BPA's best resource choice for the following reasons:

- It is low-cost. Regional costs for the conservation proposed here average 27 mills/kWh in levelized 1990 prices (54 mills in nominal prices).
- It helps resolve transmission limitations in the Puget Sound area.
- It is environmentally sound.
- It lowers BPA's exposure to fuel price increases and the "dry hole" risk of other resources.

Analysis of Generation Resource Strategies

The analysis of generation resource strategies was performed using ISAAC. This model is a Monte Carlo-style decision analysis model that considers the effects of random regional electricity loads, random water levels in the Columbia River system, and random DSI loads. It runs 100 "games" of random loads and water levels for each year of the simulation, and "acquires" resources to meet projected needs in each year of each game for Bonneville, the generating public utilities and the investor-owned utilities. ISAAC also simulates the operation of the Columbia River and its tributaries, as well as the rest of the Northwest power system, and then calculates the total present value of the costs of resource acquisition and operation.

ISAAC is used to compare the impacts on regional system costs of different approaches to meeting electricity needs, considering these different uncertainties. In this way, different strategies can be compared to one another, providing insight into different policy choices.

The analysis for the Draft 1992 Resource Program consists of three stages. The first stage considers the quantity and timing of resource acquisitions for the Federal system. The second stage uses these results and expands them to assess how much of each resource should be built and how much should be acquired (see Chapter 8 for a full explanation of options). These two stages consider only effects on regional system costs, but give considerable direction to the formulation of strategies that are evaluated in the third stage relative to all of the decision factors. The third stage of the analysis considers four different strategies, a subset of the 16 different combinations of "build" and "option" amounts of new resources considered in Stage 2, and analyzes each one relative to the quantifiable decision factors.

Stage 1

Stage 1 considers the effects on regional system costs of acquiring different amounts (250, 500 and 750 aMW) of three different kinds of resources. These resources come on-line in either 1997 or 1999, or are divided evenly between the two years. All of the resources considered cost 35 mills per kWh (real levelized) but differ in operating characteristics and cost structure. These three types were: (1) baseload resources characterized as must-run resources with high capital costs and low operating costs; (2) combined cycle combustion turbines that are displaceable and have low capital costs but high operating costs; and (3) cogeneration that is a must-run resource acquired through an output contract with no capital costs and high operating costs.

As is the case for all of the analysis described in this section, the newly acquired resources (250, 500 and 750 aMW) are all in addition to the acquisition of about 600 aMW of conservation in the Conservation Implementation Plan, 350 aMW of billing credits and bidding resources, 47 aMW of efficiency improvements at WNP-2, 70 aMW of hydro efficiency improvements, and 800 aMW of

Table 5-8. Evaluation of Levels of Different Types of Generation Resources [1, 2]

Amount	Base [3]			CT [4]			Cogen [5]		
	1997	1999	Both	1997	1999	Both	1997	1999	Both
0	0								
250	281	247	258	-78	-103	-96	74	34	47
500	621	562	587	-106	-146	-130	202	134	165
750	982	891	926	-140	-199	-175	349	243	285

[1] Present value regional system costs (millions of 1990\$). Presented as difference from 0 aMW acquisition case (excluding external environmental costs).

[2] All resources cost 35 mills (real levelized 1990\$) and were brought online in 1997, 1999 or both.

[3] Resources characterized as predominantly capital costs and non-displaceable.

[4] Resources characterized as predominantly variable costs and displaceable.

[5] Resources characterized as all variable costs and non-displaceable.

options described in the 1990 Resource Contingency Plan.

Table 5-8 and Figure 5-5 show the results of Stage 1. For all three resource types, it is best to acquire all of the resources in 1999. In addition, displaceable 35 mill combustion turbines are more attractive resources for the system than either 35 mill cogeneration or a 35 mill baseload resource, both of which are not displaceable. Finally, this stage of the analysis also shows that the acquisition of baseload and cogeneration resources provides no net benefits to the region while, in contrast, the more combustion turbines are acquired the better.

The conclusions from this stage of the analysis are that acquisitions in 1999 are preferred to acquisitions in 1997 (or to acquisitions split between 1997 and 1999), largely because the system is surplus under most load paths by 1997 due to the planned acquisitions from bidding, billing credits, the Contingency Plan and the Conservation Implementation Plan. In addition, for the same reason, it is best to acquire no new non-displaceable resources for the Federal system, from the perspective of regional present value system costs. If resources are displaceable, complementing the availability of water in most years, the acquisition of up to 750 aMW still has benefits for the region.

Stage 2

The second stage of the analysis considers 16 different combinations of "build" and "option" levels for resources acquired in 1998 and 1999, and attempts to find the best combination(s) of added resources and options for the Federal system. Optioned resources complete the optioning phase by the beginning of 1996. Levels of acquiring and optioning resources vary from zero to 750 aMW, increasing in 250 aMW increments. The generation resource acquisitions consist of a mix of 70% combustion turbines, 20% cogeneration and 10% small hydro was used in all cases.

Table 5-9 shows the results of this analysis. First, note that differences in present value of system costs for both the 0 and 250 aMW acquisition levels are less than \$100 million. Differences of this magnitude are considered relatively small. Not until the acquisition level reaches 500 aMW do differences in present value of system costs rise significantly. Second, within an acquisition amount, differences among various amounts of optioned resources are quite small, indicating that the amount of optioned resources has little effect on total system costs.

These results indicate that, for this specific mixture of resource additions, the best strategy is to acquire no new resources. However, the strategies for the full analysis with regard to the

Table 5-9. Evaluation of Levels of Building and/or Optioning Generation Resources [1]

Option	Acquire X More Than Base Additions [2,3]			
	0 aMW	250 aMW	500 aMW	750 aMW
0 aMW	0	60	179	327
250 aMW	3	62	192	340
500 aMW	6	73	201	353
750 aMW	19	82	209	387

[1] Present Value of Regional System Costs (not including external environmental costs). Difference from (0, 0).

[2] Base Additions:

Conservation(including CVR and T&D efficiency): 663 aMW by 2003

WNP-2 efficiency: 47 aMW by 1995

Hydro efficiency: 70 aMW by 1995

Billing credits and competitive acquisitions: 350 aMW (106 aMW in 1995, 130 aMW in 1996 and 114 aMW in 1997).

[3] Resources acquired are 70% displaceable resources and 30% non-displaceable small hydro and cogeneration.

Optioned generating resources were chosen by moving down the resource stack (i.e., no predetermined mix of resources).

Most of the optioned resources were CTs or displaceable purchases, with some geothermal and coal.

decision factors consider acquisition levels greater than zero due to the large range of uncertainty not explicitly considered by the ISAAC model.

Stage 2 indicates that a lower level of acquisitions and options is preferable to a higher level. Therefore, strategies considered in Stage 3 of the analysis range from 0 acquisitions to 500 aMW of acquisitions and 0 to 500 aMW of options. These levels of acquisition and options span the reasonable range of likely actions recommended in the 1992 Resource Program and provide substantial insurance against future risks.

Evaluation of Generation Resource Strategies

In the third stage of the analysis, four strategies are evaluated to determine the levels of new generation acquisitions and options in 1993-95 that would best meet the needs of BPA's customers. The strategies considered are:

	Acquisitions	Options
Level 1 (0, 0)	0 aMW	0 aMW
Level 2 (250, 250)	250 aMW	250 aMW
Level 3 (250, 500)	250 aMW	500 aMW
Level 4 (500, 250)	500 aMW	250 aMW

These alternative levels cover the potential range of new acquisitions and options.

Each of the generation strategies was analyzed using the decision factors described in Chapter 3. Quantitative and qualitative measures of efficiency, risk reliability, environment and competitiveness were applied (see Tables 5-10 and 5-12). After considering the abilities of each of the strategies to meet the uncertainties BPA must face, a level of acquisitions and options was chosen for the 1992 Resource Program.

Decision Factor Analysis of Generation Strategies

Efficiency

System Costs. In considering how much generation should be acquired by BPA, the analysis tested the acquisition of both displaceable and non-displaceable resources from the perspective of system costs. To measure economic efficiency, the regional present value of system costs (as calculated in ISAAC) for each alternative strategy was compared to the present value of system costs of the base case that has no new acquisitions or options in addition to those already planned.

Table 5-10 shows that if resources added to the Federal system are partially displaceable, additional acquisitions beyond the base case

Table 5-10. Evaluation of Generation Resource Levels

Decision Factor	Efficiency		Risk		Reliability		Competitiveness	
	70% Displaceability	100% Displaceability			Ability to Meet High Loads [5]		Short-Term Rates [7]	Long-Term Rates [8]
Strategy	Internal	Cost [1]	Economic Risk [2]	Financial Risk [3]	Short-Term Purchases[4]			
Acquire/Option	Cost [1]	Cost [1]						
0-0	0	0	0	0	0	-321	0	0
250-250	+62	-46	+3	+1	-3	+179	+0.2	-0.2
250-500	+73	-37	+3	+1	-3	+429	+0.2	-0.2
500-250	+192	-80	+5	-4	-6	+429	+0.4	-0.3

[1] Present value of regional system costs not including external environmental costs (difference from [0-0]; millions 1990\$).

[2] The number of outcomes (out of 100) in which the strategy causes an increase in regional system costs of \$320 million more over the (0, 0) strategy.

[3] The change from the (0, 0) case of probability of negative cash flows exceeding \$200 million in 1999.

[4] The change from (0, 0) in the number of games (out of 100) in which short-term purchases were greater than or equal to 300 aMW in 1999.

[5] BPA load/resource balance in 2000 under high loads (assumes 1990 Contingency Plan resources on-line in 1998).

[6] Present value of regional quantified environmental costs (difference from [0, 0]; millions 1990\$).

[7] Average change in PF rate, 1996-1999 (difference from [0, 0]).

[8] Average change in PF rate, 2000-2009 (difference from [0, 0]).

acquisitions cause increases in system costs. The base acquisitions meet loads in all but the highest load paths, so additional acquisitions are not needed in most modeling "games." Hence, additional acquisitions cause the system to incur large costs. The small increment (\$10 million) in system costs resulting from the addition of only 250 aMW of options is explained by the low cost of options. This result shows their value because the additional cost incurred is small, even when they are unlikely to be needed soon.

On the other hand, if all of the additional acquisitions are displaceable resources, then both the 250 and 500 aMW levels provide benefits to the system. This additional value stems from the displaceability of operating combustion turbines (i.e., they are run only when needed to serve Northwest loads or if revenues from out-of-region sales more than cover costs). Options in this case have value because they simply represent additional acquisitions for the system that can eventually produce revenues.

In all cases, the increases and decreases in system costs are relatively small, taking into account that they are present values for a 50-year

study. None of these actions would be significantly negative or positive from the standpoint of economic efficiency over that period.

One can conclude from the efficiency analysis that: (1) results vary with the type of resource acquired; (2) there is no obvious "winner" among the four alternatives; and (3) system cost results do not provide much guidance when choosing among the four generation alternatives.

Sensitivity Analysis for Generation Strategies. The analysis of the strategies already discussed was performed under one set of assumptions concerning gas prices, DSI loads and resource supply. Given the large amount and varying sources of uncertainty BPA faces in the future, it is instructive to consider how the ranking of these generation alternatives varies with different assumptions concerning these variables.

Sensitivities were performed with respect to high gas prices, a reduction in DSI load after 2001, loss of 700 aMW of thermal resources in 1995, and 50% underperformance of conservation. Table 5-11 shows the results of these studies on the present value of system costs.

Table 5-11. Sensitivity Studies of Generation Resource Strategies [1]

Strategy	Base Case	DSI Uncertainty [2]	Thermal Resource Uncertainty [3]	High Gas Prices [4]	Conservation Under-Performance [5]
0-0	n/a	n/a	n/a	n/a	n/a
250-250	-46	-26	-7	+18	-6
250-500	-37	-13	-1	+25	+2
500-250	-80	-35	-24	+24	-52

[1] Present value regional system costs (millions of 1990\$). Presented as difference from (0-0) strategy (excluding external environmental costs).

[2] Loss of approximately 400 aMW of DSI load in 2002.

[3] Loss of approximately 700 aMW of thermal generating resources on the Federal system in 1995.

[4] Gas price escalation rate from NWPPC's high gas price forecast.

[5] BPA acquires half of expected acquisitions under the Conservation Implementation Plan (approximately 330 aMW).

As already described, under base case assumptions and assuming that all forced acquisitions of resources are displaceable resources, system costs decline as more resources are acquired. With the knowledge that DSI loads will decline by about 400 aMW in 2002, additional resources also provide benefits to the system relative to the base case of no additional acquisitions. These benefits, however, are less than in the base set of assumptions because loads are lower and the acquisitions in the generation strategies are even less beneficial. Benefits exist for these additions, even though they are acquired ahead of need, due to the potential for out-of-region sales.

Under the assumptions of losing 700 aMW of a thermal resource in 1995, system costs for each generation strategy decline slightly relative to the base case. However, these decreases in system cost are not as large as in the base case, which seems counterintuitive. The base case reflects the higher value of out-of-region sales relative to sales in the Pacific Northwest.

If gas prices follow the Council's High forecast rather than BPA's Medium forecast, then the generation strategies cause increases in system costs. The acquired CTs become much more expensive to operate than under Medium gas price assumptions. Therefore, in the base case,

resources less expensive than CTs are acquired to meet loads.

Finally, if the accelerated conservation path brings in only half the savings expected (at half the cost as well), then additional acquisitions also bring economic benefits to the region. The displaceable combustion turbines acquired in the (250, 250), (250, 500) and (500, 250) levels replace the unattained conservation, at perhaps a lower cost than the conservation acquired in the base case, and also provide revenues to the region from sales elsewhere on the West Coast. Hence, there will be benefits to increased levels of acquisitions, just as there were in the case of loss of a thermal resource.

Therefore, should DSI loads drop dramatically should either generation or conservation resources not produce the projected firm energy, then there is still no compelling economic reason to choose one generation resource level over another. In all cases, the base acquisitions are sufficient to meet loads. The addition of combustion turbines looks favorable economically because of their relatively low cost and the potential to produce revenues from sales outside the region.

However, should gas prices rise significantly, the (0, 0) level is economically best for the region because it has sufficient resources to meet loads

Table 5-12. Qualitative Evaluation of Generation Resource Strategies

Strategy	Efficiency	Risk	Reliability		Environment	Competitiveness
		Public				
		Acceptability:				
	Fit With West Coast System	Resistance to Types of Resources	Assessment of Reliance on Resources	Transmission Bottlenecks	Global/Local Impacts	BPA Positioning as Service Provider
0-0	4	1	4	1	1	4
250-250	3	2	2	2	2	1
250-500	1.5	3	3	3	3	2
500-250	1.5	4	1	4	4	3

in 1997-98, and does not incur the added expenses of building a combustion turbine that is expensive to operate; other less costly additions can be made to the system.

West Coast System. A dimension largely unexplored in previous Resource Programs is the way new resource acquisitions fit into the larger West Coast power system. Through the use of the Interties, BPA can enter into power sales, purchases and exchange agreements with utilities in California, the Pacific Southwest and western Canada. Accordingly, different amounts and types of resources may have significantly different implications for the efficient operation of the larger system.

The scores in the table reflect a subjective ranking of the proposed strategies, based on their potential to encourage the efficient use of the network of resources connected by the Interties. The greater the amount of potential intersystem opportunities, the higher the ranking. Thus the (250, 500) and (500, 250) strategies tie for the top ranking, followed by (250, 250) and (0, 0).

Risk

Economic Risk. The system cost impacts of each alternative are an average of 100 "games" reflecting the effects of load uncertainty, water uncertainty and the other variables considered by ISAAC. In some combinations of these variables, the base case is the preferred alternative. However, in other combinations, the base case is the

least attractive alternative. Each alternative represents a different amount of risk relative to the total spectrum of combinations of uncertain variables.

The third column in Table 5-12 shows how the strategies compare with respect to economic risk by measuring the number of modeling "games" in which the present value of system costs increased by \$320 million or more than the base case. Each strategy with more acquisitions and options than the base case entails more economic risk. Basically, under most load conditions, the base acquisitions are more than sufficient to meet loads and anything additional provides few additional benefits and many costs. Even under high loads, the base acquisitions are sufficient except in the highest of load paths. Furthermore, the base case is constrained from acquiring resources only until 2000, so if there is a need for additional resources they can be acquired beginning in 2000. Therefore, on an expected value basis, each of the strategies involves more economic risk than the base case alternative. Again, as in the efficiency analysis, the differences among the strategies are minimal.

Financial Risk. Financial risk is another dimension that measures the likelihood of revenues not covering costs. Table 5-10 shows changes in the probability of BPA net cash flows exceeding a loss of \$200 million in 1999. The base case and the two 250 aMW acquisition alternatives all have essentially the same level of financial risk. The

250 aMW of acquisitions and either 250 or 500 aMW of options do not increase the likelihood of BPA having negative cash flows greater than \$200 million. The (500, 250) case, however, had four fewer "games" than the base case in which negative cash flows exceeded \$200 million. Cash flows are slightly less likely to be negative for this alternative — in spite of the fact that the resources acquired are only needed to meet loads in the highest of load paths — because of the potential for generating secondary revenues which can more than cover costs. Furthermore, these revenues are based on the price California is willing to pay rather than the PF rate, which is an average rate.

These results indicate very little difference among the alternatives in the probability of negative cash flows exceeding \$200 million for BPA.

Deliverability Risk. In addition to the economic and financial risks dealt with quantitatively, there is a deliverability risk for the resources considered under different strategies. Given public opinion, it may be harder to bring certain types of resources on-line than others. For example, conservation characteristically provokes less public resistance than coal or nuclear resources.

The ranking of the four alternative resource strategies is straightforward. The (0,0) strategy limits acquisitions to conservation, which is generally perceived as a desirable resource by the public. The remaining strategies are ranked according to how much they might rely upon resources that could provoke resistance by the public. The (500,250) strategy guarantees the most new generation, and is thus ranked fourth. The (250,500) strategy is ranked behind the (250,250) strategy, though only slightly, because the total amount of options is higher. As such, it has the potential of acquiring a larger amount of generation resources.

Reliability

Short Term Purchases. The need to make short term purchases in order for the region to meet loads indicates the extent to which an alter-

native provides reliable service to the region. Table 5-10 shows the results of this analysis, which measures the frequency of short term purchases greater than 300 aMW in 1999. The year 1999 is chosen in order to allow sufficient time for the resources acquired to come on-line and have an effect on BPA's load/resource balance. Again, the differences among the strategies are small. In general, however, the strategies with higher amounts of acquisitions and options show less frequent need for short-term purchases greater than 300 aMW.

Ability to Meet High Loads. Another measure of the reliability of service that BPA provides its customers is the ability to meet high loads, should they occur. The seventh column in Table 5-10 shows the results for this measure of the reliability decision factor. The base case with no acquisitions is unable to meet high loads, and would imply a 321 aMW deficit. The other three strategies, however, each have the ability to meet high loads by margins of 200 to 400 aMW. Hence, those strategies with acquisitions beyond the base acquisitions are the only ones that enable BPA to meet high loads and therefore are the most reliable.

Assessment of Reliance on Resources. Once on-line, a resource may or may not perform up to expectations in terms of the energy or savings produced. Moreover, strategies involving certain types of resources may pose more significant transmission problems than others.

The first of the two columns under the "reliability" heading in Table 5-10 represents the level of confidence in the perceived performance of the resources contained in the different strategies. For example, conservation is generally thought of as a desirable resource, but the accelerated approach to acquisition is untested and may not be as successful as anticipated.

Accordingly, the (0, 0) strategy ranks the lowest among the alternatives considered, because the largest percentage of new acquisitions under that strategy comes from conservation. There is also uncertainty about the likely success of the options

approach, since it is also an untested concept. In recognition of this, the (250, 500) strategy ranks lower than the (250, 250) strategy because a greater percentage of its proposed new resources come from options. The (500, 250) strategy ranks highest because, of the four considered, it relies most heavily upon new generation, whose reliability is generally well understood.

Transmission Bottlenecks. Another dimension of reliability deals with the potential for transmission bottlenecks. The (0,0) strategy ranks highest because it meets loads with conservation that does not require transmission facilities. The (500,250) strategy ranks the lowest, because it is the one that has the highest potential for exacerbating existing bottlenecks. Finally, the (250, 500) strategy ranks lower than the (250,250) strategy because it has the potential to acquire more generation resources and hence put more stress on the transmission system.

One qualification regarding transmission considerations should be made. The sources of the new generation acquisitions and options considered in the strategies are not yet known. Power could come from new plants built in the region or could be obtained through contractual arrangements with utilities outside the Pacific Northwest. This ranking makes no assumptions about the location of the new resources. Different assumptions about where new resources are located could result in different rankings for the strategies.

Environment

There are a number of ways in which the selection of a resource strategy may affect the environment, in addition to the costs incurred by meeting environmental standards in the construction and operation of a resource. Many of these effects are not easily quantifiable but are significant in evaluating the alternative strategies.

Although the four strategies considered are not likely to display major differences in environmental impact, they may be ranked by how much new generation they propose to bring on-line and to option. Thus, the (0,0) strategy relying on nothing

other than conservation ranks highest; (250, 250) ranks second (it has the next smallest potential total new generation megawatts); (250, 500) ranks third (with more potential megawatts from generation); and (500,250) ranks last (having the highest amount of guaranteed acquisitions).

Competitiveness

Short-Term Rates. Rate impacts can be used to assess the effect of an action on utility competitiveness. All three alternatives to the base strategy cause an increase in near-term rates of between 0.2 and 0.4 mills per kWh (above the base case), measured as the average of rate impacts in 1996-1999, the years when resources would be acquired.

Long-Term Rates. Rate impacts were also calculated for the years 2000-2009 as a proxy for long-term rate impacts. In the long term, rates decline for the strategies which acquire and option resources in 1998. In comparison with the base case, these acquisitions are typically ahead of need. Therefore, in the long term, the base case acquires resources to meet loads later than the other strategies. Thus, resource acquisition costs are deferred, causing rates to rise in the long term. Accordingly, the strategies have lower rate impacts in the long term.

The competitiveness of BPA, as measured by short- and long-term rate impacts, seems to be little affected by which strategy is chosen for generation acquisitions. In addition to their impact on rates, however, the four alternative strategies have different implications for BPA's success as a service provider to its regional customers. To maintain or enhance its competitiveness, Bonneville must balance market or service expansion with the risks of over- or underbuilding, and must prudently search for new acquisitions, options and contracts.

Positioning As Service Provider. In terms of positioning BPA as a service provider, the (0, 0) strategy ranks last among those considered on the basis of competitiveness. It provides the least potential for exploring intersystem opportunities

and could cultivate a perception among some customers that BPA might not be able to provide continued service in the future. Both the (250, 500) and the (500, 250) strategies contain enough resources to cover high loads, with some supply side uncertainties (assuming the ability to exercise 1990 Contingency Plan options). Given current perceptions of regional load growth, however, this appears to be an unlikely future and incurs the risk of overbuilding. The risk is higher in the (500, 250) strategy because of the acquisition commitments; thus, this strategy is ranked third in competitiveness terms. The (250, 250) strategy appears the best in terms of competitiveness in that it balances the risks of under- or over-building with the ability to meet loads in uncertain conditions (up to High loads, or Medium-high loads with resource failure). Given the level of options in this strategy, there is also ample opportunity for intersystem purchase and exchange contracts with the least likelihood of over commitment.

Selection of Generation Resource Acquisition and Option Levels

The decision factor analysis provides a great deal of useful information about the four strategies. The (250, 250) strategy for generation acquisitions and options was selected for the Draft 1992 Resource Program for the following reasons.

The Resource Program must provide BPA's customers with adequate coverage against two major types of uncertainty. On the demand side, near-term loads may exceed those of the Medium case forecast. The ISAAC analysis described above explored this uncertainty, playing 100 "games" which covered the entire range of forecast loads. On the supply side, the possibility of resource failure or underperformance (for example, possible shutdown of a nuclear facility, loss of load and capacity from Endangered Species Act and System Operating Review results, deteriorating conservation savings, etc.) must be accounted for when setting the levels of acquisitions and options. This uncertainty was not explicitly con-

sidered in the decision factor analysis but must be accounted for in planning new generation.

The (0, 0) strategy, based on acquiring additional conservation only, is attractive both from the standpoint of costs and environmental impacts, but would prove inadequate to meet Medium case loads in the event of even minor resource failure, as illustrated by Figure 5-6. To mitigate the risks associated with load and resource uncertainties, it is therefore necessary to acquire and option additional resources.

The economic analysis of the four strategies conducted using ISAAC explored the effects of the four acquisition and option levels on total system costs. An important finding of this analysis was that, depending upon the percentage of displaceable resources acquired, adding generation resources could either increase or decrease total system cost. Accordingly, there are no obvious penalties for acquiring more generation resources (within the bounds explored in the analysis), particularly if displaceable resources can be obtained.

Given that additional insurance is needed against near-term uncertainties and that the effect of acquiring more resources on system costs seems to be minimal, the (250, 250) strategy appears to be the best way to meet the needs of BPA's customers. Without exercising any options, new acquisitions cover the most likely band of need, as shown in Figure 5-7. New generation resources, when added to the 600 aMW of conservation acquisitions, would cover Medium-High load growth (or Medium loads with major resource failure) through 2000. By exercising options, the (250, 250) strategy would be able to meet the upper bound of need (or Medium-High loads with resource failure), as seen in Figure 5-8. It would not, however, incur unnecessary costs by seeking to cover unlikely worst-case conditions, such as High loads with major resource failure.

An extensive assessment of load and resource uncertainties was conducted in selecting the Draft 1992 Resource Program. Figures 5-6, 5-7 and 5-

8 were selected from a full set of graphs presented in Appendix C of this document.

Summary of Potential Sources for Generation

It is important that the sources tapped to obtain this generation provide the best value for BPA's customers. Chapter 4 describes potential sources of generation resources in greater detail.

In short, the Resource Program proposes exploring a diverse portfolio of sources before committing to any in particular. Each of the mechanisms for acquiring or optioning resources displays its own unique strengths and weaknesses. By considering the full menu of possibilities, BPA should be able to obtain the most competitive resources while maintaining flexibility. Figure 5-9 summarizes the sources being considered for generation resources. The Resource Program emphasizes diversity and the exploration of intersystem opportunities for contractual arrangements with West Coast utilities.

Figure 5-6. Likely Range of Resource Need (I)

Figure 5-7. Likely Range of Resource Need (II)

Potential Magnitude of BPA Deficits Assuming
Medium Loads, Resource Loss* and
Proposed '92 R/P Acquisitions

Figure 5-8. Likely Range of Resource Need (III)

Potential Magnitude of BPA Deficits Assuming
High Loads and Proposed '92 R/P Acquisitions

Assumptions for Figures 5-6, 5-7 and 5-8

- [1] Loads taken from the Federal Systems Load Resource Balance 1990 Whitebook, Table 7 (adjusted for new load forecast).
- [2] Conservation taken from the Conservation Implementation Plan, aggressive numbers (1992-2003).
- [3] Billing Credits and Competitive Acquisitions — 350 aMW by 1997:
 - 1995 106 aMW
 - 1996 130 aMW
 - 1997 114 aMW
- [4] Efficiency Improvements (WNP-2 and hydro) — 117 aMW by 1995:
 - 1994 49 aMW
 - 1995 58 aMW
- [5] 1990 Contingency Plan Resource:
 - 1998 800 aMW: Two 400 aMW blocks (resource was acquired only when needed to meet loads).
- [6] Existing contracts: Assumes 1993 is first year the conversion of California and Pacific Southwest contracts from power sales to capacity/energy can occur. Puget contract automatically converts to exchange in 2001, but can be converted earlier at BPA's discretion (contracts were acquired only when needed to meet loads). Source: 1990 Whitebook, Table 6, "Federal System Resource Options."
- [7] Resource Loss: 500 aMW loss for BPA in 1993.
- [8] Additional Risk (the combination of Resource Loss and Additional Risk are characterized as "Maximum Resource Loss"):
 - Conservation acquisitions are 50% of aggressive targets.
 - 400 aMW loss of a generating resource: 200 aMW in 1995, 200 aMW in 1997.
- [9] Repurchase of Canadian Entitlement taken from 1990 Whitebook Technical Appendix, Table A-15.
- [10] 1992 Resource Program Acquisitions:
 - Generation Acquisitions
 - 1998 125 aMW
 - 1999 125 aMW
 - Options
 - 2000 250 aMW New Options available
- [11] Near Term Firm Purchases (Boardman, Basin Electric, Montana Power, Washington Water Power, Transalta):
 - 1993-1995 218 aMW
 - (Purchases guaranteed for first year only — 1992. Other years are contingent on environmental approval.)

**Figure 5-9. Menu of Possible Generation Resources
for 1992 Resource Program**

SOURCES		
PLANNED LEVELS of ACQUISITIONS		
		Additional Billing Credits
	X	New Bidding
	X	Current SP Contracts
	X	Intersystem Opportunities
	X	Canadian Entitlement
	X	Canadian Coordination
	X	Targeted Cogen/Cons.
	X	Small Generating Resources
	X	Federal Projects
	X	Renewables
	X	Current Bidding
	X	90 Contingency Plan
NEW GENERATION ACQUISITIONS 250 aMW	X	
NEW OPTIONS 250 aMW	X	

6. THE DRAFT 1992 RESOURCE PROGRAM

BPA's Draft 1992 Resource Program Proposal

Acquire all cost-effective conservation — at least 600 average megawatts — by 2003.

This conservation is the foundation of the Resource Program.

Acquire an additional 250 aMW of generation resources to meet the most-likely range of need.

Conservation can meet much of the likely range of need. The 250 aMW of generation resource acquisitions can fill the rest. Together, the proposed conservation and generation acquisitions, plus the acquisitions already under way, can meet Medium-High load growth — or Medium load growth with a 500 aMW reduction in existing resources — through the year 2000.

Acquire 250 aMW more options to cover the outer range of needs.

To provide flexibility in the face of significant load and resource uncertainty, these options could be exercised to bring more new resources on line or secure additional power quickly, if needed.

The Draft Resource Program acquisitions (250 aMW) and options (250 aMW) levels were selected because, of the four alternative strategies considered, the (250, 250) strategy was considered the best to meet resource needs, considering the major load and resource uncertainties facing BPA. In addition, all available potential sources to meet these levels of acquisitions and options will be explored before committing to any

particular sources. This effort will help BPA remain competitive and pursue the best resource value for its customers.

Before evaluating the strategy and sources underlying the Draft 1992 Resource Program, it is helpful to describe each of the components in greater detail.

Conservation

The basic building block of the Draft 1992 Resource Program is conservation. BPA is committed to acquiring at least 600 aMW of conservation through 2003, implementing the guidance of the Council's 1991 Northwest Power Plan through a partnership with its customers and other regional interests. Conservation acquisitions of 600 aMW or more represents the total sought over the ten year period, not an addition to levels currently being pursued. These accelerated levels of conservation acquisition — roughly equal to a large thermal plant — formed the basis of the new resources included in all the strategies considered in the development of the Resource Program. The Conservation Implementation Plan, presented in Chapter 8 of this document, presents the targeted levels of conservation by consuming sector and describes the strategy for acquiring all cost-effective conservation.

New Generation Resources

The Draft 1992 Resource Program includes 250 aMW of new generation acquisitions. The addition of these new acquisitions, without exercising any options, covers Medium-High loads (or Medium loads with the failure or severe underperformance of a major resource). The resources to acquire will be chosen in FY 1993 to 1995

(possibly in the fall of 1993), and will consider the full spectrum of potential sources: billing credits, competitive bidding, intersystem opportunities (exchanges and purchase options), 1990 Contingency Plan options, Canadian resources or increased coordination of the existing system with Canada, current Surplus Power contracts, and targeted cogeneration. As with conservation acquisitions, BPA intends to work cooperatively in a partnership with its customers and other interested parties to undertake full exploration of the available sources.

Options

The Draft 1992 Resource Program proposes 250 aMW of new options to address uncertainties beyond those dealt with by acquisitions. The term "options" is used broadly. It refers to the process whereby the siting and licensing phases of new construction projects are carried out, and it also covers the development of option energy contracts — such as purchase/exchange agreements, sales that can be converted to exchanges, and so on — with other utilities in the West Coast system. Developing different types of options will provide flexibility and lead time when additional power is required, while strengthening competitiveness in the West Coast market.

The contingency pool of options proposed for development has two major parts. First is the more than 800 aMW of options targeted by the 1990 Resource Program Contingency Plan. Bidding on these resources should begin in the early spring of 1992. Second is 400 aMW of existing contract options with California and Southwest utilities. Finally, the Draft 1992 Resource Program proposes acquiring 250 aMW of additional options. The source of these options is as yet undetermined. As with proposed new acquisitions, BPA will examine all potential sources before committing to any one in particular.

A basic idea behind this approach is to maintain a viable pool of options totaling roughly 1,450 aMW. If resources obtained during the 1990 Contingency Plan solicitation prove to be most

cost-effective, they could be tapped for the 250 aMW of new acquisitions. In this case, new options would be sought to replace the 250 aMW exercised, and the pool would be restored to 1,450 aMW beyond conservation and new generation. This approach allows BPA to tap whatever sources appear to have the best value while maintaining a hedge against major uncertainties.

Total Budget and Rate Impacts

Figure 6-1 shows the total expense budget for the 1992 Resource Program's accelerated conservation path and the 250 aMW of generation acquisitions and 250 aMW of options called for by the Draft 1992 Resource Program. It also shows the conservation expense budget line for the current path.

The total budget for conservation is expected to be \$1.3 billion for the period (FY 1992-2003), or about \$650 million higher than the current path. These amounts do not include Federal debt service on the capital conservation budgets, estimated to be \$1.5 billion for the period or about \$700 million higher than the current path.

Rate Impacts

Rough estimates were made of how the proposed Resource Program actions would affect BPA rates over the next 20 years. Rates including the proposed actions were compared to a base case rate forecast. The base case includes the current budget estimates for conservation and generation resources, as submitted by BPA to the Office of Management and Budget (OMB) in August 1991. The rate forecasts assume medium load growth and no loss of existing resources.

As shown in Figure 6-2, the proposed incremental spending to increase conservation levels and acquire an additional 250 aMW of generation resource acquisitions and 250 aMW of options would require rates to be approximately 0.1 mill/kWh higher than the base case rates in 1994-5, and less than 1 mill/kWh higher through 2003.

Figure 6-1. 10-Year Annual Expense Budgets
Annual Nominal \$ (Million)

Selection of the Draft 1992 Resource Program

The Draft 1992 Resource Program addresses load and resource uncertainties that BPA must address by tapping a diverse portfolio of sources for generation acquisitions and options. When added to a foundation of more than 600 aMW of conservation, the 250 aMW of new generation resources and 250 aMW of options proposed can provide reliable insurance over the range of need defined by demand and supply side uncertainties.

The Draft Resource Program balances different types of resources and acquisition approaches to meet the needs of BPA's customers. With respect to the decision factors described in Chapter 3, the following strengths of the proposal support its adoption as the Draft 1992 Resource Program.

It is Efficient

The proposal starts with a base of at least 600 aMW of cost-effective conservation acquisitions. The average total regional cost of this conservation is expected to be 27 mills/kWh in levelized 1990 dollars, or 54 mills in nominal levelized dollars. The cost of these conservation resources is considerably less than for an equivalent amount of generation resources (estimated to be 33 mills including O&M costs). Economic analysis indicates that acquiring an additional 250 aMW of generation and 250 aMW of options is cost-effective. In addition, by exploring contractual arrangements with California, the Southwest and Canada, the proposal provides the opportunities to promote more efficient use of the West Coast system.

Figure 6-2. 1992 Resource Program PF Rate Impacts (1994-2003)
Increase in mills/kWh

NOTE: For example, in 2001, proposed actions called for in the 1992 Resource Program will increase rates by roughly 0.5 mills higher than the projected PF rate without these actions.

It Mitigates Risk

Decision analysis of the performance of the "acquire 250 aMW, option 250 aMW" (250, 250) strategy over the full range of load uncertainty indicated that the additional generation had little effect on economic and financial risks. The proposed strategy also minimizes deliverability risks by providing a diverse mix of acquisitions and options from a variety of sources.

It Builds Reliability

The proposal provides coverage for load and resource uncertainties above the Medium case. Cost-effective acquisitions cover the most likely range of resource need while options cover the outer range of possible need. By tapping a variety of sources, this strategy also minimizes the

likelihood of resource underperformance by balancing acquisitions and options, in-region and out-of-region opportunities; and resources with short to medium lead times.

It Minimizes Impact on the Environment

The bulk of this strategy is comprised of conservation, which minimizes the impact on the environment. In particular, if BPA is able to take advantage of intersystem opportunities with utilities outside the region, the levels of generation acquisitions and options recommended in the proposal will have only minor additional impact. BPA is developing an environmental impact statement for this and future resource programs. This EIS work is described in greater detail in Chapter 9.

It Builds Competitiveness

Part of BPA's vision and goals is to be the "most competitive" power system. This proposal advances BPA toward this goal in several ways. BPA's competitiveness is improved by a set of resource acquisitions that are cost-effective, maintain the reliability of BPA's service, keep financial and economic risks down, and have low environmental impact. Additionally, the rate increases required to pay for the proposed resources appear reasonable, less than 1 mill/kWh above current rate projections in any given year. This proposal helps keep BPA's customers competitive by keeping BPA's power supply reliable and reasonably priced.

Staying "close to the customer" is another way to remain competitive. By relying heavily on a regional partnership to deliver the conservation resource, BPA's links to its customers will be strengthened, as will those customers' ties to their retail consumers.

This Resource Program is also aimed at building a more competitive market for resource supply on the West Coast, and taking advantage of that market for the best new acquisitions to keep BPA and its customers competitive into the next century.

It Addresses the Objectives of the 1991 Northwest Power Plan

The proposed Resource Program addresses the four objectives of the Council's 1991 Northwest Power Plan as follows:

Council Objective 1: Acquire Low-Cost Resources. BPA's Resource Program proposal targets all available cost-effective conservation. The conservation targets outlined are consistent with the targets called for in the Council's Plan.

Council Objective 2: Reduce Resource Lead Times. A commitment is being made to increase the contingency pool of cost-effective options by 250 aMW. These options, under either

pre-build or contractual arrangements, will reduce acquisition lead times.

Council Objective 3: Determine Cost and Availability of Resources. BPA will continue to work with the Council, the Pacific Northwest Utilities Conference Committee (PNUCC), the U.S. Department of Energy and others to develop the Resource Supply Expansion Program (RSEP) to confirm additional conservation and renewable resources.

Council Objective 4: Actions Supporting Implementation. Through the 1992 Resource Program, BPA has undertaken a Conservation Implementation Plan to identify and remove barriers to accelerated conservation acquisition.

7. 10-YEAR RESPONSE PLAN

The 1992 Resource Program sets out a long-term plan for obtaining conservation and provides flexibility by proposing near-term acquisitions for generation resources and options. It differs from earlier Resource Programs in that it also includes a plan to respond to significant changes in loads or resources.

The 10-Year Response Plan anticipates changes BPA might confront and explores possible course-correcting actions. The Response Plan will be subject to public discussion during the comment period, and will be developed in greater detail by the second Draft 1992 Resource Program to be released in May 1992.

Figure 7-1 depicts the general approach underlying the Response Plan. At two year intervals, as part of future Resource Programs, BPA will reassess its load/resource balance and determine what adjustments need to be made to its acquisition plans.

If, in two years, a continued balance of loads and resources is anticipated, no new actions would be taken. However, options would continue to be held as insurance against potential deficits. If the possibility of deficit increases substantially, BPA could then begin actions to acquire more power. An immediate action could then be to make short-term purchases on the spot market or to convert existing power sales contracts to exchange or purchase modes. In the longer term, BPA would exercise construction options and add new resources to the portfolio.

By contrast, if BPA were to find itself facing a surplus, it could sell power, maintain contracts in sale mode, hold (or let go of) options, and terminate plans to develop new resources.

A set of more specific actions, each geared to a particular set of events or conditions, is presented

in Table 7-1. This array illustrates tactics BPA could potentially use. The changes are not exclusive of one another. For example, it is possible that high gas prices, resource failure and low loads could all occur simultaneously. It is also likely that the responses described would change under different load-resource balance conditions. For example, the decision to acquire more low-cost resources would differ depending upon whether the region was facing surplus or deficit. This part of the Resource Program will be more fully developed in the second draft.

Figure 7-1. 10-Year Response Plan

Table 7-1. 10-Year Response Plan: Example Scenarios

CHANGE	Early Signals	RESPONSE				
		Conservation	Contingency Options	New Acquisitions	CA Exchanges & Options	Other
1. RESOURCE FAILURE: Shutdown or Underperformance Loss of 500 aMW BPA Energy, With Medium-High loads	6 months-several years; pre-election polls or environmental decision could serve as triggers	No change	Exercise more options	Acquire capacity and energy resources if needed	If sufficient low cost acquisitions are unavailable, convert contracts to exchange mode; if capacity is affected negotiate out-of-region contract to fit changes in system operation	Short-term spot market purchases
2. NEW TECHNOLOGIES RSEP Success Availability of 1000 aMW of new resources at 35 mills (spread over 10 years)	Good performance at first RSEP demonstrations seen by 1997	Acquire additional RSEP conservation	Drop some old options Option RSEP renewables	Acquire RSEP resource instead of exercising options	Probably don't sign more options	Probably terminate WNP-1 and WNP-3
3. GAS PRICES: Higher than Expected	Current prices rise, followed by changes in long-term projections by major economic forecasters	No change	Do not exercise gas-fired options Drop other gas-fired options	Probably acquire added resources to replace now-expensive gas-fired generation	No clear direction; revenue increase, but value of energy increases also	Change position of gas resources in resource stack Possibly convert any gas-fired generation to gasified coal
4. ECONOMIC/LOAD CHANGES: Low Loads BPA has large surplus to sell	Actual loads display 1-2 year downturn pattern	Lengthen ramps	Do not exercise options Possibly drop options	No new acquisitions	Leave SCE and BGP contracts in sale mode	Sell on spot market

8. IMPLEMENTATION PLAN

Draft Conservation Implementation Plan (CIP)

The Draft Conservation Implementation Plan (CIP) is BPA's suggested approach for achieving electric energy conservation savings in the Federal system over fiscal years 1992 to 2003.

During September and October 1991, BPA circulated a preliminary draft CIP for public review and comment intended to stimulate discussions on how to achieve proposed savings targets. The preliminary draft CIP was developed by a team of resource planners, energy consultants, evaluators, load forecasters, economists, program designers, engineers and program implementers. This chapter of the Resource Program Technical Report constitutes the revised Draft CIP. The draft CIP is also being published as a separate document.

Public Review of the Preliminary Draft CIP

BPA received many comments on the preliminary draft CIP, signifying a good deal of interest in the region. Meetings were held with BPA customers, state officials, utility associations, the Northwest Power Planning Council and some interested members of the public at large. Based on the attendance at the meetings, the enthusiasm exhibited, the requests for additional meetings, and the large number of thoughtful written responses, the document easily achieved two of its primary goals:

- To stimulate thinking on new and innovative methods for achieving proposed savings targets.

- To encourage further discussion on the importance of conservation in meeting the region's growing resource needs.

As BPA reviewed comments and met with interested parties, it became clear that there were many more perspectives and issues than could be fully addressed in the redraft of the CIP. Although this draft does not incorporate all of the comments and suggestions received, many of the major points and recurring themes have been included.

BPA intends to continue discussion of all CIP items through an appropriate public forum over the next several months. Acquiring 600-700 aMW of savings on the Accelerated Path can only be accomplished through an ongoing, open and honest long-term partnership with the region's utilities, the four states, the Council and other interested parties.

An attempt was also made to streamline this version of the CIP compared to the earlier draft, most notably by trimming the discussion of conservation development in the 1980s and consolidating the Challenges from seven to five. The following is a summary of some common themes that emerged this fall.

Positive Response

In almost every public meeting and comment letter there was support, encouragement and appreciation for the openness expressed in the preliminary draft CIP. (Copies of all letters are available through BPA's Public Involvement office.) Commenters applauded BPA's desire to explore innovative methods to acquire conservation jointly with its partners, rather than promote a specific approach.

There was similar agreement about the proposed Aggressive Scenario (which is now being called the "Accelerated Path") for acquiring conservation: it is not going to be easy, yet it is the right path to take.

There is a fair degree of uncertainty whether the megawatt targets associated with Accelerated Path are achievable, but most people agreed that the targets are worth pursuing. It is tough to "buy into" regional targets when there remain so many uncertainties regarding what it will take to develop a resource of this magnitude. Some utility commenters believe that they will need to make significant changes to their existing mode of acquiring conservation savings (e.g., increase staffing levels and use more contractors).

'We Want Solutions That Work'

There was also a broad consensus that the region can and should work together to meet the Challenges that impede the Accelerated Path. Many commenters seemed to agree that the Challenges identified in the preliminary draft were basically on target; there were a few suggestions for additional Challenges and possible solutions.

Alignment

A recurring theme seemed to be rooted in the Council's message that "No opportunity for cost-effective energy conservation should be missed." BPA agrees that conservation should be the cornerstone of the 1992 Resource Program just as it is for the Council's 1991 Northwest Power Plan.

Many people had particular suggestions for getting savings in their local areas and wanted to be sure that these opportunities would not go untapped. Others discussed the need to improve particular aspects of conservation programs — to make sure that programs and policies are connected and to ensure that consumers do not receive mixed messages. An idea that emerged

from such discussions was the concept of moving toward a unified or holistic approach to resource acquisition that provides better integration of policies, pricing and programs.

Power Partners

BPA agrees with many commenters that the relationship between BPA and the region's utilities should be that of a partnership. A major role for BPA would be to motivate utilities to acquire conservation, assist in education and interchange of ideas, and then help determine the impacts of acquisition efforts.

Concurrent with this partnership is a recognition that not all utilities have the same needs, nor function the same way with the same resources. Thus BPA agrees that successful current centrally-designed programs should not be abandoned as there is further development and acceleration of different ways of achieving 600 to 700 aMW of conservation.

Partnership applies to planning and developing programs as well, and even applies to the CIP. Utilities should not be merely providing input to a BPA decision team; they should be part of the decision team. Later in the section on local conservation plans an idea is presented for greatly increasing the participation of utilities in conservation planning.

Solutions and Ideas

People responded very positively to the request for "solution(s) that work." The following is a partial listing of ideas offered; it suggests the diversity of views expressed. Commenters thought BPA should:

- Appoint "account executives" to work with utilities to assure a more consistent approach to program development and implementation, and project performance tracking.
- Reinstitute pilot projects that have worked in the past, until other program mechanisms are more clearly established.

- Develop a menu of approaches with consistent price signals so that the utility can select from this menu without being concerned that it may have missed a better opportunity through another program.
- Develop bond financing arrangements for conservation.
- Test the concept of an energy service charge in commercial and industrial facilities, similar to PacifiCorp's program, where consumers pay a portion of the cost of conservation services.
- Keep administrative and program payment structures simple.
- Step up program efforts in areas of low irrigation efficiency.
- Focus monitoring and verification to be forward-looking to improve and refine programs; do not view monitoring and verification as a punitive tool for retroactively adjusting payment levels.
- Offer multiple program options such as the post-1990 Weatherwise (Residential Weatherization) Program and Options 1, 2 and 3 in the Energy Smart Design Program.
- Go after all homes in the Weatherwise Program that had electric heat installed after April 1983, and post-1983 newly constructed homes.
- Give grants to utilities for conservation staff.
- Put a contractor pool in place that utilities can call on to help identify conservation resources and design programs.
- Develop cooperative education efforts and infrastructure training with community colleges, state entities, etc.
- Intensify low-income energy conservation programs.
- Begin a series of retreats with utility representatives aimed toward working together to better understand each other's

needs, constraints, perceptions, concerns and ideas regarding conservation.

- Revisit BPA's cost-share policy.

There was also a suggestion that the states coordinate and cooperate with local utilities to support local utility conservation programs. BPA plans to work with its regional partners to flesh out this list further.

Varying Points of View

As is to be expected, some conflicting views were offered, and a number of issues were raised that have yet to be resolved, among them:

- **Pay-for-performance.** Under what circumstances might the concept of payment for verified savings be incorporated into program design?
- **Risk-sharing.** How should the concept of risk sharing be treated?
- **Free riders.** How should they be treated in programs?
- **Conflicting price signals.** Should consistency among sectors be a goal, and if so, what would be the guiding principles?
- **Lost utility revenues.** Should there be compensatory payments to utilities that suffer significant financial losses due to lost sales resulting from conservation?
- **Cost- vs. value-based payments.** Should the basis for developing a price for conservation savings be the cost of the conservation measures or the value of the resource?
- **Efficiency vs. load reduction.** Should the objective of conservation programs be to reduce BPA loads, or to increase the efficiency of energy use even if these improvements do not reduce the absolute magnitude of loads BPA is expected to serve?

Some of these are regional issues; others are more local in nature. BPA will work with its part-

ners in open forums to resolve these issues in the manner best suited for local needs. Issue papers are being prepared on these topics to help focus discussions. The papers will lay out the concepts only and will not propose final solutions.

BPA Commitment

Many commenters also suggested that attaining the Accelerated Path will require BPA to make a stronger long term commitment to conservation. In this document, BPA hopes to demonstrate such a commitment.

What is the CIP?

The Council has set aggressive regional goals for acquiring conservation in its 1991 Northwest Power Plan, the region's guide for resource acquisition. As noted in the plan, the region is now in load/resource balance and will need an additional 2,000 aMW of resources by the turn of the century.

This CIP describes BPA's own best estimates of the energy savings that reasonably could be added to the Federal system each year of the 10-year planning horizon under Current Path and Accelerated Path acquisition scenarios (called the "Status Quo" and "Aggressive" scenarios in the preliminary draft CIP). BPA's estimates differ from the Council's in that the BPA figures focus only on the savings obtainable in public-power service are as plus BPA's non-smelting Direct Service Industrial (DSI) loads.

The CIP also presents cost estimates under the two paths. It identifies what BPA believes to be the major implementation Challenges to achieving the Accelerated Path savings targets. It also presents some possible Solutions to overcoming them, and a number of Ongoing Actions to improve and refine the region's conservation efforts.

The CIP suggests the principal implementation Approaches which could be used to acquire conservation programmatically in each sector (industrial, residential and commercial). Also described

are different methods to encourage saving energy across sectors (multi-sector).

In general, the CIP can be thought of as a guideline or compass that points the general direction to be pursued in terms of broad approaches from a regional perspective.

The Accelerated Path

The BPA system has now moved from a period of energy surplus to one where loads are likely to exceed available resources. Since loads on the system are anticipated to continue to grow at a significant rate, the region needs to step up its resource acquisition activities substantially.

Conservation is BPA's resource of choice. There is a large untapped supply available in the region at relatively low cost. Given properly designed and managed programs, conservation is a reliable resource — although a labor-intensive one for some applications — and it is environmentally superior to alternative resources.

Between 1992 and 2003, about 660 aMW can be saved throughout the BPA service area under the Accelerated Path — BPA's proposed course of action. The Accelerated Path target is comparable to the Council's most recent projection of 741 aMW under its Medium-High forecast (see Figures 8-1, 8-2 and 8-3).

The Accelerated Path savings figure can be thought of as what might be reasonably obtained if the region goes after as much as possible of the available programmatic conservation. The numbers were derived by looking at regional conservation supply curve figures and judging what might be done from a practical standpoint — including the use of innovative new implementation approaches — and with all Challenges met and satisfactorily resolved. (BPA's approach differed from the Council's, which was model driven.)

The Accelerated Path target contrasts with the 380 aMW projected under a Current Path approach. (As a point of comparison, the 1990 Resource Program anticipated 220 aMW through

**Figure 8-1. Bonneville Conservation Acquisitions:
Current and Accelerated Paths**

the year 1997. The Current Path is characterized by traditional program design and operation, with some evolutionary refinements and modestly increasing incentive levels.

What Does the Accelerated Path Mean?

BPA cannot meet the Accelerated Path target alone; it will take a full commitment from all parties in the region, especially from its electric utility customers.

The CIP Accelerated Path anticipates tripling public power's current overall level of conservation acquisition. Is the region willing to make the commitment with BPA to pursue the Accelerated Path?

From the perspective of a utility manager, what might the Accelerated Path mean for ratepayers? Is the utility prepared to add staff? What are the

expectations about participating in building an Accelerated Path "conservation power plant"? What assistance do utilities expect from BPA? Is a big conservation program part of the utility's agenda? If not, where else should BPA concentrate its efforts? Should the focus be on large utilities with big savings?

BPA is interested to learn what utilities think it will take to achieve the Accelerated Path in their service territories. There have already been indications of the need for more contract drafting support, less hassle from BPA and more freedom to design programs; as well as more technical assistance, for consortia of utilities to run programs, and for more Area Office support. This list will continue to be fleshed out as the Accelerated Path is pursued.

**Figure 8-2. Bonneville Conservation Acquisitions:
Current vs. Accelerated Paths**

**Figure 8-3. Bonneville Conservation Acquisitions:
Accelerated Path**

The proposed Accelerated Path will have profound implications. The region would be turning away, sharply, from a generally cautious approach and modest budget allocations. Thus, the Pacific Northwest would make an even stronger long-term commitment to conservation as a resource.

Acquiring more conservation will mean increasing budgets. The acquisition cost to BPA under the Accelerated Path would be an estimated \$2.8 billion (nominal) through 2003. By comparison, the cost under the Current Path scenario would be \$1.5 billion. Of course, the benefit of such a substantial conservation investment is the region's ability to avoid or defer the construction of potentially costly and environmentally damaging generation resources.

Tables 8-1 through 8-6 show estimated savings and dollars by conservation sector. They have been adjusted since the preliminary draft CIP to correct some errors and to reflect further thinking about each sector.

The dollars are represented in nominal terms — that is, the dollar that is spent in a particular year is that year's dollar. These dollars represent how much BPA would have to spend to get the accompanying savings. Generally, they are approximately equivalent to "regional cost" because most programs assumed close to 100% financing of measures.

The figures also include "non-acquisition" costs (for example, RD&D and training, and some utility administrative costs for some programs). Where other entities finance programs (with BPA paying

the debt service), the figures include the interest payment but not installments paid after 2003.

Staffing

BPA recognizes that the Accelerated Path — as with designing and building 600 megawatts of any new resource — will be labor-intensive. Some of the labor intensity to implement the conservation power plant will reside at the BPA and utility levels. The rest of the labor needed to bring the conservation resource on line must exist in the infrastructure (equipment dealers, installers, design engineers, etc.)

It is very difficult to estimate the amount of human resources required to nearly triple the amount of conservation being acquired today. To determine how many people it might take to be on the Accelerated Path, BPA estimated the number of utility staff administering conservation activities now to be about 375. The number of utility people necessary to get nearly a three-fold increase in conservation could range anywhere from the current level to a

peak of perhaps nearly three times that. (Staffing might taper off somewhat toward the end of the 12-year planning horizon as targets are achieved.)

A firmer estimate would require better knowledge of how proficient and efficient the region becomes at developing and implementing programs, and a better feel for who is taking most of the ac-

BPA Commitment

BPA will pursue all cost-effective conservation under the Accelerated Path. To assure this goal becomes a reality, BPA commits to working in partnership with the region to meet and overcome all Challenges at both the regional and local level.

We will continue to work with our partners — utilities, States, the Council, public interests — to identify and resolve issues in an appropriate ongoing public forum.

Consistent with our obligations as a Federal agency, we will develop solutions jointly with our partners using a collaborative, open, consensus-seeking approach that values diversity, promotes flexibility, values entrepreneurial efforts, reflects prudent business practice, and firmly establishes conservation as the region's resource of choice.

Randy Hardy
BPA Administrator

Table 8.1 BPA Conservation Projections -- Total
Average Megawatts Added Each Year and \$Million Spent by BPA (Nominal)

	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		TOTAL		Council	Achievable
	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	Targets	Potential
GRAND TOTAL																												
Current Path	23	\$73	25	\$85	25	\$95	29	\$105	31	\$116	33	\$123	33	\$132	35	\$142	35	\$135	37	\$144	37	\$151	37	\$157	373	\$1,458	741	1002
Expensed		\$24		\$30		\$36		\$42		\$49		\$54		\$60		\$65		\$65		\$70		\$75		\$77		\$647		
Capital		\$48		\$54		\$59		\$63		\$67		\$69		\$73		\$77		\$70		\$74		\$78		\$80		\$811		
Accelerated Path	25	\$114	31	\$138	41	\$176	49	\$202	58	\$231	61	\$257	67	\$285	70	\$312	68	\$311	67	\$276	63	\$257	63	\$268	661	\$2,827		
Expensed		\$36		\$48		\$66		\$80		\$96		\$111		\$128		\$145		\$151		\$145		\$143		\$151		\$1,302		
Capital		\$76		\$89		\$110		\$122		\$135		\$146		\$157		\$168		\$160		\$131		\$114		\$118		\$1,525		
RESIDENTIAL																												
Current Path	14	\$57	13	\$62	11	\$64	13	\$64	13	\$64	13	\$62	13	\$64	13	\$66	13	\$53	13	\$55	13	\$57	13	\$59	156	\$726	296	424
Expensed		\$19		\$21		\$22		\$22		\$23		\$22		\$23		\$24		\$20		\$21		\$21		\$22		\$259		
Capital		\$38		\$41		\$42		\$42		\$42		\$39		\$40		\$42		\$33		\$34		\$36		\$37		\$466		
Accelerated Path	15	\$78	17	\$94	21	\$126	23	\$134	24	\$139	23	\$140	24	\$151	25	\$161	21	\$142	18	\$90	13	\$57	13	\$56	236	\$1,367		
Expensed		\$25		\$31		\$43		\$47		\$50		\$52		\$57		\$61		\$56		\$39		\$26		\$25		\$513		
Capital		\$52		\$62		\$83		\$87		\$89		\$88		\$94		\$99		\$86		\$52		\$30		\$32		\$854		
COMMERCIAL																												
Current Path	1	\$6	3	\$10	4	\$16	6	\$23	7	\$30	8	\$38	9	\$45	10	\$49	10	\$54	10	\$58	11	\$62	11	\$66	90	\$457	196	323
Expensed		\$2		\$3		\$6		\$9		\$12		\$16		\$19		\$22		\$24		\$27		\$28		\$30		\$198		
Capital		\$4		\$7		\$11		\$14		\$18		\$22		\$26		\$28		\$29		\$31		\$33		\$36		\$259		
Accelerated Path	2	\$27	5	\$31	9	\$33	13	\$46	16	\$63	19	\$83	21	\$93	22	\$102	23	\$112	24	\$120	24	\$128	25	\$135	202	\$973		
Expensed		\$8		\$10		\$12		\$18		\$25		\$32		\$38		\$42		\$46		\$50		\$53		\$56		\$392		
Capital		\$18		\$20		\$21		\$28		\$39		\$50		\$56		\$60		\$66		\$70		\$74		\$79		\$581		
INDUSTRIAL																												
Current Path	6	\$5	7	\$8	7	\$10	8	\$13	8	\$16	9	\$17	9	\$19	10	\$21	10	\$23	11	\$25	11	\$27	12	\$29	108	\$214	153	149
Expensed		\$3		\$5		\$7		\$10		\$12		\$13		\$14		\$16		\$18		\$20		\$21		\$23		\$161		
Capital		\$3		\$3		\$3		\$4		\$4		\$4		\$4		\$5		\$5		\$6		\$6		\$6		\$54		
Accelerated Path	6	\$6	7	\$9	8	\$11	9	\$15	11	\$19	12	\$22	13	\$26	14	\$30	15	\$34	16	\$38	17	\$42	18	\$46	146	\$297		
Expensed		\$3		\$5		\$8		\$11		\$15		\$18		\$21		\$24		\$28		\$32		\$35		\$39		\$238		
Capital		\$3		\$4		\$4		\$4		\$4		\$4		\$5		\$5		\$5		\$6		\$7		\$7		\$58		
IRRIGATION																												
Current Path	2	\$4	2	\$4	2	\$4	2	\$4	2	\$5	2	\$5	1	\$3	1	\$4	1	\$4	1	\$4	1	\$3	0	\$1	14	\$45	8	14
Expensed		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$0		\$13		
Capital		\$3		\$3		\$3		\$3		\$3		\$3		\$2		\$3		\$3		\$3		\$2		\$1		\$32		
Accelerated Path	2	\$4	2	\$4	2	\$4	2	\$4	2	\$5	2	\$5	1	\$3	1	\$4	1	\$4	1	\$4	1	\$3	0	\$1	14	\$45		
Expensed		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$0		\$13		
Capital		\$3		\$3		\$3		\$3		\$3		\$3		\$2		\$3		\$3		\$3		\$2		\$1		\$32		
UTILITY SYSTEM																												
Current Path	0	\$0	1	\$0	1	\$1	1	\$1	1	\$1	1	\$1	1	\$1	1	\$2	1	\$2	1	\$2	1	\$2	1	\$2	11	\$16	88	93
Expensed		\$0		\$0		\$1		\$1		\$1		\$1		\$1		\$2		\$2		\$2		\$2		\$2		\$16		
Capital		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$0		
Accelerated Path	0	\$0	1	\$1	2	\$2	3	\$3	4	\$5	5	\$7	8	\$12	8	\$16	8	\$20	8	\$24	8	\$27	8	\$30	63	\$146		
Expensed		\$0		\$1		\$2		\$3		\$5		\$7		\$12		\$16		\$20		\$24		\$27		\$30		\$146		
Capital		\$0		\$0		\$0		\$0		\$0		\$0		\$0		\$10		\$0		\$0		\$0		\$0		\$0		
NON-ACQUISITION COSTS*																												
Current Path		\$26		\$25		\$25		\$26		\$24		\$25		\$25		\$26		\$27		\$28		\$30		\$31		\$318		
Accelerated Path		\$36		\$35		\$35		\$37		\$33		\$34		\$35		\$37		\$38		\$39		\$41		\$43		\$443		

Notes for Table 8-1

This table presents a draft estimate of costs that BPA will need to budget directly for conservation programs. Included are acquisition costs, non-acquisition costs and additional payments through 2003 to utilities and parties other than the U.S. Treasury who are financing conservation investments on BPA's behalf.

Non-acquisition costs are those costs associated with program support activities. These include support for the Model Acquisition Standards, technology research, development and demonstration, and support for training and education. Part of these costs reflect a long-term investment (i.e., beyond 2003) because some of these activities will bear fruit only by then.

The portion of measure costs paid directly by consumers is not included in this chart.

Expensed Dollars are costs that BPA recovers in its rates in the year of BPA's expenditure. These include all of the costs for programs where retail utilities, consumers or government agencies are financing the installation of measures and BPA pays them back over time. Approximately one-third of the savings are assumed to come through programs financed by these parties. Although this table stops in the year 2003, there are costs in years beyond 2003 for some of these programs. This occurs where savings have been financed for periods extending beyond 2003. Also included in the Expensed category is a portion of the costs for programs where BPA makes its entire payment in the year that the measures are installed. Expense budgets do not include debt service on Federal borrowing for conservation.

Capital Dollars are costs that BPA pays for conservation in the year that the measures are installed, and borrows funds to cover the cost. The funds are paid back to the lender (typically, the U.S. Treasury) with interest over time. The costs in this category are a portion of the costs for programs that are not financed by retail utilities, consumers or government agencies.

This 600+ aMW does not include transmission and distribution line loss savings. Total savings from conservation, including credit for not incurring these losses, approaches 700 aMW.

Multisector programs (e.g., billing credits, bidding, competitive acquisitions, etc.) are reflected as parts of these programs.

Achievable Potential as shown is for the years 1992 through 2003.

*Non-Acquisition Costs are a subset of the above costs.

Table 8.2 BPA Conservation Projections -- Utility Systems
Average Megawatts Added Each Year and \$Million Spent by BPA (Nominal)

	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		TOTAL		Council	Achievable	
	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	Targets	Potential	
CONSUMER UTILITY SYSTEMS EFFICIENCY TOTAL -- Voltage Reduction and T&D Efficiency Improvements																													
Current Path	0	\$0.1	1	\$0.3	1	\$0.5	1	\$0.8	1	\$1	1	\$1	1	\$1	1	\$2	1	\$2	1	\$2	1	\$2	1	\$2	11	\$16	88	93	
Accelerated Path	0	\$0.2	1	\$0.6	2	\$2	3	\$3	4	\$5	5	\$7	8	\$12	8	\$16	8	\$20	8	\$24	8	\$27	8	\$30	63	\$146			
CSEI -- ACQUISITIONS*																													
Current Path	0	\$0	1	\$0.2	1	\$0.4	1	\$0.6	1	\$0.9	1	\$1	1	\$1	1	\$1	1	\$2	1	\$2	1	\$2	1	\$2	11	\$14	88	93	
Accelerated Path	0	\$0	1	\$0.4	2	\$1	3	\$3	4	\$5	5	\$7	8	\$11	8	\$16	8	\$20	8	\$23	8	\$27	8	\$30	63	\$144			
NON-ACQUISITION COSTS																													
Current Path		\$0.1		\$0.1		\$0.1		\$0.1		\$0.1		\$0.1		\$0.1		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$2			
Accelerated Path		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$0.2		\$2			

NOTES

Non-Acquisition Costs are those costs associated with program support activities. These include support for the Model Acquisition Standards, technology research, development and demonstration, and support for training and education. Part of these costs reflect a long-term investment (i.e., beyond 2003) because some of these activities will bear fruit only by then.

Achievable Potential as shown is for the years 1992 through 2003.

*These projections assume that all of the MW under this program are to be financed by retail utilities.

Table 8.3 BPA Conservation Projections -- Industrial
Average Megawatts Added Each Year and \$Million Spent by BPA (Nominal)

	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		TOTAL		Council Targets	Achievable Potential
	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M		
INDUSTRIAL TOTAL*																												
Current Path	6	\$5	7	\$8	7	\$10	8	\$13	8	\$16	9	\$17	9	\$19	10	\$21	10	\$23	11	\$25	11	\$27	12	\$29	108	\$214	153	149
Accelerated Path	6	\$6	7	\$9	8	\$11	9	\$15	11	\$19	12	\$22	13	\$26	14	\$30	15	\$34	16	\$38	17	\$42	18	\$46	146	\$297		
LARGE PROJECTS**																												
Current Path	2	\$0.9	2	\$2	2	\$3	2	\$4	2	\$5.0	3	\$6	3	\$6	3	\$7	3	\$8	3	\$9	3	\$9	4	\$10	32	\$68	NA	NA
Accelerated Path	2	\$0.9	2	\$2	3	\$3	3	\$5	5	\$7	6	\$10	7	\$13	7	\$15	8	\$18	8	\$21	9	\$23	10	\$26	70	\$144		
SMALL PROJECTS***																												
Current Path	4	\$3	5	\$5	5	\$6	5	\$8	6	\$10.0	6	\$11	6	\$11	7	\$13	7	\$14	8	\$15	8	\$17	8	\$18	76	\$130	NA	NA
Accelerated Path	4	\$3	5	\$5	5	\$6	5	\$8	6	\$10	6	\$11	6	\$11	7	\$13	7	\$14	8	\$15	8	\$17	8	\$18	76	\$130		
NON-ACQUISITION COSTS																												
Current Path		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$1		\$2		\$2		\$2		\$16		
Accelerated Path		\$2		\$2		\$2		\$2		\$2		\$2		\$2		\$2		\$2		\$2		\$2		\$2		\$23		

NOTES

Non-Acquisition Costs are those costs associated with program support activities. These include support for the Model Acquisition Standards, technology research, development and demonstration, and support for training and education. Part of these costs reflect a long-term investment (i.e., beyond 2003) because some of these activities will bear fruit only by then.

Achievable Potential as shown is for the years 1992 through 2003.

*BPA may have programs for the Direct Service Industry smelter loads, but has not yet projected costs and savings.

**These projections assume that all of the MW under this program are to be financed by parties other than BPA.
 Large projects include non-smelter DSI loads.

***These projections assume that 50% of the MW under this program are to be financed by parties other than BPA.

Table 8.4 BPA Conservation Projections -- Residential
Average Megawatts Added Each Year and \$Million Spent by BPA (Nominal)

	1992		1993		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		TOTAL		Council	Achievable	
	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	Targets	Potential	
RESIDENTIAL TOTAL																													
Current Path	14	\$57	13	\$62	11	\$64	13	\$64	13	\$64	13	\$62	13	\$64	13	\$66	13	\$53	13	\$55	13	\$57	13	\$59	156	\$726	296	424	
Accelerated Path	15	\$78	17	\$94	21	\$126	23	\$134	24	\$139	23	\$140	24	\$151	25	\$161	21	\$142	18	\$90	13	\$57	13	\$56	236	\$1,367			
WEATHERIZATION*																													
Current Path	5	\$17.0	5	\$19	5	\$20	5	\$21	5	\$22.0	5	\$24	4	\$25	4	\$26	3	\$21	3	\$22	3	\$23	3	\$23	50	\$264	77	70	
Accelerated Path	5	\$24.0	7	\$35	12	\$65	12	\$69	12	\$74	12	\$78	12	\$83	12	\$87	8	\$63	5	\$45	0	\$12	0	\$10	95	\$647			
NEW RESIDENTIAL CONSTRUCTION																													
Current Path	3	\$14.0	4	\$20	5	\$22	5	\$24	5	\$27.0	5	\$25	5	\$26	5	\$27	7	\$19	7	\$20	7	\$20	7	\$21	65	\$264	76	85	
Accelerated Path	4	\$18.0	5	\$24	6	\$28	6	\$33	7	\$39	7	\$41	8	\$47	8	\$51	9	\$56	9	\$21	9	\$22	9	\$23	87	\$402			
ENERGY EFFICIENT LIGHTING																													
Current Path	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	0	\$0	9	14	
Accelerated Path	0.7	\$2	1	\$3	1	\$4	2	\$6	2	\$6	1	\$4	1	\$4	1	\$4	1	\$5	1	\$5	0.6	\$3	0.6	\$4	14	\$49			
Weatherization	0.5		1		1		2		2		0.5		0.5		0.5		0.5		0.5		0		0		9				
New Construction	0.1		0.2		0.2		0.4		0.4		0.4		0.4		0.4		0.6		0.6		0.6		0.6		5				
DOMESTIC WATER HEATING																													
Current Path	6	\$6	3	\$4	2	\$5	3	\$1	3	\$1	3	\$2	3	\$1	3	\$1	3	\$0	3	\$0	3	\$0	3	\$0	41	\$20	134	255	
Accelerated Path	6	\$6	3	\$4	2	\$5	3	\$1	3	\$1	3	\$2	3	\$1	3	\$1	3	\$0	3	\$0	3	\$0	3	\$0	41	\$20			
Efficient Tanks	0.1		0.3		1		2		2		2		2		2		2		2		2		2		19				
Efficient Appliances	0		0		0.1		0.1		0.1		0.1		0.6		0.6		1		1		1		1		7				
Retrofit	6		3		0.8		0.8		0.8		0.8		0.8		0.8		0		0		0		0		14				
NON-ACQUISITION COSTS																													
Current Path		\$20		\$19		\$17		\$17		\$13		\$12		\$12		\$12		\$13		\$13		\$14		\$14		\$177			
Accelerated Path		\$28		\$27		\$24		\$24		\$19		\$16		\$17		\$17		\$18		\$19		\$19		\$20		\$248			

NOTES

Non-Acquisition Costs are those costs associated with program support activities. These include support for the Model Acquisition Standards, technology research, development and demonstration, and support for training and education. Part of these costs reflect a long-term investment (i.e., beyond 2003) because some of these activities will bear fruit only by then.

Achievable Potential as shown is for the years 1992 through 2003.

The cost per MW for weatherization increases in 1998 under the Current Path because continued savings may be difficult to achieve without enhanced efforts.

The difference between projections of water heating savings in this analysis and Council targets results from lower assumed savings in this analysis for showerheads and exhaust air heat pumps.

Exhaust air heat pumps are included in this projection under New Construction and are not yet considered a confirmed resource in existing homes.

Costs for Domestic Water Heating decrease and MW increases in 1995 and 1996 as standards come into effect.

The weatherization program under the Accelerated Path includes some categories of homes not currently included in Achievable Potential

*These projections assume that 15% of the MW under this program are to be financed by parties other than BPA.

Table 8.5 BPA Conservation Projections -- Commercial
Average Megawatts Added Each Year and \$Million Spent by BPA (Nominal)

	1992*		1993*		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		TOTAL		Council	Achievable
	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	Targets	Potential
COMMERCIAL TOTAL																												
Current Path	1	\$6	3	\$10	4	\$16	6	\$23	7	\$30	8	\$38	9	\$45	10	\$49	10	\$54	10	\$58	11	\$62	11	\$66	90	\$457	196	323
Accelerated Path	2	\$27	5	\$31	9	\$23	13	\$46	16	\$63	19	\$83	21	\$93	22	\$102	23	\$112	24	\$120	24	\$128	25	\$135	202	\$973		
NEW BUILDINGS, UTILITY DELIVERED (other than centralized chains)																												
Current Path	0.6	\$2.0	1	\$3	1	\$4	1	\$5	2	\$6.0	2	\$8	2	\$8	2	\$9	2	\$10	3	\$11	3	\$12	3	\$14	23	\$92	NA	82
Current Path	1	\$12.0	2	\$13	3	\$11	4	\$13	4	\$14.0	4	\$16	5	\$17	5	\$19	5	\$21	6	\$24	6	\$26	6	\$28	51	\$215		
UTILITY AND GOVERNMENT RETROFIT**																												
Current Path	0.4	\$0.8	1	\$2	2	\$3	3	\$5	3	\$8.0	3	\$10	4	\$15	4	\$17	4	\$19	5	\$21	5	\$22	5	\$23	40	\$144	NA	96
Accelerated Path	0.6	\$7.0	2	\$8	3	\$5	5	\$9	6	\$15	7	\$21	7	\$26	8	\$30	8	\$33	8	\$35	8	\$37	8	\$39	69	\$265		
DESIGNED REMODEL & EQUIPMENT REPLACEMENT																												
Current Path	0	\$0.0	0.2	\$1	0.4	\$1	0.5	\$2	0.5	\$2.0	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	5	\$20	NA	13
Accelerated Path	0	\$0.0	0.3	\$1	1	\$2	1	\$2	1	\$2	1	\$3	1	\$3	1	\$3	1	\$4	1	\$4	1	\$4	1	\$5	8	\$33		
CENTRALIZED CHAIN STORES (new, remodel, equipment replacement, retrofit)																												
Current Path	0	\$0	0	\$0	0.3	\$1	0.5	\$2	1	\$4	1	\$5	1	\$5	1	\$5	1	\$6	1	\$6	2	\$7	2	\$7	12	\$47	NA	65
Accelerated Path	0.5	\$2	0.6	\$2	0.8	\$3	2	\$5	3	\$11	4	\$14	4	\$15	4	\$16	4	\$17	4	\$18	4	\$19	5	\$21	36	\$143		
REMODEL & EQUIPMENT REPLACEMENT -- DEALER REBATES																												
Current Path	0	\$0.0	0.1	\$0.3	0.1	\$0.3	0.2	\$1	0.3	\$1.0	0.4	\$1	0.5	\$2	0.6	\$2	0.6	\$3	0.8	\$3	0.8	\$4	0.8	\$4	5	\$22	NA	35
Accelerated Path	0.2	\$0.6	0.3	\$1	0.5	\$2	0.9	\$3	1	\$5	2	\$6	2	\$8	3	\$10	3	\$12	3	\$13	3	\$13	3	\$14	22	\$87		
DIRECT INSTALL RETROFIT																												
Current Path	0	\$0.0	0	\$0	0.1	\$0.3	0.3	\$1	0.4	\$1.0	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	0.5	\$2	4	\$17	NA	32
Accelerated Path	0	\$0.0	0	\$0	0.5	\$0	1	\$3	2	\$5	2	\$7	2	\$8	2	\$8	2	\$8	2	\$8	2	\$9	2	\$9	17	\$68		
NON-ACQUISITION COSTS																												
Current Path		\$4		\$4		\$6		\$7		\$8		\$11		\$11		\$12		\$12		\$13		\$13		\$14		\$116		
Accelerated Path		\$5		\$6		\$9		\$10		\$12		\$15		\$16		\$17		\$17		\$18		\$18		\$19		\$162		

NOTES

Non-Acquisition Costs are those costs associated with program support activities. These include support for the Model Acquisition Standards, technology research, development and demonstration, and support for training and education. Part of these costs reflect a long-term investment (i.e., beyond 2003) because some of these activities will bear fruit only by then.

Achievable Potential as shown is for the years 1992 through 2003.

*1992 and 1993 costs per MW are higher than in later years because larger budgets are required in those years to encourage program participation.

**These projections assume that a portion of the MW under this program are to be financed by parties other than BPA.

Table 8.6 BPA Conservation Projections -- Irrigation
Average Megawatts Added Each Year and \$Million Spent by BPA (Nominal)

	1992*		1993*		1994		1995		1996		1997		1998		1999		2000		2001		2002		2003		TOTAL		Council	Achievable
	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	MW	\$M	Targets	Potential
IRRIGATION TOTAL																												
Current Path	1.5	\$4	2	\$4	2	\$4	2	\$4	2	\$5	2	\$5	1	\$3	1	\$4	1	\$4	1	\$4	1	\$3	0	\$1	14	\$45	8	14
Accelerated Path	1.5	\$4	2	\$4	2	\$4	2	\$4	2	\$5	2	\$5	1	\$3	1	\$4	1	\$4	1	\$4	1	\$3	0	\$1	14	\$45		
IRRIGATION -- ACQUISITIONS**																												
Current Path	1.5	\$3.5	1.5	\$3.6	1.5	\$3.7	1.5	\$3.8	1.5	\$3.9	1.5	\$4.1	1	\$2.8	1	\$2.9	1	\$3.0	1	\$3.1	0.8	\$2.6	0	\$0	14	\$37	8	14
Current Path	1.5	\$3.5	1.5	\$3.6	1.5	\$3.7	1.5	\$3.8	1.5	\$3.9	1.5	\$4.1	1	\$2.8	1	\$2.9	1	\$3.0	1	\$3.1	0.8	\$2.6	0	\$0	14	\$37		
NON-ACQUISITION COSTS																												
Current Path		\$0.6		\$0.6		\$0.6		\$0.6		\$0.6		\$0.6		\$0.7		\$0.7		\$0.7		\$0.7		\$0.8		\$0.8		\$8		
Accelerated Path		\$0.6		\$0.6		\$0.6		\$0.6		\$0.6		\$0.6		\$0.7		\$0.7		\$0.7		\$0.7		\$0.8		\$0.8		\$8		

NOTES

Non-Acquisition Costs are those costs associated with program support activities. These include support for the Model Acquisition Standards, technology research, development and demonstration, and support for training and education. Part of these costs reflect a long-term investment (i.e., beyond 2003) because some of these activities will bear fruit only by then.

Achievable Potential as shown is for the years 1992 through 2003.

The Irrigation Program is implementing some improved techniques and new measures which are not currently in supply curves.

This increases overall potential, and also average cost/MW. These measures will be examined for inclusion in the supply curves in 1992.

Costs per MW are higher than historical costs due to inclusion of higher cost conservation opportunities.

*1992 and 1993 costs per MW are higher than in later years because larger budgets are required in those years to encourage program participation.

**These projections assume that all of the MW under this program are to be financed by BPA.

tion. An estimate for the number of BPA people would follow the same general process. Because there is imperfect knowledge of how conservation programs will be accomplished in the future, it is not possible to provide a more exact estimate of regional staffing requirements at this time. Better figures should emerge through the development of local conservation plans.

General Programmatic Approaches

At the start of the 1980s there was very little regional conservation expertise. There was a definite need to develop a consolidated base from which to begin construction of the conservation power plant. Utilities helped develop some successful programs under a strong centralized system, and much was accomplished. In BPA's service area alone 300 aMW of documented conservation savings were acquired. Approximately 240,000 homes were weatherized. Aluminum plants became more energy efficient. Conservation measures were installed in commercial buildings throughout the region. And energy efficient building codes were adopted, ensuring a solid future for the next generation of Pacific Northwest buildings.

During the 1980s, the Pacific Northwest achieved international recognition for its pioneering efforts to find new ways to deliver and account for energy savings. As these accomplishments occurred, the number of people with expertise in energy conservation was growing. This increase in regional expertise has highlighted the desirability of breaking out of traditional molds of acquiring conservation.

Two key features were part of the 1980s: by and large, BPA financed the resource through up-front payments; and BPA controlled risk for the region through specifications and cost-control mechanisms. While this system worked well to help develop conservation expertise in the region, it did result in burdensome oversight responsibilities for BPA.

During the last decade many of the region's utilities developed conservation expertise. They

began designing and delivering excellent programs, without close BPA scrutiny. By the late 1980s, BPA was growing concerned that the old central-design model might not be the best approach for all circumstances in the future. There was a growing belief that other approaches might be required to supplement or augment the traditional central-design model.

Menu of Program Options

BPA believes future resource acquisition efforts must make room for combining the newer methods such as competitive bidding, targeted acquisition and some form of billing credits, along with other utility program designs, plus a complementary set of centrally designed and administered program options. The idea would be to create a menu or spectrum of program options from which program implementers could choose. Most centrally designed programs would remain available. Centrally designed programs and those that focus on single sectors, segments or end uses may be the most effective route for some conservation market segments.

In other cases where a program design required individual tailoring to meet local needs, implementers would be encouraged to try their own designs. Some programs might combine BPA and independent design elements.

Local Conservation Plans

A recent idea would be for BPA Area Offices to work with utilities in their jurisdictions to develop local conservation plans that help ensure the right program mix for the local situation.

These plans might feature:

- Projections of loads.
- Conservation potential and savings targets.
- Infrastructure in place and that needed to pursue targets.
- Staffing requirements.
- Marketing and public relations plans.
- Budget and financing proposals.

- Plans to address and resolve local issues and challenges.
- Implementation schedules for the local situation.

The plans could be thought of as the utility's equivalent of or contribution to the CIP. Utility plans might be summed together to form a composite BPA Area Office conservation implementation plan. These plans might be developed jointly with Area Office staff, with BPA headquarters support as requested, and — depending on local preferences — with assistance from local government entities, consumers, citizen advisory groups or other appropriate entities.

Developing local conservation plans could go a long way toward helping solve the dilemma of how the region will set about achieving the Accelerated Path megawatt targets. The plans also would put utilities more firmly in control of local conservation activity and assist the CIP process by providing more of a bottom-up approach to developing regional megawatt, dollar and FTE estimates, rather than the current top-down approach used in the CIP that relies heavily on conservation supply curves and regional assumptions. The local conservation plan is yet just an idea, and BPA is interested in comments on this concept.

BPA's customer utilities are the agency's first choice as resource providers. Many of them have consumer relationships, expertise and skills BPA cannot — in fact, should not — hope to duplicate. BPA wants to rely more and more on their successes, leverage their unique abilities and build on their experiences. Utilities are most familiar with local, unique needs, and they know best how to motivate their consumers.

The transition to a menu of options that features a complementary mix of centrally and independently designed programs is expected to take five or six years. In the interim, BPA wants to experiment, try out various models, modify approaches, solve problems, build on successes, and generally foster a flexible and creative atmosphere. Mistakes will be made along the way, but they will help the region learn what works and

what does not in achieving large amount of conservation.

Pay-for-Performance Contracts

Through its centralized program design, BPA historically has financed the cost of measures up-front, and accordingly borne most of the risk of project performance. But BPA believes much of the oversight requirements imposed in the past can be dropped under contracts that simply purchase measurable savings over time. BPA payment would occur similarly to the way payments are made under output contracts for generating resources as the kilowatt-hours accrue.

From BPA's perspective, such pay-for-performance transactions have the advantage of freeing the local utility to make program decisions quickly. There would be reduced need to seek BPA permission to make program changes or go through a time-consuming contract amendment process.

Of course, such output contracts are just one type of transaction worth trying out. BPA looks forward to working with its regional partners to identify other possible approaches. Perhaps a mix of up-front payments and payments over time would be appropriate for some situations.

Another factor behind BPA's desire to move away from up-front payments stems from a desire to decrease its Treasury borrowings (which have been the primary source of funding for BPA's conservation programs to date). Because of increasing pressures on BPA to borrow from the Treasury to finance fish and wildlife, transmission and other system improvements, payments over time that could be financed from current revenues might ease the situation. (For additional information, see the BPA Issue Alert, "Financial Planning for the Long Run," October 1991.)

BPA thinks off-budget (non-Treasury) capital funding sources for conservation also should be pursued. Other entities would borrow required capital or float bonds, and BPA would pay all or a portion of the debt service (again likely financed primarily through BPA revenues).

Offer Value-Based Incentive Payment Structures Where Appropriate

The value of a conservation resource to BPA is a function of the degree to which investment in a more costly alternative generating resource having similar output characteristics (similar availability) can be avoided or deferred. Accordingly BPA desires to move toward value-based payments where they appear to be a workable option. Such payments would emphasize negotiated prices, shared benefits among all parties, and verifiability of savings.

BPA wants more discussion on the appropriate places to depart from its traditional approach of paying on the basis of the cost of measures (or percentage of the cost). This may mean BPA would be willing to fund conservation up to, or in some circumstances perhaps exceeding, the cost of measures. Value-based payments might work best under pay-for-performance arrangements.

For transactions involving large blocks of savings, when the potential cost is very high, BPA and utilities should research the cost and value of the installation to all parties, and directly negotiate an individual deal to share the costs and benefits reasonably. This approach would seem most appropriate for large industrial and commercial consumers.

For smaller, more routine transactions involving standard conservation measures, where savings and cost are relatively well-known and understood, parties would establish standard incentive structures or measure-specific incentives. This strategy seems appropriate for smaller commercial and residential conservation opportunities, such as fixed rebates for specific equipment or incentives for measures of a specific payback. This approach is very simple, and perhaps simplistic. It means that in some cases there will be overpayments, and underpayments in others. But this approach can acquire savings when more elaborate incentive structures are impractical.

Provide Clear Guidance to Resource Providers

To encourage resource developers and others to start participating in conservation activities, BPA and utilities should take steps to promote a system for guiding them to those program vehicles that provide the best win-win deal for all parties.

An entity proposing a program must know the appropriate BPA staff to work with, the basis on which a proposal will be accepted, and which acquisition method will provide the best deal. There should be no need for a resource provider to hesitate and shop around for different programs, hoping that there might be a better deal around the corner. BPA will need to get better at providing quick, accurate and easily accessed information on a broad spectrum of topics.

Help Smaller Utilities Design and Operate Programs When Appropriate

With proper support, small utilities can generate significant savings. BPA programs like Energy Smart Design (ESD) and the Energy Savings Plan (ESP) that enable utilities to offer many services under one umbrella contract will serve as the model for other transactions. These off-the-shelf programs enable the small utility to pick and choose the level of involvement (i.e., program services) it is willing to handle, with Area Office support for the remaining components. Utilities must be further encouraged to choose a level of activity and BPA support that, in combination, can effectively acquire the available conservation resources. Contractors could be used where necessary to ease staffing burdens.

Independently Designed Programs: Opportunities to Pursue Multi-Sector and Multi-Utility Transactions

The areas of multi-sector and multi-utility transactions show promise in terms of savings potential. To achieve high conservation levels, independently designed approaches offer a broad diversity of conservation opportunities. The com-

bined efforts of the region's utilities, state entities, local governments and private parties will complement centrally designed programs.

Independently designed approaches should focus on targeted acquisition processes (TAP) and power plant programs, billing credits, competitive acquisition, and BPA-supported multi-sector programs. This focus will increase the opportunities for utilities to choose how they want to participate in creating future resources. Utilities should be able to do what is most appropriate for their service areas.

TAP and power plant programs would be vehicles to solicit performance-based approaches that cover one or more sectors. The emphasis would be to work with single utilities or consortia of smaller utilities to encourage the development and proposals.

Billing credits, mandated by the Northwest Power Act, are customer-initiated actions to develop conservation or generating resources. Utilities are paid for savings over time, the value of which is theoretically a credit against their wholesale power bill. BPA proposes continuing to offer some form of billing credits on a scheduled basis rather than on an ongoing, open-ended basis because of the high workload impact. (BPA acknowledges that the recent billing credits process proved cumbersome and is taking steps to streamline it.)

Competitive acquisition requests for proposals will be offered in the future, but their focus may target specific resources and/or markets that are most appropriate.

BPA-supported multi-sector efforts may address residential/commercial water heating efforts, industrial/commercial non-process activities, and equipment replacement programs for motors, lighting and HVAC equipment in all sectors.

BPA expects to maintain a core group of regionwide, sector-specific activities, but will focus some activities in defined geographic areas. The concept of a single utility contract to support multiple conservation efforts will also be explored, as

will the feasibility of combining certain commercial and industrial programs as a way to minimize confusion among participants.

Multi-utility programs may play a role in markets where key consumer decision-makers or trade allies (e.g., motor distributors) span several utility service territories. Utility groups or non-utility service providers should contract for conservation from many service territories. In situations where utilities are unable to pursue conservation aggressively, BPA may use the services of third parties, such as private sector contractors or state energy offices.

The following pages share some sector-specific implementation Approaches, Challenges, possible Solutions, and Ongoing Actions.

Industrial Sector

The industrial sector includes industrial, irrigation and customer system efficiency improvements (CSEI) programs and activities. (CSEI involves system improvements to reduce line losses; see Figure 8-4).

BPA's industrial conservation acquisitions have grown rapidly, as knowledge was gained in understanding the inherent complexity created by project diversity, varying investment criteria, changing production parameters and uncertain long-term viability. As a result, acquisition efforts have been extended to include conservation projects for new and expanding industries, long-term BPA-industry and BPA-utility contracts, pay-for-performance mechanisms and large irrigation facilities.

Although considerable knowledge has been gained and programs have adapted, it is becoming apparent the complexity of this sector will most likely prevent existing acquisition efforts from achieving the Accelerated Path target. Therefore, these initiatives need further exploration if the Accelerated Path is to be achieved. The following approaches are suggested to stimulate discussion regarding how aggressive

**Figure 8-4. Industrial/Irrigation/Utility Sector:
Annual Megawatts Acquired**

industrial conservation acquisitions can be facilitated.

Approaches

1. Independently Designed Programs. The primary acquisition approach will encourage customers (utilities and DSIs) to develop mechanisms to acquire industrial conservation resources that meet local needs, and share economic benefits commensurate with the level of risk assumed. The mechanisms should also feature long-term savings verification and non-BPA financing. Third parties may be solicited (for example, through competitive acquisitions) to help achieve the Accelerated Path targets if the combination of customer designed and centrally designed programs cannot achieve the goals.

2. Centrally Designed Programs. Realizing independently designed programs may not work in all situations, programs designed and managed by BPA will continue to be available. However, it is likely these programs will be adapted, over time, to combine innovative acquisition mechanisms with desirable existing features. The idea would be to maintain an alternative, secondary acquisition mechanism and create an umbrella marketing approach.

3. DSI Conservation. BPA has information indicating that significant but nonquantified DSI conservation potential (including the aluminum smelters) remains untapped (almost 25% percent of BPA's electric load is from the DSIs). Assessment of this sector's potential will continue, any comments regarding the speed and level of acquisitions in this sector will be welcome.

BPA is also interested in suggestions about the issues mentioned in the earlier section called "Varying Points of View" plus the concept of "take-back," as well as determining the value of the DSI conservation resource. Until the impacts of these issues can be better quantified, acquisition targets and costs for the DSIs will not be presented.

4. Flexible Technical Assistance. Technical assistance must be flexible and adaptable to meet utility customer and end user (consumer) technical and business needs. This assistance may include energy reviews, auditor training, case studies and handbooks.

5. Increased Communication. BPA wants more discussion of industrial conservation acquisition issues. The goals are to develop a mutually derived common understanding of the value of industrial conservation, and to build stronger professional and interpersonal relationships with utility customers and, when appropriate, industrial consumers.

Industrial Sector Challenges

1. Large Project Strategy. Because of the size of industrial loads, industrial conservation acquisition requires significant expenditures. Naturally this means more care must be given to industrial acquisitions to assure a wise investment of ratepayer funds.

Program implementation has often been slowed as BPA sought to address issues such as long-term project viability, takeback and free riders. BPA's hesitancy has been perhaps misinterpreted as a lack of a clear industrial acquisition strategy, and regrettably the situation may have discouraged some program participation.

2. Insufficient Utility Staffing. Industrial implementation activities will be constrained if customer staffing levels are not increased significantly.

3. Utility/Industry Motivation. Many utilities and industries are troubled by the current level of BPA's acquisition payments, the time required to participate in programs, a perception of program

instability, and skepticism regarding the efficacy of some measures.

4. Lost Revenue. Industrial sales revenues represent a major portion of some utilities' total revenue. Projects resulting in significant conservation may adversely impact the utility's balance sheet and require rate adjustments, especially if total system loads are stagnant or declining.

5. Perceived Subsidy. There may be a general perception that payments for industrial conservation are subsidies and therefore inappropriate from a societal standpoint.

Possible Solutions

1. A public process should be undertaken to develop a policy on takeback and free riders so that industrial acquisitions can incorporate these decisions.
2. Customers could reallocate human resources to the industrial sector to work with their industrial customers.
3. BPA could detail staff to utilities.
4. A common, unified industrial acquisition approach could be established that:
 - Creates a rational acquisition payment structure integrating varying degrees of risk (industry viability, takeback and free riders), non-BPA financing and utility revenue concerns.
 - Creates stability by planned adjustments to the level of the acquisition payment (conceivably concurrent with the BPA rate case).
 - Creates an ethic for planned, orderly program evolution.
 - Simplifies participation as much as practical.
 - Recognizes the efforts of people in industrial firms who devote time to analyzing and installing conservation projects.

5. With regard to the perception industrial conservation acquisition payments are a subsidy, BPA could facilitate discussions to share perspectives on the issue. The goals would be to develop a common understanding of the issue, develop mutually beneficial goals, and come to a joint commitment that industrial conservation is a resource, not just a customer service.

Ongoing Actions

The complexity and interrelated nature of industrial issues requires BPA and its customers to learn more about the sector during the initial years of the proposed Accelerated Path. Here are some of the actions needed to undertake while learning more about industrial conservation:

- Research activities need to be directed toward determining the nature and impact of ancillary non-energy benefits of individual projects.
- BPA will find a way to improve communication among all parties to guide the evolution of industrial acquisition activities.
- Methodologies for verifying savings in new and expanding industrial facilities need to be refined.

Residential Sector

The Pacific Northwest has attained a high degree of expertise in acquiring residential conservation. For over a decade, BPA programs established the national standard, providing many of the fundamental demand side management concepts and approaches used today around the country. These efforts have recently culminated in statewide adoption of Model Conservation Standards (MCS) for Oregon and Washington, as well as contributing to more stringent Federal standards for refrigerators, freezers and water heaters.

In partnership with utilities, BPA intends to pursue program mechanisms that meet these tar-

gets. These include both centralized⁹ programs and non-centrally designed programs (see Figure 8-5).

Approaches

1. Residential Weatherization. The existing program provides a solid foundation from which to build an expanded portfolio of resources. Additional savings under the Accelerated Path scenario are possible through inclusion of a more comprehensive package of thermal measures, energy-efficient lighting, house sealing/tightening and improved window options.

Homes constructed after 1983 (previously ineligible) and manufactured housing are included in the Accelerated Path scenario. To achieve these megawatt targets, BPA needs to: (1) adjust incentives and/or administrative payments to reflect market response; (2) continue a strong focus on low-income participation; and (3) consider educational components to augment acquisition efforts.

2. Lighting Efficiency. Currently, BPA does not offer a residential lighting program or lighting options within existing programs. A Super Good Cents Program lighting energy budget for kitchens/bathrooms and existing exterior lighting is being planned. The Accelerated Path approach involves multiple components to reach this highly diverse market. It would include:

- Developing a lighting program for non-electrically heated homes.
- Developing a lighting program that targets the entire new construction market, including those who don't participate in Super Good Cents.
- Negotiating the inclusion of lighting efficiency in the New Manufactured Homes Program.
- Installing efficient lighting as a supplemental component of the Weatherization Program or appliance programs.
- Using general mass-marketing and consumer education to provide broad-based market penetration.

Figure 8-5. Residential Sector: Annual Megawatts Acquired

3. Residential Appliances: Purchase/Replacement Programs. This market segment includes replacement of failed/outdated equipment and purchase of new appliances when moving or buying a new home. Appliances included are electric water heaters, refrigerators, freezers, clothes washers, dishwashers and air conditioners.

The proposed approach is to influence adoption of more energy-efficient Federal appliance standards. Since standards are strongly related to product availability, the region must influence manufacturers to produce more energy-efficient appliances. Manufacturer incentive programs to encourage production and delivery of energy-efficient appliances to the Northwest (and to other parts of the country through consortiums and coalitions) will accomplish this goal. "Golden carrot"

programs to encourage industry to develop energy-efficient appliances beyond what is available in current production lines also meet this end. Marketing to consumers and retailers will be needed to stimulate the market for these energy-efficient appliances.

4. Water Heating Retrofits. Water heating measures such as tank and pipe wraps are included in the Weatherization Program. A major initiative to install energy-efficient showerheads and to encourage consumer purchase of 0.95 EF (energy factor) water heaters is planned under the Appliance Efficiency Program.

5. New Construction. BPA is developing a Long-Term Super Good Cents (SGC) Program that includes all regionally cost-effective measures. Incentives are set at roughly full incre-

mental cost. A whole-house approach is emphasized, including options for efficient water heating, appliances and lighting, as well as measures to improve thermal efficiency. Also included will be exhaust-air heat pump water heaters and high-efficiency heat pumps. The SGC Program has been one of the most successful in the nation. Yet history shows that the region cannot expect saturation rates greater than about 30%. To achieve the targets in this sector, supplemental approaches must be offered. Utility hookup standards, with builder payments at full incremental cost for two to four years, are envisioned in the Accelerated Path approach. The New Manufactured Housing Program breaks away from the conventional SGC design to work directly with the limited number of manufacturers that dominate the regional market. In exchange for a direct incentive per unit produced over a specified time period, program participants will retool their plants to produce only energy-efficient models. Hookup standards are also envisioned as a supplement to this approach. This market segment offers unique opportunities to pilot-test emerging technologies, because of the ability to negotiate with a limited group of manufacturers and to take advantage of controlled construction equipment. Emphasis will be placed on technical comprehensiveness, with exploration in the areas of lighting design, "super windows," exhaust-air heat pumps and water saving devices.

Residential Sector Challenges

1. Fuel Choice. The attractiveness of incentives available under residential conservation programs could inadvertently influence consumers to choose electricity over other fuels for appliances and space heating equipment in new and existing houses.

2. Weatherization. Residential consumers are particularly reluctant to make conservation investments.

3. Lighting. There is a lack of awareness of efficient lighting products and their applications, and problems with product availability and reliabil-

ity. Cost effectiveness in existing residences is also an issue.

4. Appliance Industry. Manufacturers have little incentive to build energy-efficient appliances.

5. Shelter Industry Acceptance. In the new home sector, builders are the first line of defense in installation of energy-saving measures. This market has generally not been eager to change practices quickly, and is extremely sensitive to cost. With the large and dispersed infrastructure of the builder industry, their reluctance has presented a formidable challenge in the past.

Some Possible Solutions

1. Work with gas/oil heating associations in developing conservation programs. Work to promote energy efficient lighting and appliances in the gas/oil heated housing market. Work with utilities on mutual understanding of program intent.
2. Use full utility funding of weatherization measures through direct investment/installation or cash incentives.
3. Promote extensive consumer/professional education about lighting technology and applications. Establish and maintain a relationship with manufacturers to promote production and availability of the most reliable and efficient lighting products. Sponsor research and development to improve reliability.
4. Use appliance manufacturer incentive programs, combined with marketing, to stimulate consumer demand for energy efficient appliances.
5. Full incremental cost incentives are a partial solution. Mandatory codes and intensive marketing and technical support for home buyers could also help.

Ongoing Actions

1. BPA will look at promising new technologies that are not yet cost-effective regionally but

could show promise in the future (for example, certain appliance improvements, ground-source heat pumps, etc.).

Commercial Sector

Commercial sector activities began in the early 1980s. Conservation resources were acquired from institutional buildings, street and area lighting, and water heating.

Tests were begun on new construction potential through the Energy Edge project, alternative financing methods through the Purchase of Energy Savings program, and retrofit methods through the Commercial Incentives Pilot Program. They were first scaled back to a capability-building level in response to the energy surplus of the mid-1980s and then closed down.

The sector began rebuilding its efforts in new commercial construction and renovation three years ago with the launch of Energy Smart Design (ESD) and its companion efforts, the Lighting Design Lab and the Electric Ideas Clearinghouse. In 1990, incentives were added to Energy Smart Design, and other program components such as building commissioning and the Prescriptive Path were added.

A critical development was the beginning of discussions in 1991 with several of the utilities having the largest commercial retrofit resource, concerning sale of their conservation potential to BPA through pay-for-performance and value-based contracts. These agreements provide the local flexibility to adapt efficiently to changing circumstances and continue the development of a high quality, cost-effective conservation resource. Most importantly, the process of negotiating contracts fosters BPA-utility partnerships and enhances utility capability.

Approaches

The choice ahead is significant. An Accelerated Path approach to getting the commercial conservation megawatts would more than double

achievements estimated under current approaches (see Figure 8-6).

The commercial sector is complex, and a one-size-fits-all approach will not capture resources at the Accelerated Path levels. To maximize the ability to capture the commercial resource and to meet megawatt targets, inroads must be made into all market segments. Therefore, the commercial sector strategy is market-based. While this includes a number of approaches, BPA is committed to developing consistent, straightforward requirements across these approaches.

The approaches are:

1. Working Through Utilities. BPA is committed to working through utility customers to acquire as much of the resource as possible. This includes stepping up efforts under Energy Smart Design to capture savings in new construction and renovation. It also means adding new components under the ESD umbrella. Technical assistance and incentives to ensure efficient equipment replacement choices will be added. Smaller utilities will have the choice to offer limited retrofit measures through a rebate approach under the ESD umbrella. BPA's goal is for half the megawatts to be acquired under these approaches.

2. Program Mix. BPA is not relying entirely on centrally designed programs. Medium to large utilities and consortiums of small utilities will be encouraged to design their own programs under a targeted acquisition process (TAP). BPA anticipates that 50% of the retrofit savings will be acquired under a pay-for-performance approach. This will include public-sector buildings brought in by the states and Federal agencies.

3. Outside Support. For some markets, a linear "BPA to utility to consumer" approach may be ineffective, because transactions in the commercial building market are time-critical. It is imperative to reach the consumer at the right time with the proper combination of information, incentives and technical expertise to encourage a favorable decision on energy efficiency. To do

Figure 8-6. Commercial Sector: Annual Megawatts Acquired

this means participation of many people outside the utility industry. For example, consumers need to be reached with incentives for efficient equipment directly through trade allies such as equipment and service vendors. Current untapped market segments which contain substantial resources must be reached. For example, energy efficiency can be purchased across many utility service territories in a single "mega-deal." This could be done centrally or by consortia of utilities. An example is centrally managed chains.

4. Existing Market Structures. BPA will work with existing market structures for equipment vendors, building management and developers to develop an extensive network of informed and committed trade allies.

5. Direct-Install Component. For some end-use consumers, particularly small businesses with less immediate interest, a direct-install component can be added. This would involve centralized bulk purchases and installation of measures to reach these consumers on a cost-effective basis.

Commercial Sector Challenges

1. Infrastructure. The ability of the region's various design, construction and equipment supply businesses to meet the anticipated demand for energy efficiency services is constrained. In part this is because there was not much business in energy efficiency in this sector through the mid-1980s. Some is because the region is competing with other aggressive conservation efforts elsewhere, such as New England and California.

2. Equipment. For the near term, specific and important kinds of equipment are in short supply or take a long time to get. These include T-8 fluorescent lamps, electronic ballasts and compact fluorescent bulbs.

3. Staffing. Currently, utilities appear to have no plans to staff up significantly. Because the bulk of the work will be done at the utility level, more staff will be needed to accommodate rapidly increasing program needs in the commercial sector. Further, those utilities willing to hire are finding competition for limited numbers of highly qualified staff.

4. Training. Training is limited in scope and availability. Regional training programs active in the early 1980s were shut down when the region was in surplus.

Some Possible Solutions

1. A stable commitment by BPA to a long-term commercial conservation effort will provide businesses in the energy efficiency industry with a confident outlook on opportunities in the Northwest. In addition, BPA could support a regionwide forum on infrastructure development to develop a comprehensive approach. An effective model is the Appliance Efficiency Group that has already been set up in the region.
2. BPA will engage in innovative approaches to insure that needed and reliable equipment is available within reasonable time frames and at reasonable prices. This could include providing support to manufacturers to develop energy-efficient equipment and provide consumer information on those products. Direct purchases of certain kinds of materials may be needed. Demonstration facilities for efficient equipment, similar to the Lighting Design Lab, may be helpful.
3. A stable commitment by BPA to conservation should provide utilities with the confidence to hire additional conservation staff. BPA support for approaches using consortia of

utilities, "circuit riders" and peer matching (currently being tested under ESD) will support effective use of staff.

4. There must be substantial additional actions to improve the number and skill level of available trained people. In addition to support for ongoing continuing education, BPA could support development of two- and four-year degree programs in energy efficiency.

Implementation Challenges

A number of Challenges must be overcome if the Accelerated Path is to be achieved.

A significant contextual challenge is developing an approach to deliver the huge quantities of savings needed to achieve the Accelerated Path. Does the region really know how to produce, buy and sell hundreds of megawatts of conservation?

There are unanswered questions about whether existing or even proposed programs and savings purchase methods — of either BPA or utility design, or both — will be fully capable of delivering the savings needed. This is a non-trivial issue; the uncertainty surrounding regional capability on a macro scale would argue for more emphasis on local conservation plans.

But perhaps on a more fundamental level is the question of whether the region is fully aligned with respect to acquiring all cost-effective conservation. A review of the array of existing policies, pricing mechanisms and programs suggests it is not. Current policies are not always in harmony with one another and may not support resource acquisition. Program efforts are often frustrated by conflicting price signals, and so on.

Some have suggested the region needs to transcend the current focus on programs as the exclusive means of accomplishing conservation, and move toward a more unified, holistic approach. Such an approach might feature a complementary mix of concepts — partnership, people, policy, pricing and programs — integrated into one logical, comprehensive, internally consis-

tent package at the regional and local levels. Each element would support the others, while falling short on any of them would reduce the likelihood of achieving the Accelerated Path.

These elements can be thought of as the real challenges to the Accelerated Path. The seven Challenges listed in the preliminary draft CIP, coupled with several new ones suggested by commenters, can actually be condensed into five critical alignment categories:

- **Partnership.** It is critical for all regional and local interests to work together in a true partnership to acquire all cost-effective conservation.
- **People.** Each regional and local interest must assure its organizational structure is focused for aggressive conservation.
- **Policy.** All regional and local policies should be reviewed and modified with an eye toward enhancing conservation acquisition.
- **Pricing.** Rate structures and program incentive levels should be reviewed for their impact on stimulating or deterring conservation.
- **Programs.** Innovative new programs should be added, while existing programs retained and improved. All should focus on market segments not yet reached.

These Challenges apply at both the regional and local levels. Each regional and local interest has a role in overcoming them. It will be hard work; it will take time, dedication and perseverance. But unless these critical Challenges are successfully dealt with, the Accelerated Path will remain out of reach and the region will become more dependent on alternative resources.

Challenge 1: Partnership

All regional and local interests must work together to acquire all cost-effective conservation.

The region has had many successes and a few failures over the years in acquiring conservation. There have been some good deals struck, some

not so good. The region needs to profit from its experience and move on. The best way to proceed is by working in a partnership that values diversity of opinion, seeks out an intersection of the true interests of parties, and results in durable agreements.

In the past, BPA and utilities may not have always proceeded on this basis when trying to develop deals. Contract negotiations were sometimes seen as an impediment to making changes. Antagonism between parties frequently replaced cooperation and discovery of mutual interests as negotiating principles. Part of the problem might be traceable to a mutual misunderstanding of intent or motive, or perhaps a failure to understand fully one another's needs.

As an example, some utilities have expressed a concern that pay-for-performance transactions will become BPA's exclusive approach to acquiring conservation and that traditional programs will disappear. They questioned why BPA would suddenly abandon popular, productive and proven delivery vehicles in favor of approaches born of an untried new philosophy. They had questions about roles and responsibilities — who is doing what, when and how? — questions about the "whys" behind BPA's preferences. Perhaps many of these concerns would never have surfaced had all parties, at all levels, been working in an ongoing partnership relationship, seeking at the earliest opportunity to understand one other's needs and intents. Whatever the underlying cause for such miscommunication, BPA desires to put that history behind and move on to a clean sheet.

BPA thinks solutions in the future should be grounded in trust, willingness to listen to one another, open and honest discussions, recognition of differing legitimate interests, and mutual respect. BPA agrees with utility commenters who have stated the need to treat each other as partners and co-equals, not as rivals or competitors.

BPA and its customer utilities are all in the same situation together, and only by forging a true partnership can progress toward the Accelerated

Path be made. BPA proposes establishing an ongoing forum where authorized decision-makers from all interests may sit down to discuss issues, work out solutions in an open consensus-seeking process, and devise and implement strategies for overcoming the Challenges. This means a commitment to ending any sense of "us and them," and instead forging a true partnership founded in the mutual commitment to getting on with the important work at hand.

Part of the work of these forums might be to lay the foundation for the development of local conservation plans. The Area Offices will play a key role in setting up, developing agendas for, and managing the meetings within their jurisdictions.

Some important issues raised recently that BPA will address through the forums include pay-for-performance, risk-sharing, conflicting price signals, lost utility revenue, value vs. cost-based payments, free riders, and efficiency vs. load reduction. BPA looks forward to discussing these issues with its partners.

Some possible solutions:

- Create an ad hoc team comprised of representatives from interested parties who are empowered to make decisions for their organizations. The purpose of such a team would be to identify and seek consensus solutions on relevant conservation implementation issues and Challenges.
- Develop a process for — and work with — utilities to develop local conservation plans.
- Resurrect the annual regional energy conservation and renewable resource conference, in some form or equivalent, for team-building purposes and to share information.
- Provide training for employees in the art of principled negotiations and interpersonal relationships.
- Strengthen vertical communication within organizations.

- Provide opportunities for routine sharing of ideas (horizontally) within and among organizations.
- Encourage detail-sharing among organizations (e.g., BPA-utility).
- Include utility and state representatives on BPA program design teams.
- Publicize successful programs.

Challenge 2: People

Each regional and local interest should focus its organizational structure toward acquiring all cost-effective conservation.

There are many components to this Challenge, among them labor intensity, infrastructure constraints and segmentation of staff by sector.

Labor Intensity. Conservation is labor intensive. The region is not adequately staffed to handle the workload required to meet the Accelerated Path targets, and there may be radically different perceptions among regional leaders as to these requirements. The proposed transition to an Accelerated Path scenario presumes BPA and utilities will staff up appropriately.

Using independently designed programs partially mitigates the need for new BPA staff, but does not entirely solve the problem since some programs will remain centrally controlled. Even decentralized programs imply working with more and more diverse contracts.

Some BPA organizations — most notably the Area Office conservation staffs, headquarters contract support sections, and the headquarters financial management contract review group — appear to be understaffed to meet current peak workloads. BPA may need to reassign or detail at least some FTE (full-time equivalent) staff to overcome this problem.

Some utility staff have suggested that utility management may not always understand how programs work and how labor-intensive conservation can be; and even if they do, authority or money may not be available to hire more people. There may also be pressure from ratepayers to

hold down the number of staff. The net result is that utility conservation efforts are often capped by FTE constraints.

Additionally, even utilities that are eager to pursue conservation may not appreciate the scope of effort and FTE needed to acquire a greatly increased share of the needed resources. Some smaller utilities have but one conservation person; a few have none. Larger utilities may have several staff on board, but not necessarily in proportion to the greater amount of work at hand.

For certain highly specialized tasks, such as commercial facility energy auditing, sufficient qualified personnel may not exist in the region and may be unobtainable in certain locales at any cost.

Some possible solutions:

- Address BPA's FTE ceilings and assure adequate support for increased energy resource development activity.
- Increase the number of details to organizations requiring staff within BPA; reassign FTE if required.
- Explore ways to use more contractor support.
- Permit Area Offices, utilities and contractors to draft more of the conservation contracts and exhibit revisions.
- Continue efforts to decentralize program management to Area Offices and empower Area staff with greater decision-making authority.
- Provide utilities with business incentives to invest in more staff (some level of start-up funding in the form of grants may be helpful).
- Step up efforts already in place to help utility managers and others understand the expected volume of conservation acquisitions and the staffing implications.
- Identify ways to do a better job of communicating the facts about the workings of conservation programs to utility managers.

- Develop and test efficient ways of tapping contractors, state offices and community service organizations to do some of the work where appropriate (for example, technical assistance or energy auditing).
- Increase the amount of technical assistance the Area Offices are capable of providing utilities.
- Put a contractor pool in place that utilities can call on to help identify conservation resources and design programs.

Infrastructure Constraints. As a consequence of the power surplus in the mid-1980s, BPA throttled back its acquisition efforts. This wreaked havoc on much of the region's conservation infrastructure. Lack of stable work forced many consulting firms, installation contractors and other trade allies out of the energy conservation business and into other lines of work, and prompted utilities to lay off or reassign staff.

Much of the technical expertise simply moved out of the region; what remains tends to be geographically dispersed. Expertise for some skill markets such as commercial auditing may be extremely difficult to reestablish quickly because of the high demand for those skills nationwide and the importance of hands-on experience.

Some possible solutions:

- Provide assurances and concrete evidence of an even stronger long-term commitment to conservation and program stability.
- Increase technical training efforts among utility and contractor personnel.
- Support relevant technical community college/university curricula.
- Encourage developing contractor support when BPA and utility pay scales are inadequate to attract sufficient volumes of specialty-skilled labor.
- Encourage combined efforts by utilities and other program deliverers to leverage the limited pool of program skills.

- Offer assistance to utilities wanting to operate their own bidding programs.
- Tap state agencies and other entities, including energy service companies, to operate conservation programs.
- Sell state-of-the-art equipment and materials through utilities if not readily available at local stores

Segmentation by Sector. Most conservation staff at BPA and at some utilities are segmented — “compartmentalized” — by end-use sector. This breakdown is appropriate for situations in which a program deals with sector-specific measures. But measures often transcend sectors, and program approaches that are sector-limited may occasionally create inefficiencies in the use of human and material resources. This situation can also create confusion among utilities and consumers who may not be sure which measure fits under what program.

Some possible solutions:

- Phase out most of BPA's own new program design work and take steps to encourage local program design initiative; help utilities that require design assistance for their programs.
- Identify the benefits of multi-sector and multi-utility programs and strengthen efforts in that direction.
- Encourage BPA sector staff to coordinate planning efforts to a greater degree and to arrange for work details that would rotate staff among sectors and between Areas and headquarters.
- Investigate possible alternative organizational structures within BPA that emphasize the complementary melding of independently-designed and centrally-designed programs.
- Create account executive positions at BPA to serve as cross-sector intermediaries or advocates for utilities in their dealings with BPA.

- Revise performance standards at BPA to allow for shared savings and promote team efforts among sectors.
- Create a BPA staff-level multi-sector policy team.

Challenge 3: Policy

All regional and local energy policies must be reviewed and modified with an eye toward enhancing conservation acquisitions.

Regional and local entities should systematically review policies to see whether they are appropriately supportive of conservation acquisition activities. Policies should be modified where required to further the holistic approach.

Cost-Sharing. BPA's cost-share policy was developed about six years ago through an extensive public process, but it remains controversial. Based on comments received, it is a likely candidate for review and potential revision.

The problem the policy seeks to address is the equitable recovery and allocation of conservation program costs. In service territories where utilities purchase less than 90% of their firm power requirements from BPA, the current cost-share policy requires that program incentives to utilities be reduced according to a non-linear payment formula. Depending on whether the utility makes up the difference, this reduction in payment may preclude 100% incentives for measures. The effect is to detract from program performance in cases where incentive levels must be very high.

Another provision of the policy stipulates that BPA's acquisition of conservation from a utility is limited to the amount of load it places on BPA. (Again, the issue is cost recovery.) If the utility purchases 1 aMW, BPA cannot finance more than 1 aMW of conservation in that service territory, even though the potential savings may be far greater. This provision may be counter-productive from a regional perspective if the utility plans to place its load growth on BPA, which then must acquire expensive resources to meet that growth.

There may be other policies requiring review, such as BPA's New Large Single Load (NLSL) policy, environmental review policies, procurement and contracting procedures, the average system cost methodology, and so forth. All should be scrutinized for opportunities for increased efficiency.

Some possible solutions:

- Continue to refine BPA's cost-share policy through the separate public process now under way.
- Examine the New Large Single Load policy to assure that new large loads are appropriately classified and that NLSLs pay the cost of resources required to serve them.

Challenge 4: Pricing

Rate structures and program incentive levels need to be reviewed for their impact on stimulating or deterring conservation.

A key element to a holistic approach to resource acquisition is pricing, both of rates and programmatic incentives. One goal may be to send price signals that more closely reflect the marginal cost of resources required to serve new load.

Wholesale Rates. There is some concern that the rates currently used by BPA may not reflect consistent economic signals when developing low-cost conservation resources. Average cost pricing does not fully send the price signal to customers of the long-term economic consequences of adding significant new load.

Although the issue of marginal vs. average cost pricing is controversial, several commenters explicitly mentioned tiered rates as a possible solution. Gaining a better understanding of the issue is crucial to completing an aligned, holistic approach to accelerated conservation levels.

Some possible solutions:

- Investigate concerns relative to average cost pricing, review current wholesale rate practices, and develop through an appropri-

ate public forum, such as Rate Issue Workshops, appropriate solutions that may include tiered rates.

- Enlist utilities to review their rate structures with an eye toward assessing the impact their rates will have on consumer willingness to promote efficient use of energy resources.

Programmatic Price Signals. BPA offers many conservation programs, and they all feature different incentive levels. As a result, it may not seem very clear to utilities and consumers exactly what BPA is "willing to pay" for conservation. There is confusion whether BPA's payment currently reflects the value of the savings to BPA, the cost of the measures or some other value. The issue has come to a head with recent discussions about pay-for-performance contracts, where the value of savings and risk-sharing are central themes.

Many commenters say that "a kilowatt-hour is a kilowatt-hour," yet in their view, BPA has appeared reluctant to pin down exactly what a kilowatt-hour is worth, when it should be available to the system, what reliability and persistence it should have, and so forth.

Another issue related to pricing is utility lost revenue, discussed in Programs.

Some possible solutions:

- Provide a more logically differentiated incentive structure, and the levels of technical and administrative assistance required to distribute costs and benefits more equitably.
- Develop a conservation pricing policy that appropriately harmonizes among sectors/programs/markets.

Challenge 5: Programs

Innovative new programs should be added, while existing programs can be retained and improved. These new programs all should seek to focus on market segments not yet reached.

This is a complex Challenge involving elements of program design, perceptions about program-

matic savings and consumer reaction to programs.

Existing and New Programs. As mentioned earlier, BPA and many commenters believe most existing centrally designed programs should be kept in operation and improved to keep in step with changing times. There should also be opportunities for utilities and other entities to implement programs of their own design. BPA desires to move toward a complementary mix of centrally and independently designed programs. Utilities should be free to choose which approaches from a broad menu of options work best for their service territory.

Some possible solutions:

- Make it clear that most traditional program approaches will continue to be available.
- Provide guidance as to the types of conservation, markets and utilities BPA views as appropriate for various acquisition vehicles (including competitive acquisition, billing credits, individually negotiated contracts and BPA programs).
- Create account executive positions to serve as cross-sector intermediaries or advocates for utilities in their dealings with BPA.
- Increase efforts to develop the technical knowledge of what measures are cost-effective and under what conditions.

Conservation as a Resource. Programs should result in conservation savings that can be counted on. Due to faulty program design, assumptions, difficulties in measurement or other problems, there have been situations where the actual savings as determined through program evaluations have come in well below estimates. For some, this has eroded confidence in conservation as a bona fide resource. Other individuals have not been convinced conservation savings can be quantified like the output of a generating resource.

To exacerbate the problem, some utility managers may calculate no economic benefit, either

short- or long-term, for conservation investments. Some utilities with stable or declining loads may realize a short-term disincentive due to lost revenue. Investing in conservation for the sake of regional benefit may be considered esoteric and, if perceived to increase rates, is tough to sell to ratepayers who are concerned about electric bills.

Some possible solutions:

- Work with regional leaders to identify the benefits of conservation, both short- and long-term, and make the story more relevant to local circumstances.
- Distribute the findings of evaluation efforts and project case studies more widely and more aggressively. There are already good examples, such as BPA's Issue Background, "Big Savings from Small Sources - How Conservation Measures Up" (March 1990) and the BPA listing entitled "Technical Reports on Program Evaluation" (September 1991).
- Explore the concept of keeping utilities financially "whole" for doing conservation, to mitigating — at least in part — lost-revenue effects, and reward moderation of load growth. This may be a possible feature of value-negotiated payments as discussed above.
- Recognize leaders who accept the challenge of developing conservation.

Consumer Motivation. Some consumers may be tired of hearing about the need to conserve energy. Perhaps some are skeptical of results or refuse to take what they may perceive to be a hand-out from the government, the utility, the state energy office or the energy services company. Some may have little time for the paperwork hassles and red tape often associated with programs.

Many businesses may not be motivated to focus their management resources on conservation because electricity costs are an insignificant portion of their operating costs and conservation is not an area of their expertise.

Industrial consumers may be unwilling to consider conservation projects if they perceive a risk that their production line would be adversely affected (production levels constrained or capped). Some may require very high rates of return on investment — a simple payback of two years or less. Conservation competes for capital with other projects, and if the payback from energy savings and program incentives falls short of a firm's economic hurdle, there will be no deal.

Some possible solutions:

- Heighten marketing, public relations and advertising efforts to generate greater consumer awareness of conservation programs.
- Engage in a greater variety and intensity of conservation demonstration projects to reach a greater diversity of consumers.
- Develop program strategies that encourage the commissioning of operation and maintenance services for certain types of measures to assure long-term savings.
- Provide greater contractor support for program implementation.

Evolving Program Focus. Over time, as policies and price signals are brought into alignment with accelerated conservation activities, program focus could be directed at those markets where price signals have little effect or undesirable societal effects occur.

Some possible solutions:

- Target industrial plants where the cost of electricity has an inconsequential effect on decisions to install conservation.
- Give priority to weatherizing low-income houses.

Ongoing Actions. Where do we go from here? BPA believes that it is imperative to continue to move forward, boldly, with vision and determination. We need to experiment, take risks, and be willing to make some mistakes along

the way. We cannot stand still and wait until all Challenges are met and overcome. It can fairly be said that if we don't make mistakes, we will not have pushed hard enough.

Probably the biggest job will be to cope with the uncertainties inherent in the steps toward the Accelerated Path — how to actually make it happen and get people comfortable with it. In the interim, BPA will do what it can to minimize the confusion.

BPA is confident that the region will continue to make progress a step at a time, adding to collective knowledge, building on one another's successes, correcting for mistakes, and supporting those willing to take the first steps. Fortunately, there is already a remarkably solid base from which to grow, due in no small part to the dedicated partnership of interests that exists in the region.

The Abstraction of Megawatts. This document deals in megawatts and millions of dollars. To most of us, these terms are abstractions, and their use creates a communication problem. How does one convey in concrete, graspable terms what is meant by an Accelerated Path conservation approach? What does it mean for the typical utility? What reality does it have for a homeowner, a business person, an irrigator, a factory manager?

If some assumptions are made about housing stock, penetration rates, space heat saturation, staffing levels and contractor availability, it is possible to roughly convert megawatts into, say, weatherization jobs for a typical regional utility. Using a similar process, one could estimate the number of square feet of commercial space that might be relamped, or industrial processes to be upgraded, or irrigation systems to be revamped.

But, in truth, only utilities themselves can translate megawatts into the reality of action. The new emphasis on the local conservation planning process will help.

Conclusion

This document is intended to be a catalyst — a call to action — to encourage the reader's thinking. BPA hopes to find support for a lot of what has been proposed, but also realistically expects disagreement with parts. The point is, BPA wants to stimulate participation in the form of written comments and phone calls, attending meetings, visiting Area Offices or moving to action in other ways.

The energy problems we face are the region's collective problems. Only through a partnership with all interested parties working together can they be solved. BPA is sincere in wanting feedback on this document — thoughts as to how the region can best attain its conservation vision.

Ideas are needed on how best to meet the challenges presented so that the region's resource needs can be met successfully.

Sources of Generation Resources

The analysis to determine the amount of generation and options BPA should acquire indicates that some additional acquisitions provide benefits to the region. Acquiring a mix of new generation resources and options provides the flexibility needed for Bonneville to respond effectively to fluctuations in load growth, and to adjust generation resource acquisition levels every two years (as part of future Resource Programs) to reflect the region's progress in meeting the conservation challenge.

As part of the Resource Program, BPA is exploring a number of different sources from which to acquire and option new generation resources. The following sections describe BPA's goals and strategy for generation resource decisions, the potential sources of generation resources, and the generation budget through 2003 (see Figure 8-7).

Strategy for Generation Resource Decisions (Acquisitions and Options)

BPA will address several goals in acquiring 250 aMW and optioning 250 aMW of generation resources between 1993 and 1995:

- Tap BPA's unique advantage to develop cost-effective resources for its customers, while enhancing the efficiency of the West Coast system as a whole.
- Explore all opportunities for resource acquisitions, including Canadian, California and Southwest sources, preferably before committing to any one source.
- Maintain a commitment to improve the billing credits approach as a workable alternative for BPA's utility customers.
- Pursue an ongoing dialogue with BPA's customers and other interested parties about available acquisition sources.
- Help build a competitive West Coast market for resources and take full advantage of competitive forces to ensure acquisition of the best resources for the region. A major focus will be on acquiring generation resources that are cost-effective and consistent with the Council's plan. Competitive acquisitions minimize system costs (and ultimately rates), provide flexibility in responding to the market, and promote competition among resource providers.

Potential Sources of Generation Resources and Proposed Actions

Additional Billing Credits

- Continue to work with customers to make this a workable acquisition mechanism alternative for customers who wish to develop their own resources.
- Review, evaluate and consider revising BPA's current Billing Credits Policy by

Figure 8-7

GENERATION STRATEGY: Pursue Multiple Sources Encourage Competition Preserve Flexibility

December 1992, based on experience with the current round of billing credits proposals.

- Issue a new Alternative Cost forecast around March 1993 to communicate appropriate price signals to the region.
- Open billing credits to additional proposals around March 1993.
- Evaluate customer interest in billing credits and the amount likely to be developed, based on proposals received, by August 1993.

Intersystem Opportunities¹

- Pursue discussions and negotiations regarding new intersystem opportunities, beginning in the spring of 1992.
- Consider long-term commitments before 1993 only if exceptional opportunities arise.

Resource Contingency Plan Options

- Sign new resource contingency plan options by late 1992.
- Make significant progress on preconstruction work for "new build" option resources by late 1993.
- Consider exercising contingency options in competition with other sources of acquisitions in late 1993.

New Round of Bidding

- Use bidding proposals to double-check market signals.
- Decide in January 1993 whether to solicit new bids for generation resources. Base this decision on evaluation of the current round of bidding, assessment of whether more bidding would reveal more competitive resources, and changes in resource needs.

Canadian Entitlement

- Pursue mutually agreeable arrangements between United States and Canadian parties for disposition of Entitlement power, including arrangements which leave the Entitlement power in the U.S.
- Indicate that Bonneville is also open to making a commitment to agreements before the fall of 1993 that preserve Entitlement capacity in the U.S.
- Postpone a commitment until Fall 1993 to keep Entitlement energy in the U.S., but do not rule out earlier commitments for exceptionally good opportunities.

Canadian Coordination

- Pursue increased system coordination with Canada.
- Adjust BPA acquisition plans as new agreements are negotiated to increase system coordination.
- Current SP Contracts.
- Leave SP contracts in sales mode and acquire resources to support them, rather than recalling or converting them to exchanges.

Unsolicited Proposals

- For resources other than conservation, do not consider unsolicited proposals outside of BPA's established acquisition processes.

Small Resources

- Determine if a targeted small resources project is desirable, based on discussions with interested parties during 1992.

Federal Projects

- Continue to pursue both efficiencies and additional development at Federal projects. Determine by 1993 whether it is likely that

¹Exchanges, sales convertible to exchanges, resources as transmission mitigation and other potential "package" deals.

success can be achieved in reaching agreement with other agencies.

Current Bidding

- Limit acquisitions through the current bidding process to the currently-planned 300 aMW. Consider bid proposals not selected for acquisition for optioning in the Resource Contingency Plan process, if sponsors are interested.
- Complete negotiation of contracts for the current round of bidding by the end of FY 1992, or as soon as possible thereafter.
- Use information resulting from these negotiations about actual costs, risks and reliability of generation resources to design future acquisitions processes.

Renewables

- Renewable resources are targeted in RSEP (see Chapter 9). Acquisition of cost-effective renewables is also included in bidding and the geothermal pilot program.

Targeted Cogeneration/Conservation

- Entertain regionwide discussions through the spring of 1992 on whether BPA should offer an acquisition process to target cogeneration linked to commercial/industrial conservation.

Generation Budget

The cost of the 250 aMW of acquisitions and 250 aMW of options is estimated from the costs of resources proposed in the current competitive bid solicitation, which are very close to generation supply curve estimates. While actions leading to acquisition will occur in FY 1993, 1994 and 1995, expenses will not be incurred by BPA until the resources are on-line. Therefore, FY 1994-95 expenses are expected to increase by \$16 million to cover the cost of new options. Acquisition expenses are not expected to begin until FY

1998. The total expense for the acquisitions and options is roughly \$725 million through 2003.

Options

Options are rights to firm power on short notice. Obviously, the shorter the lead time the more valuable the option. However, the perception of short notice is relative to the source of power. Generally, options involve a contract with a resource developer or provider which allows BPA to purchase the output of a resource under specified terms and conditions. For the Draft 1992 Resource Program, two types of options have been identified:

Preconstruction Options. These are agreements that allow the developer of a generation resource to complete initial steps such as design, siting, lining up a fuel supply and preliminary licensing, but defer actual construction until BPA decides the output is needed and the option is exercised. Preconstruction activities are time-consuming but relatively inexpensive steps. Completing them can shorten lead times by as much as half and reduce some of the risks associated with resource development.

System Contract Options. (1) Existing Contracts. BPA has several power sales contracts with extra-regional (primarily California and Southwest) utilities which give BPA the option to acquire firm energy during winter months and/or exchange summer capacity for firm winter energy. The lead time for acquiring firm energy is between two weeks and one year, depending on which of several contract alternatives is exercised.

New Contracts

Future sales or purchase contracts with option and/or exchange provisions can provide another source of firm energy on very short notice. Lead times for acquiring firm energy depend on individual contract terms, but could be as short as two weeks.

9. OTHER RESOURCE PROGRAM ISSUES

Fuel Choice Policy Development

"Fuel choice" refers to the decision consumers face in deciding what form of energy to use for various purposes. Although the term could apply to other fuel choices and uses, this discussion deals mainly with the choice between electricity and natural gas for use in residential space and water heating. The term "fuel switching" is also used when discussing the substitution of gas for electricity in existing residences.

Over the past several months, BPA conducted technical analyses and a public process to develop a policy with respect to BPA's role in influencing consumer fuel choice and fuel switching. This effort was initiated for several reasons:

- BPA is currently acquiring conservation and generating resources to meet the actual and projected electricity requirements of BPA customers. Some new resources under consideration may be fueled by natural gas.
- For some end uses in some areas, it appears that natural gas may be both less expensive and more efficient than using electricity produced with gas-fired generators.
- Current BPA policies, programs and rate structures may indirectly influence the choice between natural gas and electricity in the marketplace.
- BPA currently does not have a policy defining its role with respect to current and potential actions influencing consumer fuel choice.

Although relatively limited in scope, this process coincides with the Council's efforts to improve the region's ability to take account of natural gas in power planning. "The Council recognizes that natural gas plays a vital role in power planning,

both because it is used to produce electricity, and because, in many instances, gas and electricity are close substitutes. The Council will initiate the formation of a gas policy group, including gas distribution companies, pipeline suppliers, and other interested entities to determine how best to integrate natural gas planning into regional power planning."¹

The process also follows from BPA's "Global Warming Study," published in the 1990 Resource Program. In that study, several alternatives for reducing BPA's potential contribution to global warming were assessed. One alternative that seemed to offer both economic and environmental benefits was the substitution of natural gas for electric water heating. That analysis, however, was designed to screen options for reducing emissions of greenhouse gases regionally. It did not include a detailed analysis of energy markets, current and projected fuel choice, or fuel switching patterns. The assessment of technical potential was limited to water heat; it did not include space heat or other end uses. As a screening analysis, the Global Warming Study was not intended to support specific policy or program proposals.

Fuel switching was required for two recent BPA environmental impact statements as a potential component of future BPA load management strategies. In 1990 and 1991 an initial fuel switching analysis was conducted in the Puget Sound area by BPA and Puget Sound area utilities to determine whether fuel switching should be part of a strategy to manage area peak electricity loads. Rapid growth in that area has put pressure on the ability of the transmission system to meet severe winter peak loads reliably.

¹ 1991 Northwest Power Plan, Volume II, Ch. 1, p. 25.

Several alternative strategies to solve the problem are being considered. Although there was some interest in pursuing programmatic fuel switching, it is not a component of the preferred strategy in the draft Puget Sound Area Electric Reliability Plan Environmental Impact Statement which was issued for public review and comment on October 17, 1991.

BPA also considered fuel switching as an alternative to meet high load growth in the draft Resource Programs Environmental Impact Statement which is currently available for public review and comment. This analysis assumes that an aggressive fuel switching effort is pursued and assesses resulting costs and environmental effects. These assumptions should not be viewed as an indication of BPA's policy direction.

Process Objectives

The process involved in preparing the Draft 1992 Resource Program had several objectives:

- To provide opportunities for broad regional participation in discussion and consideration of fuel choice issues.
- To identify technical, institutional and environmental issues surrounding consumer fuel choice and end use fuel switching.
- To develop, refine and test an analytical framework for addressing technical, institutional and environmental issues.
- To provide a comprehensive background and context for regional fuel choice policy discussions.
- To present preliminary findings and conclusions for public review and comment.
- To propose a BPA policy direction for public review and comment.

Concurrent with the initiation of technical studies, BPA conducted a two-phase public involvement process.

Fuel Choice Consultation Group. BPA met first with public utility managers to understand bet-

ter how energy markets were operating and expected to operate in their service territories. Through this consultation BPA developed a better understanding of how fuel switching affects the business interests of its utility customers. The managers also worked with BPA to help identify policy and analytical considerations that BPA's customers view as key elements of a BPA fuel choice policy. These customer considerations, outlined in the following section, formed the basis for BPA's policy formulation.

Technical Work Group. Second, BPA convened a technical work group representing BPA customers and other interested parties to review BPA's analytical methods, key assumptions, data, and preliminary findings and conclusions. The technical work group also served as a forum for sharing the results of work done by others.

Public Comment Period. Public involvement is now entering its third phase as BPA seeks public comment on its analysis, findings and conclusions, and draft policy. To submit written comments, please refer to Chapter 1.

Customer Considerations. A major accomplishment of the Fuel Choice Consultation Group was the development of a list of "customer considerations" that reflect the concerns of BPA's public utility customers. Customers represented in the group had a wealth of knowledge and varied experience to offer. Some were encountering rapid load growth; others were expecting little or no growth. In some service areas there is no natural gas available; in others gas is a direct competitor; in still others gas is seen as a viable alternative to ease the pressure of rapid electricity load growth. One public utility customer sells both gas and electricity; another expects to enter the gas business soon.

With these diverse perspectives, the utility managers had varying opinions concerning BPA's role. Some strongly oppose any intentional action by BPA to influence fuel choice. They maintain that the existing market is adequate to induce consumers to make appropriate fuel choices. Any

action by BPA to change its current programs or practices would be viewed by these managers as market interference, and therefore undesirable.

Most of the managers agree that market allocation of energy services does promote greater efficiency. However, some managers disagree that the status quo represents an efficient market. These managers argue that current policies, programs and rate structures in both the natural gas and electricity industries have distorted the market in some areas. They allow for the possibility that some action by BPA might serve to improve the operation of the market.

The Fuel Choice Consultation Group agreed that any BPA policies or programs that influence consumer fuel choice should address the following key considerations:

Utility Choice. Voluntary participation, flexibility and responsiveness to local situations are desirable qualities of a BPA policy or program. Utility choice should be valued in policy development.

Consumer Choice. Uncertainty over what is in the best interest of consumers over the long term should be acknowledged. In general, efficient market allocation of energy services should be encouraged, and consumer choice should be preserved.

Public Agency Roles. The unique relationship between public utilities and their customers should be recognized, taking into account the legal authorities of both BPA and its customers, including any potential liability issues.

Intraregional Equity. Issues of equity among customers and inequitable local impacts should be examined. Both regional benefits and distribution of benefits should be evaluated, and equitable sharing of costs should be considered.

Gas Industry Policy. Differences between the electric and natural gas industries should be recognized, including obligation to serve, incentive for conservation and rate design. The degree of uncertainty over gas supply and price should be assessed. The potential for subsidization of gas

consumers and gas company stockholders should be recognized.

In addition to issues of philosophy and policy, numerous unanswered technical questions arose during the consultation process. These were assembled into a list of "analytical considerations." Although some managers continue to believe that BPA should not study the issue of fuel choice, most agreed that more information needs to be developed. The following analytical questions were raised by members of the Consultation Group.

- How much fuel switching potential is there? How much will occur due to market forces alone?
- Will gas be available over the long term? What if it isn't?
- Will gas prices be volatile? What if they are?
- How would any benefits be distributed? Would benefits be reliable? Would they persist over time?
- Could the results of a BPA program be measured? How would program results be separated from market effects? How would the issue of "free riders" be addressed?
- How will electricity rates and revenue be affected?
- How do environmental effects, including greenhouse emissions, compare to alternative actions?

The first issue was the subject of BPA's initial technical analysis. A detailed description of this analysis follows. The issues of gas price and availability were discussed with the Consultation Group. BPA presented a preliminary analysis of these issues which is available on request. The last four questions were also discussed, but largely deferred as programmatic issues that are beyond the scope of this analysis.

Interim BPA Position Statement

In July, based on preliminary technical analyses and the results of the consultation process, BPA adopted the following interim position statement:

- For some electricity end uses, and under some conditions, direct use of natural gas is both less expensive for the consumer and more efficient than using electricity generated with fossil fueled resources.
- The market will deliver some cost-effective fuel switching without action by BPA.
- Over the next 20 years, approximately 400 aMW of cost effective regional fuel switching potential will not occur due to market forces alone. About 200 aMW of this potential is in the service areas of BPA's public utility customers. This potential is not large and accrues gradually over 20 years.
- In the 1992 Resource Program BPA's primary focus will be directed toward implementing the Council action plan which includes acquiring more than 600 aMW of conservation over the next ten years.
- BPA will continue to investigate the potential for meeting future loads by influencing consumer end use fuel choice. Although no regional program is proposed, selected pilot projects to gather additional information and test alternative approaches may be considered.

This position formed the starting point for additional technical analysis and discussions with the Technical Work Group. The following is a description of the technical analysis.

Analysis of Fuel Switching Potential

Cost Effectiveness. From the perspective of the electric power system, fuel switching behaves like conservation. Both result in electricity load reductions. Conservation, as the term is used here, means accomplishing the same task with less electricity. The consumer is, by definition, no

worse off with conservation because the level of end use service is the same but less electricity is used. If the conservation measure is cost-effective, the total cost of providing the end use service (e.g., heating or lighting) is less than it otherwise would have been.

Although fuel switching does not appear to qualify as a conservation resource under the Northwest Power Act, it may be a potential load management tool for BPA. Fuel switching (away from electricity) always results in less electricity use, but does not necessarily result in less energy use because the amount of energy used depends on the characteristics of the fuels used to meet the end use. Fuel switching, like conservation, is cost-effective if it results in end uses being met at a lower total cost. This means that the region's total costs of meeting the end use after fuel switching must be compared to the total costs of meeting the end use without fuel switching. Regional total costs include utility costs (gas and electric) and environmental costs.

Scope of Technical Analysis. The analytical work was narrowly defined for this process. It was not designed to analyze specific fuel switching implementation strategies, only to determine whether it would be worthwhile for BPA to devote further study to fuel switching policy development.

Additional study would be worthwhile only if there were evidence that fuel switching would be cost-effective for society and BPA, and would not occur from current market forces alone, or that it would be cost-effective to accelerate fuel switching. If opportunities exist in sufficient magnitude to justify further study, then policy development should be pursued. Several policy issues concerning BPA's role in encouraging fuel switching would need to be resolved before it would be appropriate to proceed with an analysis of implementation strategies.

Analytical Overview. The first step in the fuel switching analysis was to separate households into relatively homogeneous categories. In each such market segment the total cost of switching a single household — the capital costs of conver-

sion from electricity to gas plus the operating costs of the gas equipment — were compared to BPA's marginal cost of electric power. If the total costs of switching are less than BPA's marginal cost, then it might be cost-effective for society to switch the equipment. An estimate of the number of households which might be converted was multiplied by the forecast of annual electric energy consumed for the affected end uses to derive an estimate of the total electricity load that might be affected by a fuel switching policy.

Market Segments. Certain types of buildings were screened out of the scoping analysis: classes of buildings where the data quality was not sufficient to permit reasonable confidence in the analysis, those where initial analysis indicated fuel switching would be prohibitively expensive, and those where fuel switching would be likely to occur from market forces alone. The following is an explanation of the screening factors applied.

Industrial and commercial sectors were excluded. Only residential sector fuel switching was analyzed. Commercial and industrial fuel choice is specific to site, equipment and process. Complex economic and engineering issues and data inadequacy makes these segments difficult to analyze. The residential sector is believed to provide the most immediate and probable fuel switching potential.

Within the residential sector, only single family and manufactured housing were included. Multifamily housing is excluded. Multifamily fuel switching is believed to be less likely to occur because of high capital costs and low annual fuel use per unit. Operating cost savings are relatively unimportant to owners.

Existing residences that currently have gas space heat and electric water heat were excluded from water heat switching estimates. This is based on the assumption that these residences are likely to switch under current market conditions. In addition, this category presents a potential "free rider" problem. Under a programmatic

approach, utilities might pay for switching that would have occurred without additional incentive.

Several parties encouraged BPA to include this market segment. They believe some very inexpensive savings may exist here, and concern about free riders should not override the potential savings. BPA may include this segment in future analyses to improve information on market induced fuel switching.

New residences within a quarter mile of a gas main were excluded. This reflects the assumption that these residences are likely to choose gas under current market conditions. Current gas penetration in such residences is approaching 100%; those choosing electricity may not be open to gas.

Only residences with central forced air electric heat are included for space heat switching; houses with zonal and baseboard heat are excluded. Switching zonal and baseboard heat to natural gas would be expensive and disruptive due to extensive ducting requirements. These consumers would be less likely to consider fuel switching.

From the remaining housing stock not excluded, market segments were developed by separating the stock by housing type (single family or manufactured housing), housing vintage (new units built in 1992 or later and existing units built before 1992), the type of equipment switched (space and water heater or water heater only), and gas availability. Households are grouped by gas availability depending on the requirements of connecting the household to natural gas service. The four categories of gas availability are: (1) households already receiving natural gas; (2) households not receiving gas, but requiring only a service drop (also defined as within a quarter mile of a gas main); (3) households requiring both a main extension and service drop; and (4) households requiring more than a main extension or requiring significant distribution system expansion.

Table 9-1. Residential Fuel Choice Market Segments

Housing Type	Housing Vintage	Gas Availability	Electric Equipment [1]
Single Family	Existing	Service Drop	CFA + Water
Single Family	Existing	Main Extension	CFA + Water
Manufactured Homes	Existing	Service Drop	CFA + Water
Manufactured Homes	Existing	Main Extension	CFA + Water
Single Family	New	Main Extension	Space + Water
Manufactured Homes	New	Main Extension	Space + Water
Single Family + Manufactured	Existing	Service Drop	Water Only
Single Family + Manufactured	Existing	Main Extension	Water Only

[1] CFA = central forced air furnace; Water = water heater.

The above assumptions yield market segments shown in Table 9-1.

Cost Calculations

Capital Costs. Capital costs fall into three categories; equipment, administrative and gas hookup. Equipment costs include space and/or water heating equipment, flues, venting, piping and any required code improvements. Administrative costs were included to account for expected but unspecified costs for design, implementation and oversight of a fuel switching policy. These costs were set equal to 20% of equipment costs, which is roughly equivalent to BPA's experience with conservation programs. Gas hookup costs are the costs of gas service drop and/or main extension, metering equipment and installation.

In existing homes, the capital equipment cost of water heat conversion was only the difference between the price of gas and electric equipment. The analysis assumed that the water heater was near the end of its useful life and would be replaced in the near future as a matter of course. The full capital cost of gas space heat was counted as a necessary cost for existing homes.

For new homes, the capital equipment cost assumed for both space and water heat was the difference between gas and electric equipment. For this analysis it was assumed that the equipment is not yet installed and the relevant cost is

only the extra cost of choosing new gas equipment compared to new electric equipment, not the cost of providing water and space heat.

Capital costs were converted to life-cycle cost using a 3% discount rate for the real time value of money. The expected useful life of water heating measures was estimated to be 13 years; space heating equipment was estimated to last 23 years. Administrative cost, hookup charges, ductwork and other equipment were spread over 50 years.

Life cycle costs were calculated according to the following formula:

$$LC = CC ((i((1+i)^n))/(((1+i)^n)-1))$$

where LC = life cycle cost; CC = capital cost; i = time value of money; and n = lifetime of capital in years.

Operating Costs. Operating costs were calculated by multiplying annual energy consumption by the applicable unit price or rate. Gas consumption was calculated by dividing electricity consumption in kWh by the relative efficiency of gas to electric equipment. This value was then multiplied by the factor to convert kWh to British thermal units (Btu). For water heat, the efficiency of gas relative to electric equipment was assumed to be 0.58 (0.53/0.91). For central forced air space heat the relative efficiency was assumed to be 0.84 (0.78/0.93).

The applicable rate is society's avoided cost of gas. Two gas rates were used in order to test results for sensitivity to gas price fluctuations.

First, BPA's forecast of the city gate (wholesale) gas price was used as a proxy for natural gas avoided cost. The second was similar to the Northwest Natural Gas (NNG) avoided cost used in a fuel switching study by the Oregon Department of Energy (ODOE). That estimate averaged 57% higher than the city gate price. The specific NNG cost contained discrete investments and timing peculiar to NNG not applicable to other regional gas companies. A simple adder of 57% on the city gate price was used as the higher cost test for gas prices. ODOE staff have characterized this as a reasonable Medium High rate.

Operating costs were computed annually for 20 years. Costs were discounted at a 3% real rate to account for society's time value of money. The levelized operating cost is the average discounted value over the 20 years.

Potential Load. The number of households by housing type, vintage and electric equipment was taken from the Medium load forecast published in the final 1991 Northwest Power Plan. The number of households in each market segment was multiplied by the gas availability ratio to determine the total number of households in each market segment. Gas availability ratios were based on an analysis of county population and gas service areas plus data gathered from several gas and electric utilities and the Association of Northwest Gas Utilities.

The total number of households was multiplied by an estimated participation rate to determine the number of participating households in each market segment. The number of participating households multiplied by the annual energy consumption for the affected end uses yields the total load potential for fuel switching. The annual energy use for the affected end uses is consistent with the final Council forecast. The participation rate varies by market segment and shows penetration ramping up over time. The participation rates were based on an earlier fuel switching analysis for the Puget Sound Electric Reliability Plan. These rates were based on the professional judgment of conservation staff at Puget Sound utilities.

The rates were not drawn from a technical analysis and are not tied to any specific program design.

Results. The results are summarized in Table 9-2. For each market segment the number of households and the annual end use kWh are shown in the first two columns, respectively. The third column shows the product of these two, the total load estimated as fuel switching potential in the year 2010. The total regional potential is 385 aMW in 2010. This total includes some homes that would switch due to market forces alone. However, by screening out existing homes having gas space heat and electric water heat and all new homes built within a quarter mile of gas mains, a large portion of homes which would switch due to market forces alone were ruled out. The screened out market segments may also contain some homes which will not switch due to market forces alone.

The fourth column of Table 9-2 shows the levelized social capital cost per household. The remaining columns show the social operating cost and the total social cost under the two gas price scenarios. The results show that, even under the high gas price assumption, the large majority of fuel switching potential is less than BPA's marginal cost of approximately 33 mills/kWh in 2010 (1990\$).

Conclusions. The results indicate a strong probability that some fuel switching may cost less to the region than BPA's marginal cost. More study is needed to determine the amount of market-induced fuel switching that will occur due to market forces. When better data is available it will be feasible to include some of the market segments that were screened out. Further analysis is also needed to test sensitivities.

Policy Implications

Two major insights for policy development can be drawn from the scoping analysis.

The technical analysis does confirm that there is potential for regionally cost-effective fuel

Table 9-2. Regional Fuel Switching Supply (2010)

Market Segment	Participating Households (Thousands)	Annual kWh per Household	Total Annual aMW	Levelized Capital Cost (\$/HH/year)	City Gate Operating Price			ODOE Operating Price		
					Levelized Op Cost (\$/HH/yr)	Levelized Total Cost (\$/HH/yr)	Levelized Total Cost (mills/kWh)	Levelized Op Cost (\$/HH/yr)	Levelized Total Cost (\$/HH/yr)	Levelized Total Cost (mills/kWh)
Ex SF/CFA + WH/SD	49.84	15262	87	142	156	298	20	245	387	25
Ex SF/CFA + WM/ME	38.21	15262	67	177	156	333	22	245	422	28
Ex MH/CFA + WH/SD	30.50	15559	54	135	159	294	19	250	385	25
Ex MH/CFA + WM/ME	23.38	15559	42	170	159	329	21	250	420	27
New SF/CFA + WM/ME	7.49	11345	10	97	118	215	19	185	282	25
New MH/CFA + WM/ME	10.77	18392	23	96	184	280	15	289	385	21
Ex SF + MW/WH Only/SD	159.46	3783	69	33	51	84	22	80	113	30
Ex SF + MW/WH Only/ME	79.73	3783	34	68	51	119	31	80	148	39
Total	399.37		385							

Ex = Existing House (built before 1992)

New = New House (built 1992 or later)

SF = Single Family

MH = Manufactured Housing

CFA = Central Forced Air

WH = Water Heat

SD = Service Drop

ME = Main Extension

switching beyond that expected to occur as a result of current market forces. The amount may be substantial over the 20-year planning horizon; however, only a small portion of this potential could be considered a "lost opportunity" if not captured in the near term. The analysis did not address whether actions by BPA or its utility customers could be effective in capturing potential benefits through programmatic fuel switching.

These two insights lead to the conclusion that there is no immediate need or justification for BPA to pursue fuel switching aggressively. BPA should continue to monitor market-induced fuel switching and improve its characterization of fuel choice and fuel switching in load forecasts.

Proposed Fuel Choice Policy

These statements of principle, taken together, express BPA's proposed policy:

Integrated Energy Planning. BPA believes it is in the best interest of the Northwest region to move in a deliberate, measured way toward integrated least cost energy planning. This would include expanding electric utility planning to include consideration of consumer end use fuel choice as well as fossil fuel generation alternatives. BPA is committed to moving with the region in this direction.

Market Allocation of Resources. BPA supports the efficient allocation of energy resources through market mechanisms and informed consumer choice.

Implementation Guidelines

- BPA does not propose to embark on any programs or other actions to encourage fuel switching. BPA does not intend to offer a fuel switching program or to participate in fuel switching programs initiated by others.
- BPA will continue to refine its characterization of fuel choice and fuel switching in load forecasts.
- Toward this end, BPA will review its existing policies, regulations, procedures and program incentives to assess their effects on fuel choice.

Resource Programs Environmental Impact Statement

In order to comply with the National Environmental Policy Act (NEPA) in its resource planning activities, BPA is in the process of completing the Resource Programs Environmental Impact Statement (RPEIS). The RPEIS focuses on the environmental tradeoffs among the various resources BPA might develop — including conservation, renewables, combined cycle combustion turbines, nuclear, coal, etc. — and the environmental impacts of adding these resources to BPA's existing system. The draft RPEIS is scheduled to be released for public review in January 1992.

Although supplements may be necessary in the future, the RPEIS analysis is intended to be broad enough to support several Resource Programs. In 1992, BPA plans to begin using the RPEIS, along with the results of additional analyses, to prepare Records of Decision supporting the Resource Programs. Following identification of the actions proposed by BPA in each Resource Program, specific resource acquisitions will be proposed. Separate site-specific environmental documents will be prepared to evaluate their impacts. The RPEIS will be used in each site-specific environmental document to compare the environmental effects of the proposed resource to those of all other resource categories.

Although costs are analyzed in the RPEIS, resource costs are expected to change significantly over time. Changes among the relative costs of resources will be incorporated and analyzed in each Resource Program. Subsequently, in addition to the site-specific environmental documents, economic analyses will also be pre-

pared to assess cost effectiveness at the time of the specific resource acquisition.

The RPEIS includes discussion and modeling of both potential environmental effects and possible mitigation measures for each of the following resource types: conservation, generation efficiency improvements, transmission efficiency improvements, cogeneration, geothermal, hydro-power, solar, wind, coal (including conventional coal and clean coal technologies), combustion turbines, fuel switching, nuclear and imports. Other sources of energy, such as new and emerging technologies which might become commercially available within the planning horizon, and various types of load management, are described and discussed but not modeled.

Thirteen alternative mixes of these resources were developed to represent the range of actions BPA could take to meet its load obligations. The resource actions proposed in future Resource Programs are expected to fall within this range. Each alternative mix examined allows BPA to meet projected load growth under the High load forecast, or an equivalent need for resources caused by the combination of load growth and possible loss of existing resources. Analysis of the High load forecast enabled examination of the maximum environmental impacts to insure that the potential effects of acquiring resources would be covered.

Analysis so far indicates that BPA's preferred alternatives in the draft RPEIS will be the Conservation Alternative, which places all of the conservation available within BPA's standard supply estimates at the top of the resource stack and is thus given preference over other resources. Under this alternative, system and environmental costs are low, as compared to the Base Case. Environmental impacts from conservation are minimal. Based on the RPEIS analysis, this alternative is clearly superior to those that emphasize generation resources.

The majority of new acquisitions proposed in the 1992 Resource Program are conservation resources, with generating resources filling BPA's

remaining needs. Thus, the draft RPEIS analysis, with the preferred alternative emphasizing conservation, supports the recommendations of the Draft 1992 Resource Program.

Resource Actions in the Puget Sound Area To Mitigate Peak Load Problems

The Puget Sound region's increasing power demands have strained BPA's cross-Cascade transmission system to its limits. During winter cold spells, over 70% of the area's power is supplied by generation east of the Cascades. Had a critical contingency occurred during the extreme cold snaps of February 1989 and December 1990, a condition known as voltage collapse might have occurred.

BPA and Puget Sound region utilities have been working together since early 1990 on the Puget Sound Area Electric Reliability Plan (PSAERP), looking at a wide range of transmission and non-transmission solutions to the growing reliability problem. The plan was developed jointly by BPA, Seattle City Light, Tacoma Public Utilities, Puget Power and Snohomish PUD.

The PSAERP Plan weighs the environmental, economic and technical tradeoffs of possible solutions. Transmission fixes, conservation, load management, local generation and curtailment were all examined as solutions to at least part of Puget Sound's need for winter peak capacity. The amount of capacity needed depends on Puget Sound's load growth. Solutions were constructed to meet Medium load growth needs of 1600 MW by 2003, with contingencies for higher loads or other changes to deficit conditions.

The preferred plan that emerged relies heavily on transmission voltage support. It also includes the acceleration of three existing conservation programs and the addition of a fourth. The three accelerated programs are the Residential Weatherization Program, the Energy Savings Plan (E\$P)

program for industrial conservation, and the commercial retrofit program. The new effort will be an efficient showerhead program.

Although the amount is highly uncertain, by 2003 BPA and the utilities are likely to locate additional resources in the Puget Sound to meet energy needs. The PSAERP includes an estimated 400 MW (peak) of Puget Sound Area energy resources beyond the commitments by BPA and the utilities at the time of the study. This estimate was based on tentative information within BPA and the least cost plans of the Puget Sound utilities.

Should fewer resources locate in Puget Sound than expected, or if growth exceeds expectations, the preferred plan could run out of capacity as early as the year 2000. The plan therefore includes two contingency measures: a cross-Cascade transmission line and combustion turbines.

A lead time of seven to eight has been assumed for the transmission line. For the line to be available in the year 2000, utilities will need to start the environmental analysis, preliminary planning and design work in late 1992 or early 1993. A decision to build would not be necessary until 1996, and if the line is unnecessary it could be deferred at that time. Combustion turbines could also provide a short lead time option to respond to sudden increases in the peak power deficit.

The plan will be regularly reviewed and updated to account for changing conditions. (For more information see the PSAERP Draft Environmental Impact Statement.)

The PSAERP and its Resource Program implications are discussed below.

The PSAERP calls for accelerated conservation programs which are included in the 1992 Resource Program. The PSAERP establishes annual program targets which are higher than those described in the 1990 Resource Program and would achieve peak load reductions and energy savings sooner.

In effect, the Conservation Implementation Plan (see Chapter 8), which outlines a more aggressive strategy for BPA to acquire conservation resources, proposes on a regional level what the PSAERP determined for the Puget Sound Area. Thus, the PSAERP conservation targets become a subset of the proposed acquisitions under the CIP.

An implementation team in the Puget Sound Area Office is developing revised budgets and savings targets for the PSAERP conservation efforts for FY 1992 and FY 1993, which will again be incorporated into the regional targets.

In early stages of the PSAERP process, adding more generation resources was considered as a potential solution to meeting peak loads. However the analysis indicated that although adding energy resources would help solve the peak problem, peaking needs alone would not be enough to justify energy acquisitions. An estimate of 400 megawatts of new resources was included, since energy planning by the utilities would lessen the capacity needs of the Puget Sound Area. Puget area resources BPA acquires through the current bidding program are a part of the 400 megawatt estimate. Since the location is not known until contracts are awarded, the megawatts available to the Puget Sound Area are uncertain.

Acquisitions through the billing credits and bidding mechanisms give an additional increment of value to resources located west of the Cascades, since this location contributes to system reliability and helps delay the need for more cross-mountain capacity. This incremental benefit is intended to encourage developers to consider the system effects of new resource location as west-side capacity needs grow.

DSI Load Uncertainty Beyond 2001

As the year 2001 approaches and BPA is faced with larger resource decisions, DSI load uncertainty is likely to play a bigger role in future

Resource Programs. As in 1990, the assumption for most of the 1992 Resource Program analysis was that the DSIs would continue to receive the same type of service after their contracts expire in 2001 as they receive now.

Changes in the type of service or rates after 2001 could change the level of DSI load served by BPA. Since this uncertainty is not yet resolved, BPA analyzed whether the Resource Program proposal would still make sense assuming a decrease of about 25% of the DSI load starting in 2002. The results indicated that the Resource Program remains a good choice — resource actions in the proposed program remain economic even if a part of the DSI load is assumed to leave BPA's system.

Resource Supply Expansion Program (RSEP)

Background

The Council has called on the region's utilities to acquire over 1,500 aMW of conservation from already identified sources by the year 2000; BPA is expected to acquire over 600 aMW of that amount. However, under some foreseeable conditions the region's future needs will exceed the presently identified conservation resource. These needs may increase further as the generation availability of existing resources is reduced due to a variety of factors.

The Council and BPA have established goals and objectives to address the choices for additional power resources. The Council stated that confirming additional conservation and renewable resources is one of four primary objectives of its recently released 1991 Northwest Power Plan. Last year Bonneville's Office of Energy Resources established a similar goal, with a target of confirming an additional 1,500 aMW of resources by 1995. The Resource Supply Expansion Project (RSEP) is one important means toward those

ends. RSEP is a new collaborative process among electric utilities and other interested parties, aimed at demonstration projects with a specific purpose: resource confirmation.

The region has an unknown but undoubtedly large potential for additional energy resources from emerging generation and conservation technologies. However, BPA and other utilities in the region lack operating experience with and confidence in the reliability and deliverability of many innovative technologies. New conservation and renewable resource technologies are always in the pipeline, passing through basic research and development stages. But it is a big step from basic R&D to market acceptance. Examples of technologies that are technically available but are relatively untested in the Northwest include: efficient lighting in both residential and commercial sectors, efficient motors in the industrial sector, and geothermal generation. (BPA has already initiated a process to confirm geothermal resources in the region.)

RSEP is being developed to confirm the performance, reliability and market acceptance of conservation and renewable generating resources that may prove to be beneficial to the region. RSEP is one response to the growing need for "proven," cost-effective, environmentally benign energy resources in the Pacific Northwest and the nation.

RSEP has sub-goals related to the efficiency of resource confirmation and transferability of findings. Many entities have an interest in renewable resource confirmation. These include the U.S. Department of Energy (DOE) Office of Conservation and Renewable Energy, other utilities both inside and outside the region, industry trade groups, public interest groups, DOE laboratories, and State and local governments.

RSEP is promoting the efficient work of these various interests toward their complementary resource confirmation objectives. The creation of an environment conducive to developing promising new technologies among the region's utilities will provide significant opportunities to leverage

resources and accelerate commercial development.

DOE has expressed a strong interest in RSEP. BPA has submitted a proposal to them for collaboration, including financial participation. The RSEP team has responded to DOE's questions about the program and anticipates their participation in the early stages of the program. Part of DOE's interest is in transferability of the collaborative process and findings to other parts of the country.

Resource Confirmation

Resource confirmation means the movement of efficiency and renewable resource technologies to the point where they are ready for acquisition by utilities. This means demonstrating that the technologies are cost-effective, reliable and available. This includes identifying how market, institutional, technical and other barriers can be removed or reduced to ensure that the resource can be acquired by the utility. The principal resource confirmation activity of RSEP is the demonstration project.

How RSEP Will Work

One vision of RSEP is the "entrepreneurial" model: a diverse set of organizations with complementary interests in resource confirmation would agree to collaborate on demonstration projects. Many of them would agree that by pooling their financial resources they can leverage their own investments. They also would recognize that collaboration requires relinquishing some control of the overall process.

The process would involve soliciting proposed confirmation/demonstration projects from a variety of sources. Participants in the process would be encouraged to seek support and interest (including financial involvement and project management) from one another, building a coalition of interest around each project concept. Ultimately, projects would be implemented because of these shared interests, not because they appear on any

particular list. Projects would be developed in utility environments with active utility involvement. They would be objectively monitored, evaluated and documented, with information made available widely.

The RSEP process will work on an annual cycle, starting with relatively few projects in 1992, peaking in about 1995, and holding steady thereafter.

RSEP Phases

Figure 9-1 illustrates the four distinct phases for the RSEP project.

Phase I: Planning/Preparation. This phase focuses on the clarification of roles and responsibilities of the participants, identification of project selection criteria, and the development of process and implementation details.

Phase II: Quick-Start Projects. This phase is intended to provide rapid identification of projects which have the potential for collaborative effort and can be initiated in FY 1992. Utilities will develop the first list of projects. Other entities will be consulted for implementation of these projects.

Phase III: Full Operation. Projects initiated during this phase will be developed systematically. Demonstration of second generation technologies with more thorough research design than Phase II projects is expected. Full DOE participation is expected during this phase.

Phase IV: Full Operation/Transition to the Region. This phase will continue the project demonstrations as in Phase III. DOE will begin to phase out of the process.

BPA's participation and cost share is expected to come from existing Energy Resources RD&D budgets.

RSEP Issues

Control By Financial Contributors Over Project Selection. Those funding RSEP may seek veto power over projects that are selected

Figure 9-1. Resource Supply Expansion Program (RSEP)

for demonstration, given their financial involvement. BPA must seek to strike a balance between being responsible stewards for its financial resources and being a reliable partner in a broad, collaborative relationship. This means defining a role between having a strong veto and reducing control over project decisions for the sake of building a stronger partnership.

Public Utilities vs. IOUs. Most of the early resource acquisition in the region, particularly that of renewable resources, may fall to the IOUs. What amount of cost sharing is appropriate? BPA's interest is in having an appropriate balance of investment in from the various parties: DOE, BPA/publics and the IOUs.

Some in the Federal government view BPA dollars as Federal dollars, not as the region's or ratepayers' dollars. OMB, in particular, is expected to note that the combination of BPA and DOE dollars is too high relative to "other" dollars in the RSEP proposal.

Council Role. BPA has consulted with the Council starting with the preparation of the initial RSEP proposal to DOE. The Council provided a letter of support to accompany the proposal.

The Council is expected to be a collaborator in RSEP. Their role will be commensurate with that of a planning organization and not an implementer. That is, the Council itself will not serve as the coordinator or leader of RSEP.

The Council's 1991 Northwest Power Plan includes a confirmation agenda for renewable resources. That agenda will be the basis for RSEP's first discussions of renewable confirmation projects.

National Environmental Policy Act (NEPA). It is not yet known precisely what technologies will be demonstrated in RSEP, other than a general focus on conservation and renewable resource technologies. However, at a general level, RSEP can be incorporated into the Resource Program EIS. As specific actions are identified, they will be subject to project-specific NEPA assessments.

Public Involvement. RSEP is based on broad collaboration, involving interests both inside and outside the region. A public involvement plan is in preparation.

State and Interest Group Roles. There is widespread interest in RSEP because of the effect it may have on power planning and resource acquisition programs. The roles for these entities have not yet been determined, but will be addressed as the collaborative process unfolds. We expect that some of these organizations will also seek strong decision-making roles.

Tiered Rates

There has been growing interest by some BPA customers in reconsidering BPA's Priority Firm (PF) rate design and its role in least cost resource development. In the Action Plan for the 1991 Northwest Power Plan, the Council recommends that BPA consider a "multilevel priority firm rate" for the 1993 Rate Case if it appeared that billing credits and other approaches would not be successful in achieving the Plan's conservation goals.

In preparing for the 1993 rate case, BPA is convening a series of Rate Issue Workshops which will include consideration of tiered rates. The objective of these workshops is to provide a forum for regional interests to discuss and potentially resolve rate-related issues before the beginning of the formal 1993 rate case. The Tiered Rates Workgroup was convened to address whether BPA's PF rate design needs modification or replacement given the current electric utility business environment, what challenges motivate the interest in such rate design changes, and what alternatives exist (including tiered rate designs).

The final 1992 Resource Program will incorporate the results of the Tiered Rates Workgroup because of the important linkage between BPA's wholesale pricing, customer avoided costs and resource acquisition decisions. This connection is even more important today, in the context of

BPA's commitment to an aggressive conservation strategy and transition toward decentralized approaches to conservation resource development.

The Rate Issue Workshops will be the public forum for discussing the tiered rate issue. All those interested are encouraged to attend the workshops. Workshop progress reports will be provided to the Resource Program Technical Review Panel.

WNP-1 and WNP-3

In April 1991, the Council released its 1991 Northwest Power Plan, which included an objective to determine the cost and availability of resources in the region in the next 20 years including, among others, WPPSS Nuclear Projects (WNP) 1 and 3. The Council recommended that BPA and the Washington Public Power Supply System (WPPSS) resolve outstanding issues so that the Council can make an informed judgment in the next Northwest Power Plan (1994-1996) whether to continue preserving the projects, to construct either of the projects if needed, or to terminate them if appropriate.

In response to the Council's recommendation, the Supply System and BPA agreed to review the viability of the projects. Three initial areas were identified as having potential significant impact on the viability of the projects: institutional issues, the National Environmental Policy Act (NEPA) process, critical path analysis.

The institutional issues include potential litigation that may affect the Supply System's ability to finance completion of the projects. Some utilities which are project participants have alleged that the projects have been legally terminated, and under existing net billing agreements would not be obligated for the repayment of bonds sold to finance completion of the projects. While BPA's General Counsel, the Supply System's Chief Counsel and the Bond Counsel to the Supply System agree that neither the projects nor the net

billing agreements have been terminated, there remains potential for lawsuits on this issue. BPA and the Supply System have agreed to identify develop alternatives for resolution of this issue.

BPA has taken the lead in addressing the NEPA process issue by hiring a consultant to conduct an independent review of NEPA requirements. The purpose is to determine what unresolved or new issues, regulations, or additional tasks or studies would be needed for any future site-specific environmental compliance actions. Further, the study will determine whether the NEPA process can be accommodated in a six-year completion schedule from the earliest possible decision on need (July 1993).

The Supply System has issued a task order for its contractors to develop a critical path analysis for a six-year completion schedule for the projects. It is believed that this is the most effective approach to assuring that the projects can be completed in a time frame competitive with other resources in the resource stack, and to identify other potentially significant obstacles to completion.

10-Year Financial Plan

The 10-Year Financial Plan is being developed to achieve a mutual understanding between BPA and its customers on how best to position the agency financially. This process will provide an opportunity for input on identifying financial issues and their impact over the next decade. With customer participation and input from other planning processes, the Administrator will make final financial planning proposals at the completion of the process in September 1992.

Alternative solutions to address the financial issues faced by BPA will be identified and evaluated. There will be an opportunity to discuss the costs and benefits of BPA's long-term financial goals. The 10-Year Financial Plan will incorporate analysis from other long-term planning processes

such as the OM&R Plan, the Transmission Plan and the Resource Program.

Opportunities for Interregional Transactions

From the West Coast perspective, the Pacific Northwest appears to be energy constrained with some excess summer capacity, while California and the Pacific Southwest states appear to be summer capacity constrained with an excess ability to produce energy. Currently, California utilities rely on the Northwest for about 1,700 MW of spot capacity. In addition to firm purchases and exchanges, California utilities plan to add over 10,000 MW of capacity by the year 2001 to serve summer peak load. Of this they plan on over 7,000 MW of demand side management and 3,500 MW of PURPA qualifying facilities and independent power producer (IPP) supplied capacity.

Summer capacity from the Pacific Northwest is an alternative source of future capacity for California and the Southwest and could replace relatively higher cost sources of capacity. Likewise, energy from California and the Southwest is an alternative form of firm energy for the Pacific Northwest.

BPA has opportunities to take advantage of its unique situation within the long-term West Coast electricity market to meet future resource needs through mutually beneficial extraregional transactions. These opportunities include:

- Long-term firm option energy and/or exchange contracts with California utilities to satisfy firm energy resource needs.
- Long-term resource acquisitions tied to sales of surplus capacity and energy, or to capacity-for-energy exchanges.
- Joint ventures in which the output of a new resource is shared and meets both California and Pacific Northwest needs for capacity and energy.
- Increased coordination of the operation of Canadian and U.S. resources, resulting in more firm energy output from both systems.
- Arrangements which leave Canadian Entitlement power in the U.S. (roughly 600 aMW capacity by 2003) could provide economic and environmental benefits to the U.S. and Canada.

It is too soon to conclude that these interregional opportunities are preferable to BPA's other sources of acquisitions. However, these opportunities have several potential advantages that need to be explored in comparing sources for energy:

- **Reduced new resource construction.** Many of these potential transactions would rely on fuller use of existing West Coast resources to meet growing needs, reducing the need for construction of new power plants and the associated transmission lines.
- **Cost effectiveness.** These transactions are potentially a very cost-effective way of meeting new resource needs, mainly because they minimize the need to build new resources and transmission.
- **Environmental benefits.** These interregional transactions appear to have promise for environmental benefits by reducing air emissions at key times of the year, facilitating changes in river flows to benefit salmon migration, and minimizing the construction of new power plants and transmission lines. The environmental benefits of each type of transaction are discussed in detail below.

Environmental Benefits of Interregional Transactions

Interregional transactions may provide capacity and energy to West Coast electric utilities with lower environmental impacts than the construction of new generating resources. Appropriate NEPA review of such arrangements would be required,

but the general observations below about environmental effects appear valid.

Capacity/Energy Exchanges

Under a capacity/energy exchange contract with California and the Pacific Southwest, BPA would provide capacity to a southern utility in the spring and summer when Southwest loads are at their peak, thus reducing emissions into the Los Angeles air basin in the summer when pollution problems are the worst. Increased flows in the Columbia River at this time, used to generate the capacity, would speed the migration of young anadromous fish downstream, which would increase their survival rate. The Southwest would benefit because capacity from the Northwest hydroelectric system would displace capacity provided by oil and natural gas fired plants in California. Southwest utilities would provide return energy — energy associated with the capacity provided by the Northwest — off-peak (nights and weekends) from baseload resources. Because of return energy, the Northwest would see no net loss of energy in the summertime.

Instead of receiving money for the provision of capacity to the Southwest, BPA would receive "exchange energy" in the winter months, when Northwest loads are highest, and loads and air pollution in California are lower. This exchange energy could prevent BPA from having to acquire new generating resources needed to meet peak winter loads. Thus, both regions would benefit from a capacity/energy exchange agreement.

Seasonal Exchanges

Seasonal exchanges are power-for-power exchanges. That is, BPA would provide capacity to the Southwest in the summer and the Southwest would provide power to the Northwest in the winter. Seasonal exchanges differ from capacity/energy exchanges in that the Southwest would not provide return energy in the summer to BPA under seasonal exchanges as it would under capacity/energy exchanges. The environmental benefits of seasonal exchanges would be similar

to those of capacity/energy exchanges except that because no return energy is involved, Southwest air emissions would be even lower in the summer.

Option Energy

The Northwest could contract with the Southwest for an option to purchase energy. That is, the Northwest could purchase winter energy from the Southwest occasionally if needed (generally one out of five years when water levels in the Columbia River are low). The Northwest could avoid building a peaking resource (i.e., a combustion turbine) in the region, thus lowering Northwest air emissions and other impacts. The Southwest could provide the option energy offpeak from a baseload plant.

Joint Ventures

It is also possible that Southwest and Northwest utilities could jointly sponsor the construction of a new resource. Due to the complementary nature of the load shapes of the two regions, one resource could serve the peak needs of the two regions. The environmental effects would depend on where the resource is located. The parties could seek locations where operation of the resource would not have significant effects. Therefore, such joint ventures result in less total environmental impacts than if the two regions acquired resources independently of each other.

Increased Coordination With Canada

Increased coordination of the hydroelectric system with Canada may have environmental benefits for both countries. The U.S. would be able to defer the addition of new resources and thus defer the environmental effects associated with construction and operation of those resources. Canada would also be able to defer some resource additions. In Canada, this could lead to deferral of environmental effects of resource construction and operation, as well as possible deferral of effects due to transmission system additions.

Repurchase of Canadian Entitlement

An agreement which allows use of Canadian entitlement power by U.S. parties could have environmental benefits for both countries. A variety of arrangements appear possible which allow the U.S. to retain all or part of the entitlement power, add necessary resources in Canada and avoid the need to construct new transmission in Canada and the U.S. for return of entitlement power. Such arrangements could reduce the environmental impacts associated with building transmission in both Canada and the U.S. Additionally, entitlement repurchase would have no air or water quality impacts in the U.S. Canadian impacts would depend on the type and location of resources it acquired to replace the entitlement. Discussions of such arrangements between the U.S. and Canada will be pursued.

APPENDIX A. GLOSSARY

acquisition

The gain of a power resource, including demand side and supply side categories, in the form of energy or capacity. The term is commonly used by BPA to distinguish acquisition from ownership of a project and its facilities, from which BPA is prohibited by law.

average megawatt (aMW)

A unit of energy output over a year. It is equivalent to the energy produced by the continuous operation of 1 megawatt of capacity over a period of 1 year (equivalent to 8,760 megawatthours or 8,760,000 kilowatthours).

billing credits

Under the Northwest Power Act, billing credits give a utility credit on its BPA power bills or equivalent cash payments for resources the utility supplies that reduce its need for power from BPA. Billing credits defer an acquisition by BPA and encourage customers to develop their own resources.

Canadian Entitlement

The Canadian Entitlement is Canada's 50% share of the downstream power benefits of Canada's three large storage dams, Duncan, Keenleyside and Mica. These dams were built as part of the Columbia River Treaty. Canada offered the rights to this Entitlement for sale in the U.S. for a period of 30 years, beginning with the operational dates of the storage project dams.

Canadian Treaty

The Treaty between the United States and Canada, which became effective on September 16, 1964, for joint development of the Columbia River.

capacity

The amount of power that can be produced

by a generator or carried by a transmission facility at any instant. Also, the service whereby one utility delivers firm energy during another utility's period of peak usage with return made during the second utility's off-peak periods; compensation for this service may be with money, energy or other services. Equivalent terms: peak capability, peak generation, firm peakload, carrying capability. In transmission, the maximum load a transmission line is capable of carrying.

capital costs

The costs to construct a power plant, including the costs of materials, permits, and interest on borrowing.

cogeneration

The simultaneous production of electricity and other useful energy from a fuel source, often accomplished by the recovery of excess energy created by various industrial and commercial applications.

combined cycle

Combination of a combustion turbine and steam turbine in an electrical generation plant. The waste heat from the combustion cycle provides the heat energy for the steam cycle.

competitive acquisition

An approach used by BPA to acquire power resources for long-term use, involving soliciting and selecting proposed resources by applying systematic quantitative and non-quantitative criteria. The term "competitive acquisition" is commonly used by BPA to refer to resource acquisition from non-Federal sources through means other than BPA resource programs.

competitive bidding

An approach used by some utilities to

acquire power that is similar to competitive acquisition. The difference between competitive acquisition and competitive bidding is that BPA does acquisitions and utilities do bidding. Bidding programs are typically regulated by local utility commissions and often characterized by fixed-price bidding. (See competitive acquisition.)

conservation

According to the Northwest Power Act, any reduction in electric power consumption as a result of increases in the efficiency of energy use, production, or distribution.

conservation and generation resources

Generating facilities, power importing arrangements and energy efficiency measures that contribute toward BPA meeting its load obligations. Generation resources produce electricity; while conservation results in the efficient use, distribution or production of energy resources.

critical period

That portion of the historical streamflow record during which the recorded streamflows, combined with all available reservoir storage, produced the least amount of energy.

curtailment

Temporary reduction in the supply of electricity during emergency conditions.

demand

The level of electric energy, in kilowatts or megawatts, that is needed at any given time.

demand side management

Strategies for reducing, redistributing, shifting or shaping electrical loads, with an emphasis toward reducing or leveling load peaks. These strategies can be accomplished by influencing when and how customers use electricity. Examples include conservation measures, rate incentives for shifting peak loads, more effective controls, and energy storage schemes.

direct service industry (DSI)

Industrial customers, primarily aluminum

smelters, that buy power directly from BPA at relatively high voltages.

discretionary (deferrable) resource

A resource that can be deferred for acquisition without cost or availability penalties. Resource cost is based on equipment or replacement cost.

displacement

The substitution of less-expensive energy (usually hydroelectric energy transmitted from the Pacific Northwest or Canada) for more expensive thermal energy produced in California. Such displacement means that the thermal plants may reduce or shut down their production, saving money and often reducing air pollution as well.

end-use load

A final, discrete use of electrical energy, such as lighting, space heating and cooling, refrigeration, office equipment, or any other discrete load.

environmental impact statement (EIS)

A document prepared by a Federal agency on the environmental impact of its proposals for legislation and/or other major actions significantly affecting the quality of the human environment.

exchange energy

Under a capacity/energy exchange contract, the energy that must be generated or purchased by a utility as compensation for capacity service that was provided by another utility.

Federal Base System

The system including the Federal Columbia River Power System Hydroelectric projects, resources acquired by BPA under long-term contracts prior to the Northwest Power Act, and resources acquired to replace reductions in the capability of existing resources subsequent to the Act.

Federal Energy Regulatory Commission (FERC)

A Federal agency which regulates interstate aspects of electric power and natural gas industries. It has jurisdiction over the licensing of hydropower projects and the setting of BPA and other rates.

firm energy

Electric energy which is intended to have assured availability to the customer to meet all or any agreed upon portion load requirements over a defined period. On BPA's system, firm energy is that produced under critical water conditions.

firm surplus

An amount of firm energy that is in excess to firm contractual commitments.

fiscal year (FY)

The 12-month period October 1 to September 30. For example, FY 1991 is October 1, 1990 to September 30, 1991.

generation

The act or process of producing electric energy from other forms of energy; also the amount of electric energy so produced.

geothermal energy

The heat energy available in the rocks, hot water and steam beneath the earth's surface.

greenhouse effect

The warming of the lower atmosphere and the surface of the earth caused by the absorption and reradiation of infrared radiation by carbon dioxide, water vapor and other gases in the atmosphere.

grid

The name given to 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.

hydroelectric power (hydropower)

The generation of electricity using falling water to turn turbo-electric generators.

interruptible power

Power that, by contract, can be interrupted in the event of a power deficiency.

Intertie

A transmission line or system of transmission lines permitting a flow of energy between major power systems.

investor-owned utility (IOU)

A utility which is organized under state law as

a corporation to provide electric power service and earn a profit for its stockholders.

kilowatt (kW)

The electrical unit of power which equals 1,000 watts.

kilowatthour (kWh)

The common unit of electric energy equal to 1 kilowatt of power supplied to or taken from an electric circuit for 1 hour.

levelized cost

The present value of a resource's cost (including capital, interest and operating costs) converted into a stream of equal annual payments and divided by annual kilowatthours saved or produced.

load

The amount of electric power or energy delivered or required at any specified point or points on a system.

lost-opportunity resources

Resources which, because of physical or institutional characteristics, may lose their cost effectiveness unless actions are taken to develop these resources or to hold them for future use. Resource cost is based on the incremental cost of equipment.

marginal cost

The cost of producing or saving the last unit of energy (the long-run incremental cost of production).

megawatt (MW)

The electrical unit of power which equals 1 million watts or 1,000 kilowatts.

mill

A tenth of one cent. The cost of electricity is often given in mills per kilowatthour.

model conservation standards (MCS)

Energy efficient building standards developed by the Northwest Power Planning Council, pursuant to section 4(f)(1) of the Northwest Power Act.

National Environmental Policy Act (NEPA)

An act passed by Congress in 1970 requiring that the environmental impact of most large

Federal agency projects and programs be considered.

nominal dollars

For economic analysis, dollars in the year specified, not adjusted for the effects of inflation or the time value of money.

nonfirm energy (or power)

Energy produced by the hydropower system that is available when water conditions are better than critical period water flows and after reservoir refill is assured. Non-firm energy is available in varying amounts depending upon season and weather conditions. Non-firm energy is made available or supplied by BPA to a purchaser under an arrangement that does not have the guaranteed continuous availability of firm power (see critical period).

Non-Treaty Storage Agreement (NTSA)

Three storage dams were built under the Canadian Treaty: Mica, Duncan and Arrow (Keenleyside). These dams together provide more storage than is required under the Columbia River treaty. This extra storage space was not covered by the Treaty. In 1983, a short-term ten year agreement was worked out on this issue; recently (November 1990) a new agreement was reached on how to share the extra several million acre-feet.

Northwest Power Plan

A 20-year power plan developed by the Pacific Northwest Electric Power Planning and Conservation Council. In the Plan, the Council proposed a comprehensive set of actions and projects to be undertaken to assure the region of adequate power resources, giving due consideration to conservation and fish and wildlife needs.

operating year (OY)

The 12-month period July 1 to June 30. For example, OY 1991 is July 1, 1990 to June 30, 1991.

option

The purchase of a right to acquire a resource within a particular time on specified terms.

Pacific Northwest

According to the 1980 Northwest Power Act,

the Pacific Northwest comprises Oregon, Washington, Idaho, and Montana west of the Continental divide, as well as portions of Nevada, Utah and Wyoming within the Columbia-Snake River Basin. The Pacific Northwest also includes any contiguous areas not more than 75 miles from the region defined above that are part of the service area of rural electric cooperative customers served by BPA on the effective date of the Act whose distribution system serves both within and without the region.

Pacific Northwest Electric Power Planning and Conservation Act

In December 1980 Congress passed this Act, Public Law 96-501 (referred to as the Northwest Power Act). The Act authorized the four Pacific Northwest states -- Idaho, Montana, Oregon and Washington -- to enter into an interstate compact for the purpose of long-range planning and protection of shared resources. As a result of the Act, each of the four states passed enabling legislation to create the Pacific Northwest Electric Power Planning and Conservation Council in April 1981.

Pacific Northwest Electric Power Planning and Conservation Council (Council)

A council established by the Northwest Power Act in 1981, made up of two voting representatives from each Northwest state -- Washington, Oregon, Idaho and Montana. The Council is charged with planning for power resources and enhancement of fish and wildlife resources in the region.

Pacific Northwest Utilities Conference Committee (PNUCC)

A voluntary association of consumer and investor-owned utilities and BPA's direct service industries in the Pacific Northwest. Its primary role is to represent its members and their interests in pending legislation and regulating the formation of power planning policy.

peak capacity

The maximum capacity of a system to meet loads.

peak demand

The highest demand for power during a stated period of time.

penetration rate

The share of a conservation resource that can be acquired over a specific planning horizon, given market and other constraints.

present value

The worth of future returns of costs in terms of their value now. To obtain a present value, an interest rate is used to discount these future returns and costs.

priority firm (PF) rate

The priority firm (PF) rate schedule is for sale of firm power to be used within the Pacific Northwest by public bodies, cooperatives and Federal agencies; and IOUs participating in the residential and small farm exchange under Section 5(c) of the Northwest Power Act.

Programs in Perspective (PIP)

An annual program conducted by BPA to take the agency's proposed programs and budgets before the public, both to explain the agency's plans and to get constructive feedback.

ramp rate

The amount of conservation that a program can acquire annually based on availability of infrastructure and knowledge about the resource.

real dollars

Dollars that do not include the effects of inflation.

region

The geographic area defined by the Northwest Power Act. It includes Oregon, Washington, Idaho, Montana west of the Continental Divide, portions of Nevada, Utah, and Wyoming that lie within the Columbia River drainage basin, and any rural electric cooperative customer not in the geographic area described above but served by BPA on the effective date of the Northwest Power Act.

reliability

The ability of the power system to provide uninterrupted electric service.

renewable resource

Under the Northwest Power Act, a resource which uses solar, wind, water (hydro), geothermal, biomass or similar sources of energy, and which is used either for electric power generation or for reducing the electric power requirements of a customer.

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.

Resource Contingency Plan

A BPA plan to obtain options to bring cost-effective firm energy resources on-line in the event that BPA has to meet higher than anticipated firm load obligations.

resource supply curves

A traditional economic tool used to depict or forecast the amount of a product available across a range of prices.

sector

A large group of energy users with similar types of conservation or generation opportunities; for example, the residential sector, industrial sector, etc.

surplus capacity

Amount of electrical capacity above the amount needed to meet the current load requirements of BPA customers.

surplus energy

Generally energy generated that is beyond the immediate needs of the producing system. Specifically for BPA firm or nonfirm electric energy generated at Federal hydroelectric projects which would otherwise be wasted if there was not a market for the energy.

technical potential

The maximum amount of electric energy savings theoretically available if all consumers in an end-use sector

implemented all cost-effective conservation measures.

thermal resources

Generating plants that convert heat energy into electric energy. Coal, oil and gas-fired plants and nuclear power plants are common thermal resources.

transmission

In power system usage, the bulk transport of electricity from large generation centers over significant distances to interchanges with large industries and distribution networks of utilities.

transmission losses

Power lost in transmission between one point and another.

Washington Public Power Supply System (WPPSS or Supply System)

A municipal corporation and joint operating agency in Washington made up of representatives of public utility districts and municipal utilities. Based on power purchase contracts of its members or other utilities, the Supply System has the power to acquire, construct and operate plants and facilities for the generation or transmission of electric power.

wheeling

The use of the transmission facilities of one system to transmit power from one system to another.

APPENDIX B. COMMONLY USED ACRONYMS

aMW	Average megawatts
BC Hydro	British Columbia Hydro
BPA	Bonneville Power Administration
Btu	British thermal unit
Bureau	Bureau of Reclamation
CEQ	Council on Environmental Quality
CFC	Chlorofluorocarbon(s)
CIP	Conservation Implementation Plan
CO ₂	Carbon dioxide
CRFM	Cogeneration Regional Forecasting Model
CSEI	Customer System Efficiency Improvements
CT/CTs	Combustion Turbine(s)
Con/Mod	Conservation/Modernization
Corps	Corps of Engineers
Council	Northwest Power Planning Council
CVR	Conservation voltage regulation
DOE	U.S. Department of Energy
DSI/DSIs	Direct Service Industry(ies)
E\$P	Energy Savings Plan
ECMs	Energy Conservation Measures
EF	Energy Factor
EIS	Environmental Impact Statement
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
ESD	Energy Smart Design
EWB	Eugene Water & Electric Board
FCRPS	Federal Columbia River Power System
FELCC	Firm Energy Load Carrying Capacity
FERC	Federal Energy Regulatory Commission
FTE	Full-time equivalent
FY	Fiscal Year
HAM	Hydropower Analysis Model
IOU/IOUs	Investor-Owned Utility(ies)
ISAAC	Integrated System for Analysis of Acquisitions
kW	Kilowatt
kWh	Kilowatthour(s)

MCS	Model Conservation Standards
MSW	Municipal Solid Waste
MW	Megawatt(s)
MWh	Megawatthour(s)
NEPA	National Environmental Policy Act
NLSL	New Large Single Load
NNG	Northwest Natural Gas
NTSA	Non-Treaty Storage Agreement
NWECF	Northwest Energy Code Program
NWHS	Pacific Northwest Hydropower Data Base and Analysis System Model
Northwest Power Act	Pacific Northwest Electric Power Planning and Conservation Act
NUG	Non-utility generation
O&M	Operations and maintenance
ODOE	Oregon Department of Energy
OMB	Office of Management and Budget
OY	Operating Year
PCBs	Polychlorinated Biphenyls
PF	Priority Firm (BPA preference customer wholesale power rate)
PMDAM	Power Marketing Decision Analysis Model
PNUCC	Pacific Northwest Utilities Conference Committee
PPC	Public Power Council
ppm	Parts per million
PSAERP	Puget Sound Area Electric Reliability Plan
PV	Photovoltaic
PUD	Public/People's Utility District
PURPA	Public Utilities Regulatory Policy Act
R&D	Research and development
RD&D	Research, development and demonstration
RDF	Refuse-derived fuel
RPEIS	Resource Programs Environmental Impact Statement
RPM	Revolutions per minute
RPSM	Resource Policy Screening Model
RSEP	Resource Supply Expansion Program
SGC	Super GOOD Cents
SP	Surplus Power (BPA wholesale rate)
T&D	Transmission and distribution
TAP	Targeted Acquisition Program
TRP	Technical Review Panel
Treaty	Columbia River Treaty
WNP	WPPSS Nuclear Project
WPPSS	Washington Public Power Supply System

APPENDIX C. RESOURCE ANALYSIS

Assumptions

- [1] Loads taken from the Federal Systems Load Resource Balance 1990 Whitebook, Table 7 (adjusted for new load forecast).
- [2] Conservation taken from the Conservation Implementation Plan, aggressive numbers (1992-2003).
- [3] Billing Credits and Competitive Acquisitions — 350 aMW by 1997:
 - 1995 106 aMW
 - 1996 130 aMW
 - 1997 114 aMW
- [4] Efficiency Improvements (WNP-2 and hydro) — 117 aMW by 1995:
 - 1994 49 aMW
 - 1995 58 aMW
- [5] 1990 Contingency Plan Resource:
 - 1998 800 aMW: Two 400 aMW blocks (resource was acquired only when needed to meet loads).
- [6] Existing contracts: Assumes 1993 is first year the conversion of California and Pacific Southwest contracts from power sales to capacity/energy can occur. Puget contract automatically converts to exchange in 2001, but can be converted earlier at BPA's discretion (contracts were acquired only when needed to meet loads). Source: 1990 Whitebook, Table 6, "Federal System Resource Options."
- [7] Resource Loss: 500 aMW loss for BPA in 1993.
- [8] Additional Risk (the combination of Resource Loss and Additional Risk are characterized as "Maximum Resource Loss"):
 - Conservation acquisitions are 50% of aggressive targets.
 - 400 aMW loss of a generating resource: 200 aMW in 1995, 200 aMW in 1997.
- [9] Repurchase of Canadian Entitlement taken from 1990 Whitebook Technical Appendix, Table A-15.
- [10] 1992 Resource Program Acquisitions:
 - Generation Acquisitions
 - 1998 125 aMW
 - 1999 125 aMW
 - Options
 - 2000 250 aMW New Options available
- [11] Near Term Firm Purchases (Boardman, Basin Electric, Montana Power, Washington Water Power, Transalta):
 - 1993-1995 218 aMW
 - (Purchases guaranteed for first year only — 1992. Other years are contingent on environmental approval.)

Potential Magnitude of BPA Deficits Assuming Medium Loads

Potential Magnitude of BPA Deficits
Assuming Medium Loads and Resource Loss*

Potential Magnitude of BPA Deficits Assuming Medium Loads and Maximum Resource Loss*

MEDIUM CASE
Potential Magnitude of BPA Deficits Assuming
Medium Loads and Base Acquisitions

LIKELY RANGE OF RESOURCE NEED

Potential Magnitude of BPA Deficits
Assuming Medium Loads, Resource Loss*
and Base Acquisitions

* Assumes 500 aMW loss in 1993

Potential Magnitude of BPA Deficits Assuming
Medium Loads, Maximum Resource Loss*
and Base Acquisitions

Potential Magnitude of BPA Deficits Assuming Medium Loads and Proposed '92 R/P Acquisitions

Potential Magnitude of BPA Deficits Assuming Medium Loads, Resource Loss* and Proposed '92 R/P Acquisitions

Potential Magnitude of BPA Deficits Assuming Medium High Loads

Potential Magnitude of BPA Deficits Assuming
Medium High Loads and Resource Loss*

Potential Magnitude of BPA Deficits Assuming Medium High Loads and Maximum Resource Loss*

* Assumes 500 aMW loss in 1993, conservation acquisitions are 50% of aggressive targets, and 400 aMW loss of a generating resource.

Potential Magnitude of BPA Deficits Assuming Medium High Loads, Maximum Resource Loss* and Proposed '92 R/P Acquisitions

* Assumes 500 aMW loss in 1993, conservation acquisitions are 50% of aggressive targets, and a 400 aMW loss of a generating resource.

Potential Magnitude of BPA Deficits Assuming Medium High Loads and Proposed '92 R/P Acquisitions

Potential Magnitude of BPA Deficits Assuming Medium High Loads, and Repurchase of Canadian Entitlement*

Potential Magnitude of BPA Deficits Assuming Medium High Loads, Repurchase of Canadian Entitlement * and Proposed '92 R/P Acquisitions

Potential Magnitude of BPA Deficits Assuming High Loads

Potential Magnitude of BPA Deficits Assuming High Loads and Resource Loss*

Potential Magnitude of BPA Deficits Assuming High Loads, and Maximum Resource Loss*

UPPER BOUND OF RESOURCE NEED **Potential Magnitude of BPA Deficits Assuming** **High Loads and Base Acquisitions**

Potential Magnitude of BPA Deficits Assuming High Loads and Repurchase of Canadian Entitlement*

**Potential Magnitude of BPA Deficits
Assuming High Loads, Resource Loss*
and Repurchase of Canadian Entitlement****

Potential Magnitude of BPA Deficits Assuming High Loads and Proposed '92 R/P Acquisitions