DOE/BP--1406

DE91 000207

TECHNICAL REPORT

1990 RESOURCE PROGRAM

Bonneville Power Administration

July 1990

MASTER

DISTRIBUTION OF THIS DOCUMENT IS UNLIMITED

pa

TABLE OF CONTENTS
TECHNICAL REPORT
1990 Resource Program

	<u>Page</u>
Commonly Used Acronyms	v
Summary	S-1
<u>Chapter</u>	
I. Introduction	I-1
A. Purpose of the 1990 Resource Program	I-1
B. Development of the Resource Program	I-2
C. Public Involvement for the 1990 Resource Program	I-2
II. The Resource Program Environment	II-1
A. Guidance From the Northwest Power Planning Council	II-1
B. BPA's Load Forecast and Load/Resource Balance	II-2
C. Revenue Situation	II-13
III. Decision Factors	III-1
A. Description of Decision Factors	III-2
B. Trade-Offs Among Decision Factors	III-3
IV. New Resource Supply	IV-1
A. Conservation	IV-1
B. Generation and Contractual Resources	IV-11
V. Analytical Approach	V-1
A. Overview of Approach and Analysis Tools	V-1
B. Key Assumptions	V-4
C. Four-Stage Analysis	
VI. Development of Alternatives	VI-1
A. Resource Stack	VI-1
B. Macro Trade-Off Analysis	VI-4
C. Development of the Final Proposal	VI-15
D. Description of Alternatives	VI-32

TABLE OF CONTENTS (Cont'd)

<u>Chapter</u>	<u>Page</u>
VII. Evaluation of Alternative Sets of Resource Actions	VII-1
A. Assumptions for Quantitative Analysis	VII-1
B. Comparison of Final Resource Program Relative to the Draft Proposal	VII-1
C. Ranking of Draft Resource Program and Alternatives Against Decision Factors	VII-4
D. Selection of Final Resource Program	VII-14
VIII. Resource Contingency Plan	VIII-1
A. Back to Basics	VIII-1
B. What the Resource Contingency Plan Is	VIII-1
C. Question #1: How Big is The Risk of Deficits?	VIII-2
D. Question #2: Is BPA Prepared for the Worst Case Contingency?	VIII-9
E. Question #3: Are the Operational Options Enough? . . .	VIII-9
F. Question #4: What Actions Can Be Taken to Reduce the Risk?	VIII-11
G. Question #5: Which Actions Should BPA Take?	VIII-15
H. Conclusions	VIII-16
IX. Other Resource Program Issues	IX-1
A. Planning for Surplus	IX-1
B. WNP-1 and -3	IX-1
C. Global Warming Insights	IX-2
D. Fuel Switching	IX-3
E. Environmental Analysis of the Resource Program	IX-3
F. Resource Actions in the Puget Sound Area to Mitigate Peak Load Problems	IX-4
G. DSI Load Uncertainty Beyond 2001	IX-5
H. R&D Project Evaluation	IX-5
<u>Glossary</u>	G-1
 <u>Appendices</u>	
A 1990 Resource Program Global Warming Study	A-1
B Principles for Resource Acquisition	B-1

TABLE OF CONTENTS (Cont'd)

<u>Tables</u>		<u>Page</u>
II-1	Summary of Major Changes, OY 1990-1991 Federal Firm Surplus	II-10
IV-1	Achievable Conservation Resources - Residential Space Heat (Medium Loads)	IV-6
IV-2	Achievable Conservation Resources - Residential Appliances and Water Heat (Medium Loads)	IV-7
IV-3	Achievable Conservation Resources - Commercial (Medium Loads)	IV-9
IV-4	Achievable Conservation Resources - Industrial and Agricultural Sectors (Medium Loads)	IV-10
IV-5	Generation Resource Summary	IV-12
IV-6	Financial Factors	IV-13
IV-7	New Hydro	IV-15
IV-8	Cogeneration Supply Estimates	IV-16
IV-9	New Cogeneration Supply Estimates	IV-18
IV-10	Large Thermal Supply Estimates	IV-19
IV-11	New Coal-Fired Resource, Summary	IV-22
IV-12	New Coal-Fired Resource, Supply Forecast, Derivation of Fuel Costs	IV-23
IV-13	Other Planned Resources Supply Estimates	IV-25
V-1	1990 Resource Program Analysis, Basic Assumptions	V-3
VI-1	BPA's Resource Stack	VI-2
VI-2	Macro Level Trade-Off Analysis, Resource Alternatives, Expected Present Value of Total System Costs, Changes from Base Case	VI-7
VI-3	Macro Level Trade-Off Analysis, Resource Alternatives, Average Priority Firm Rate Impacts, Changes from Base Case	VI-8
VI-4	Final Resource Program, FY 1990 Through FY 1993	VI-17
VI-5	Resource Program Acquisitions, by Sector, FY 1990 Through FY 1997	VI-18
VII-1	Decision Factor Scores for Final and Draft 1990 Resource Programs	VII-3
VII-2	System Cost Impacts of Resource Alternatives Change in Present Value of Total System Costs From Alternative 1	VII-5
VII-3	Decision Factor Rankings for Alternatives	VII-9
VII-4	Summary of Risk Analysis of Alternatives	VII-10
VII-5	Summary of Budget and Rate Impacts of Resource Alternatives	VII-12
IX-1	Weighting Factors for Evaluation of R&D Project Proposals	IX-7
A-1	Summary, Cost of Reducing CO ₂ By Alternative	A-14
A-2	Summary, BPA Additions and Regional Operations of Selected Resources in Year 2010	A-16

TABLE OF CONTENTS (Cont'd)

<u>Figures</u>		<u>Page</u>
II-1	Regional Firm Loads, 1989 Joint Forecast	II-4
II-2	Federal System Firm Load, 1989 Joint Forecast	II-6
II-3	Federal Firm Energy Surpluses/Deficits, 20-Year Projection, Assuming No New Resource Acquisitions	II-8
II-4	Regional Firm Energy Surpluses/Deficits, 20-Year Projection, Assuming No New Resource Acquisitions	II-12
IV-1	Regional Coal-Fired Resource, New Supply Forecast	IV-21
VI-1	Distribution of System Cost Differences, Conservation Preference	VI-11
VI-2	Distribution of System Cost Differences, Nonfossil Preference	VI-12
VI-3	Distribution of System Cost Differences, Renewable Preference	VI-13
VI-4	Distribution of System Cost Differences, CT's and Displaceable Purchases Preference	VI-14
VIII-1	Proposed Resource Acquisitions Versus Need, Medium-High Loads	VIII-4
VIII-2	Resource Availability Versus Need, High Loads and No Resource Contingency Plan	VIII-5
VIII-3	Resource Availability Versus Need, Medium Loads and Loss of WNP-2 and Trojan	VIII-8
VIII-4	Resource Availability Versus Need, Option Two 420 MW Combined Cycle Combustion Turbines	VIII-13
VIII-5	Resource Availability Versus Need, 800 aMW of Out-of-Region Purchase Options	VIII-14

COMMONLY USED ACRONYMS

aMW	Average Megawatts
BC Hydro	British Columbia Hydro
BPA	Bonneville Power Administration
Bureau	Bureau of Reclamation
CEQ	Council on Environmental Quality
CFC	Chlorofluorocarbon(s)
CO ₂	Carbon Dioxide
CSEI	Customer System Efficiency Improvements
CT/CT's	Combustion Turbine(s)
Con/Mod	Conservation/Modernization
Corps	Corps of Engineers
Council	Northwest Power Planning Council
DSI/DSI's	Direct Service Industry/Industries
E\$P	Energy Savings Plan
ECM's	Energy Conservation Measures
EPA	Environmental Protection Agency
EPRI	Electric Power Research Institute
EWEB	Eugene Water & Electric Board
FERC	Federal Energy Regulatory Commission
FY	Fiscal Year
IOU/IOU's	Investor-Owned Utility(ies)
ISAAC	Integrated System for Analysis of Acquisitions
kWh	Kilowatthours
MCS	Model Conservation Standards
MWh	Megawatthours
NEPA	National Environmental Policy Act
NTSA	Non-Treaty Storage Agreement
NWECF	Northwest Energy Code Program
Northwest Power Act	Pacific Northwest Electric Power Planning and Conservation Act
O&M	Operating and Maintenance
OY	Operating Year
PF	Priority Firm
PNUCC	Pacific Northwest Utilities Conference Committee
PPC	Public Power Council
ppm	Parts per Million
R&D	Research and Development
RPEIS	Resource Programs Environmental Impact Statement
SGC	Super GOOD Cents
Supply System	Washington Public Power Supply System
T&D	Transmission and Distribution
TRP	Technical Review Panel
Treaty	Columbia River Treaty
U.S.	United States
WNP	Washington Nuclear Project

SUMMARY

This Technical Report is a detailed presentation of the actions Bonneville Power Administration (BPA) will take to develop new resources to meet the power requirements of its customers. The primary focus of this report is on what BPA will do in Fiscal Years (FY's) 1992 and 1993. However, much care has been taken to define near-term actions aimed at meeting BPA's long-term needs.

Overview of Resource Program Actions

An aggressive, steadily increasing conservation program forms the foundation of the 1990 Resource Program and resource acquisitions for FY's 1992 and 1993. BPA's commitment to a steady ramp-up of the conservation program is key to achieving the least-cost approach to resource development, and to making the conservation resource deliverable in the long run. By itself, conservation can meet much of the likely range of load growth that BPA faces.

A diverse mix of generation resources in small increments is the second cornerstone of the 1990 Resource Program. These generation resources can meet the rest of the likely range of BPA resource needs. Finally, a Resource Contingency Plan prepares BPA to reliably meet load in the event that load growth exceeds the likely range.

More specifically, the Resource Program includes the following actions:

- Acquire between 30 and 35 average megawatts (aMW) per year of cost-effective conservation in all sectors. This commits BPA to a stable and steadily increasing conservation program for the period FY's 1992 through 1997, to a target of acquiring at least 200 aMW by 1997.
- Acquire at least 100 aMW from an "all sources" competitive acquisitions process; a separate 50 aMW of energy is targeted for billing credits.
- Implement 100 aMW of Federal hydro efficiency improvements.
- Undertake a geothermal research and development (R&D) pilot project in a joint venture with other utilities; BPA will acquire up to 30 aMW in this joint venture.
- As part of the Resource Contingency Plan, begin siting and licensing of two combined-cycle combustion turbines (CT's) with a total capacity of over 800 MW, or take equivalent actions which would similarly position BPA to respond to high load growth.

The other primary reasons why BPA has selected this combination of resource actions are:

- Manages Risk Appropriately. This set of resource actions includes capturing low-cost resources that would keep BPA in or near load/resource balance under the medium-high forecast. In addition, BPA will undertake low-cost actions short of acquisitions, such as the siting and licensing of CT's, to prepare BPA to meet the high load growth contingency reliably and efficiently. These actions impose minimal increased financial risk on BPA, and minimize the risk of large future system cost increases.
- Flexibility and Diversity. Significant actions on a wide range of new resource types will be taken, without irrevocably committing BPA to major investments until the need for such investments becomes clear.
- Reflects Existing and Potential Capability to Develop Resources. The resource acquisition budgets and MW targets in this Resource Program are based on a systematic assessment of what is realistically achievable. Information on the lead time needed to expand the delivery infrastructure, potential penetration rates of conservation programs in each sector, and information developed from the conservation and generation acquisition experience of others across the country was especially crucial to BPA's determination of realistically achievable resource acquisition targets. However, if market conditions change or the ability to acquire cost-effective conservation or generation resources becomes greater, BPA will adjust its efforts to capture additional resources.
- Budget and Rate Impacts are Within Bounds. Total capital and expense costs for the proposal, not including the large thermal budget and overheads, average \$160 million per year for FY's 1992 and 1993. Considering only these expenditures, this would translate into roughly a 0.4 mill/kilowatthours (kWh) increase in FY 1992 over the current average Priority Firm (PF) rate. This rough estimate of the implications of the proposal on PF rates does not consider other BPA expenditure needs and, therefore, should not be interpreted as BPA's estimate of future rates. BPA's judgment is that these expenditures and potential rate impacts are acceptable, in view of the load/resource outlook.

Comparison of Final 1990 Resource Program to Draft 1990 Resource Program

The final 1990 Resource Program plots a more aggressive, ambitious course for resource acquisitions in FY's 1992 and 1993 than the Draft 1990 Resource Program.

There are two primary differences between the final 1990 Resource Program and the Draft 1990 Resource Program. First, more conservation will be acquired in the final program--at least 32 aMW/year in the final vs. 25 aMW/year in the Draft. This decision is consistent with comments received on the Draft 1990 Resource Program--a majority of public comments support increasing the

level of conservation acquisitions above the level identified in the Draft. In the final Resource Program BPA is budgeting to acquire cost-effective conservation to the level of the medium-high 1989 load forecast. Information from a preliminary draft of the 1990 load forecast indicates load growth in FY's 1992 and 1993 will be close to the medium-high level (i.e., the draft 1990 medium case is close to the 1989 medium-high in those years). In the Draft, BPA budgeted to acquire conservation at the medium 1989 load forecast. In addition, a major new industrial conservation program has been included in the final Resource Program. This program, which was not included in the Draft, should provide additional low cost conservation opportunities.

Second, resources developed through the billing credits test and all sources competitive acquisitions are considerably increased in the final Resource Program. In the final Resource Program BPA is budgeting for acquisitions of at least 50 aMW from billing credits resources, and at least 100 aMW from an all sources competitive acquisitions process. These acquisitions are an increase of 100 aMW from the Draft. These acquisitions were increased for three reasons: (a) the preliminary 1990 load forecast shows higher loads in the near-term indicating a greater need for resources; (b) BPA received a large number of comments suggesting that the 50 aMW test of the acquisition process proposed in the Draft was not a large enough test; and (c) many commenters support an early implementation of billing credits.

One additional noteworthy change has occurred since publication of the Draft 1990 Resource Program. Budgets for resource acquisitions in FY's 1990 and 1991 have been increased. BPA and many of those commenting on the Draft 1990 Resource Program share the concern that BPA's planned funding for FY's 1990 and 1991 was inadequate to prepare for the higher levels of spending and acquisitions that need to occur in FY's 1992 and 1993 and beyond. BPA has responded by making significant changes in both the 1990 and 1991 budgets. In FY 1990 funding for enforcement of Model Conservation Standards (MCS) codes has been increased by nearly 90 percent. This is primarily a result of the passage of codes in Washington.

The new FY 1991 budget reflects an increase of approximately 60 percent in funding to cover MCS enforcement, an increase of 75 percent in commercial conservation programs, and initiation of a major new industrial program in FY 1991. Prior to these changes, resource acquisitions would have declined slightly from FY 1990 to FY 1991. These budget increases will greatly enhance the ability of these program areas to ramp-up to the ambitious levels of FY 1992 and beyond.

Acquisition Approaches in the 1990's

It is now clear that the Federal System will need additional resources in the 1990's. After a decade of developing its resource acquisition capabilities, there is a regionwide consensus that BPA needs to accelerate acquisitions of conservation and generation resources.

The resource acquisitions planned for the 1990's represent a substantial increase in the pace of acquiring conservation and generation by BPA. This ambitious level of acquisitions challenges BPA to seek creative, flexible, and intelligent use of a menu of acquisition approaches tailored to meet the objectives of BPA and its customer utilities. To meet increased resource needs, BPA will be evolving toward greater reliance on a more diverse mix of approaches than is currently being used. The familiar methods and programs BPA has used (primarily BPA-designed programs along with codes and standards) will need to be supplemented to meet growing needs. The need for new acquisition approaches is especially apparent for generation resources and for conservation in the commercial and industrial sectors.

A variety of acquisition approaches is important because this provides the flexibility to fully utilize the capabilities of the diverse utility and nonutility communities and efficiently acquire resources when needed. BPA examined a range of alternative acquisition approaches for meeting future resource needs. BPA's future efforts will focus on the following approaches:

- BPA centrally designed programs
- Codes and standards
- Billing credits
- All source competitive acquisitions
- Targeted acquisitions

BPA's goal is to have a relationship with its customers by the middle of the 1990's that is built on shared responsibility for developing cost-effective resources. BPA will provide a stable market for utilities and others interested in developing conservation and generation resources. This market will be characterized by long-term purchases and risk sharing by placing responsibility with the party that can best control the particular risk.

Solicitations for resources will play an increasingly important role in the future. BPA will be soliciting for resources in two ways:

Open Solicitations. An open solicitation provides BPA with a means to compare and evaluate diverse resource options while providing resource developers with an opportunity to propose creative programs. Examples of an open solicitation include the all sources competitive acquisition and the billing credits test which BPA will be undertaking in 1990.

Targeted Solicitations. Targeted solicitations are directed to a specific set of conservation end-uses or generation technologies. In a targeted solicitation resource developers would not be competing against each other, but instead against established criteria or standards. Hence, if each proposal meets the established standards, all those responding to a solicitation could be selected. The specific approach in a targeted solicitation would be tailored to the nature of the resources being acquired. Targeted solicitations will be increasingly important for commercial and industrial acquisitions. These solicitations will be designed to match the abilities of BPA customers. However, not all

utilities will be able to aggressively pursue commercial/industrial conservation efforts in this way, and BPA will provide assistance to those utilities as necessary.

BPA will make these future purchases from its customers to the maximum extent practical. BPA will look to its customers first since they share the obligation to meet load growth and because of the cooperative working relationships established over the last 10 years. However, other resource providers will be able to participate in the all sources competitive acquisition solicitation, the Geothermal Pilot Program, and the solicitation for resources in the Resource Contingency Plan.

CHAPTER I

INTRODUCTION

A. Purpose of the 1990 Resource Program

The Resource Program is BPA's biennial expression of resource actions proposed to meet future loads placed on BPA. The Resource Program also discusses and attempts to resolve resource-related policy issues. The Resource Program encompasses assessments of resource availability and costs, and analyses of resource requirements and alternative ways of meeting those requirements, through both conservation and generation resources. It translates these general resource conclusions into resource programs for both conservation and generation. This Resource Program recommends energy resource budgets for FY's 1992 and 1993. In developing the 1990 Resource Program, BPA used the 1986 Power Plan (Council's Power Plan), the 1989 Supplement and early results from the development of the 1990 Power Plan as guidance in looking at the future need for resources and alternative ways of meeting that need.

The Resource Program bears directly on an important BPA responsibility: the obligation under the Pacific Northwest Electric Power Planning and Conservation Act (Northwest Power Act) to meet the power requirements of its public and private utility and direct-service industrial (DSI's) customers according to contractual agreements. Even though this is a firm legal obligation, it is an obligation whose scope cannot be predicted with certainty. The amount of resources required to meet future needs varies considerably, depending on such factors as the load growth faced by different utilities and the availability and cost of alternative sources of power to those utilities.

BPA's 1990 Resource Program consists of three documents: the 1990 Resource Program, the Technical Report, and the 1990 Resource Program Public Comment Summary and BPA's Responses. The 1990 Resource Program is a summary document that provides an overview of the resource analysis, resource program recommendations for FY's 1992 and 1993, and policy recommendations concerning some of the issues surrounding the Resource Program. The Technical Report is a comprehensive document that provides supporting data and analysis for the resource program recommendations and an in-depth discussion of the resource-related issues in the 1990 Resource Program. The Technical Report also contains the revised Global Warming Study.

The 1990 Resource Program Public Comment Summary and BPA's Responses is a compilation of the comments BPA received on the Draft 1990 Resource Program issued in December 1989, and corresponding responses. The Public Comment Summary provides a bridge between the draft and final Resource Program documents.

For a thorough understanding of how BPA arrived at the recommendations for the 1990 Resource Program, all documents should be consulted. To obtain copies of these documents, phone BPA's document request line at 800-841-5867 for Oregon, 800-624-9495 for the other western States.

B. Development of the Resource Program

Developing the Resource Program is a multiple-step process. The steps are described in detail in this Technical Report. Briefly, the steps are as follows:

The first step in the development of the 1990 Resource Program is the load forecast, which is a range of five forecasts (low, medium-low, medium, medium-high, and high). This range of forecasts reflects the uncertainties BPA faces in projecting future load growth. A range of load/resource balances are prepared by comparing the capability of the existing Federal System resources to the range of forecasted loads over the next 20 years. Following this, BPA develops new resource supply forecasts. This step is important because BPA uses these estimates to plan acquisition of resources to meet load growth.

The next step is the development of a set of decision factors, or criteria, to be used in evaluating alternative resource programs. These decision factors cover a wide range of concerns: economic, environmental, institutional, and social/political. These decision factors are used to develop and evaluate alternative resource programs for FY's 1992 and 1993.

A proposed resource program and a number of alternatives are then developed. The proposal and alternatives are influenced by a number of analytical stages. Stage 1, the Macro Trade-Off Analysis, provides insights into the advantages of strategies focused on particular resource types. Stage 2, establishment of cost-effective ceilings, provides guidance to specific elements of the proposal. Stage 3, development of the proposal, draws on the information from Stages 1 and 2, along with the guidance of the Northwest Power Planning Council (Council) and the decision factors. Then, a number of alternatives to the proposal are also developed. The proposal and alternatives are then evaluated against the decision factors to identify the recommended resource program.

In addition to recommending a particular set of resource actions, the resource program also makes recommendations on a number of resource-related issues. The proposed resource actions and policy recommendations for FY's 1992 and 1993 were presented in the Draft 1990 Resource Program, which was published for public review and comment in December 1989.

C. Public Involvement for the 1990 Resource Program

The key purposes for public involvement in developing the 1990 Resource Program were to provide information to the public on resource development alternatives, their risks (cost, performance, and reliability), and their impacts (e.g., socio-economic, environmental, regional, and political). Also, incorporating new information on these issues supplied by the public and entities with special interests or expertise enables BPA to make better informed decisions.

To assist BPA in developing the Draft 1990 Resource Program, BPA conducted a series of Technical Review Panel (TRP) meetings. The TRP was formed in 1985 and is composed of representatives from customer groups, Council staff, special interest groups, State energy offices, and individual BPA customers. Seven TRP meetings were held from April to October 1989 to scope and discuss the principal issues to be addressed in the 1990 Resource Program, to report progress on activities affecting the Resource Program (such as load forecasting, preparing the load/resource balance, and designing the resource analysis), and to share early analysis results. Through these meetings, BPA obtained valuable insights that helped shape this Resource Program. Where possible these insights were incorporated into the resource analysis.

Responding to requests from TRP members, smaller work groups were formed to work specifically on conservation and generation supply estimates, global warming, and use of CT's and displaceable purchases in conjunction with BPA's nonfirm energy. These work groups were hosted by BPA, the Council, and the Pacific Northwest Utilities Conference Committee (PNUCC). The recommendations of the work groups were incorporated into the resource analysis for the Draft 1990 Resource Program.

A major thrust in public involvement began with the release of the Draft 1990 Resource Program. Conclusions reached in the Draft were preliminary; BPA encouraged public comments to help shape the final 1990 Resource Program. BPA received over 100 letters from organizations and individuals. Most of the commenters generally supported the proposed energy resource expenditures and activities proposed for FY's 1992 and 1993. The public comments BPA received on the Draft were used with additional resource analysis to develop this final 1990 Resource Program.

CHAPTER II

THE RESOURCE PROGRAM ENVIRONMENT

A. Guidance from the Northwest Power Planning Council

1. Integration of Council and BPA Planning

The Council is charged by the Northwest Power Act with developing a long-range regional Power Plan. BPA relies on the Power Plan developed for the Region by the Council to provide the long-range context within which BPA's own planning takes place. The Council's guidance in the Power Plan helps BPA prioritize its resource analysis, program development, budgets, and staffing over the near term.

Several years ago, customers expressed confusion over the different planning assumptions and tools used by BPA and the Council. To clarify this issue, the two organizations have been working together to enhance the existing resource planning capabilities of both organizations. This collaborative effort, along with the efforts of other members of the Pacific Northwest utility community, produced the joint model used by BPA in developing the final 1990 Resource Program and by the Council in developing its 1990 Power Plan. Other significant cooperative efforts include the preparation of joint load forecasts and conservation and generation resource supply estimates.

The Council last published a Power Plan in 1986, including an Action Plan that has been a source of guidance for BPA's budgeting and resources program planning processes. The Council produced a Supplement in early 1989 that reflected the evolution of the resource environment since the 1986 Power Plan's publication. The Supplement also updated the Council's expectations concerning BPA's overall resource actions.

The Council has embarked on a process that will result in a new Power Plan by late 1990. As required for the Federal budgeting schedule, BPA has proceeded with its Resource Program planning for FY's 1992 and 1993. The budget timeframe and requirements will result in the completion of BPA's resource planning prior to or nearly concurrent with the publication of the Council's Draft 1990 Power Plan. The collaborative development of planning inputs helps assure consistent approaches, and BPA has been actively involved in the development of the Power Plan. One such effort by BPA is keeping the four members of the Council dealing with power issues fully informed of BPA's key resource decisions as they occur. As much as possible, recent information developed by the Council was used in this final 1990 Resource Program.

The schedule differences which have occurred in this planning cycle have presented a special challenge to both parties. The Council and BPA are aware of one another's needs. With their common goal--ensuring that the right quantity of the right resources, at the right cost and at the right time, is available to BPA and the region--as motivation, the Council and BPA continue to work closely together to minimize any possible difficulties.

As stated earlier, common planning tools were used whenever possible. This Resource Program marks the first time that the new joint planning model, Integrated System for Analysis of Acquisitions (ISAAC), has been used by BPA. In addition, BPA has worked and continues to work closely with the Council to develop joint load forecasts. The 1989 joint forecast was used as the basis for the 1990 Resource Program. Also, in consultation with the Council and other regional parties, BPA is developing resource supply estimates for use in determining how near-term resource needs will be met.

2. Guidance from the Council's Planning

The Council's 1986 Power Plan and 1989 Supplement include extensive analyses of the Pacific Northwest's loads and resources. There is renewed emphasis in the 1989 Supplement on the importance of planning for uncertainty. Consistent with this emphasis, flexibility to react to changing load conditions was one of the underlying principles used by BPA in developing its resource actions.

Many other issues that were addressed in the Council's 1986 Power Plan and 1989 Supplement have been proposed for further action in this final 1990 Resource Program, such as strategies to use CT and displaceable purchases in conjunction with BPA's nonfirm energy, developing and testing an acquisition process, and exploring a variety of resource acquisition approaches.

The 1989 Supplement stressed the need for BPA to aggressively pursue the accomplishment of 1986 Action Plan items, indicating that the dwindling surplus underscores the need for these actions. The 1989 Supplement also referenced the continuing need for development of an acquisition process--an effort currently underway at BPA. This Resource Program sets BPA on a course to bring a number of acquisition approaches into operation.

B. BPA's Load Forecast and Load/Resource Balance

This section describes how BPA develops load forecasts and the load/resource balance. It also summarizes current estimates and compares current forecasts with those underlying the 1988 Resource Program.

1. Regional Economic and Load Forecasts

BPA's resource planning process begins with the development of forecasts of regional economic growth. First, a range of five forecasts of employment, population, households, and fossil fuel prices is developed based on national macroeconomic forecasts, relationships between the Pacific Northwest and national economies, and input from utility and industry experts.

These forecasts of major determinants are then split into forecasts for public and investor-owned utilities (IOU) service territories, and fed through a system of electric power demand and pricing models to produce electricity forecasts for public utilities and IOU's. The result is a range of regional load forecasts: high, medium-high, medium, medium-low, and low cases. A range of DSI loads is produced similarly; major determinants are projected aluminum prices, electricity costs, and other production costs.

The long-term regional and public utility load forecasts used in the Draft 1990 Resource Program were developed jointly by BPA and Council staff and published as "Forecast of Electricity Use in the Pacific Northwest," August 1989 (1989 joint forecast).

The long-term forecasting methods used are designed to capture long-run trends in energy use. For the medium case only, a mid-term econometric forecast of loads for the public utilities through 1995 is substituted for the long-term forecast projections. These mid-term projections are developed to reflect the near-term outlook for the economy and resulting near-term loads.

The 1989 joint forecast is reduced to reflect conservation actions that consumers are projected to take in response to electricity prices (price-induced conservation), utility conservation program savings that have been achieved to date, and the projected conservation savings from currently budgeted programs. Programs are currently budgeted through FY 1991, so no new programs are included after 1991.

This forecast also is reduced to reflect building codes and appliance efficiency standards enacted or adopted as of 1989. Savings associated with Federal appliance standards effective in 1990 are included in projections for 1990 and beyond. Additional conservation available through more stringent building codes (including the MCS) and appliance standards and through expanded utility conservation programs is treated as a resource rather than as a reduction to the load forecast.

Figure II-1 shows historical regional firm loads from 1980 through 1989 and forecast loads through 2010. Forecasted regional load growth over the 1988 to 2010 period ranges from -0.3 percent annually in the low case to 2.7 percent in the high case. In the medium-high and medium-low cases, loads are projected to grow at 1.8 percent and 0.6 percent annually, respectively. In the medium case, regional firm loads grow at a rate of 1.2 percent annually from 1988 to 2010--from 17,365 aMW in 1988 to 22,817 aMW by 2010.

The most likely range of loads is between the medium-high and medium-low cases. There is a 50 percent 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 the high or between the medium-low and the low cases is 20 percent each. The high and low cases represent unlikely extremes of possible future loads, with probabilities of being higher than the high case or lower than the low case of 5 percent each.

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

Figure II-1
Regional Firm Loads
1989 Joint Forecast

Sources:

Forecasts: "Forecast of Electricity Use in the Pacific Northwest,"
BPA and Northwest Power Planning Council,
August 1989.

Historical Loads: BPA historical sales data, excluding Federal
transmission losses.

BPA and Council staff are currently working on revisions to the 1989 joint forecast. This revised forecast will be released as part of the Council's Draft 1990 Power Plan. The draft 1990 forecast will reflect increases in regional economic activity, regional loads, and Federal System loads in the medium, medium-high, and medium-low cases over those projected in the 1989 forecast. Forecast increases are small relative to regional and Federal System loads. In the most probable medium-high to medium-low range, projected regional loads in year 2010 are expected to be roughly 350 to 600 aMW (1.5 to 3.0 percent) higher than the 1989 forecast projections shown in Figure II-1. Loads in the early to mid-1990's are similarly expected to be 300 to 550 aMW higher than in the joint 1989 forecast. These higher load forecasts reflect the recent strength in the regional economy and an assessment that the DSI's are more cost-competitive relative to national and international competitors than in the past.

2. Federal System Loads

Federal System loads, the loads BPA plans 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 DSI's, BPA sales to other Federal agencies, and other BPA contractual obligations to deliver power. The public utilities' net requirements and the DSI loads are the bulk of Federal System loads, accounting for over 80 percent of Federal System loads in Operating Year (OY) 1989.

The net requirements of the public utilities is determined by subtracting the amount of generation resources they dedicate to serving their own load from their total load forecasts. Each year, the public utilities provide BPA with the amount of "dedicated resources" for the next 7 years under provisions of their Power Sales Contracts with BPA.

The Federal System load forecast described here does not include IOU loads beyond current contract obligations. Under BPA's Power Sales Contracts with the IOU's, a utility must give BPA 7 years' notice that it will place load on BPA. Only one utility, Puget Sound Power and Light, has given such notice. This notice expires after OY 1993. Thus the Federal System forecast described here includes no IOU loads after that year. Planning assumptions used in the 1990 Resource Program are discussed in more detail in Chapter V-B.

Figure II-2 shows historical Federal System firm loads from 1980 through 1989 and forecast loads through 2010. Forecast load growth over the 1988 to 2010 period ranges from -0.7 percent annually in the low case to 2.6 percent in the high case. In the medium-high and medium-low cases, loads are projected to grow at 1.6 percent and 0.4 percent annually, respectively. In the medium case, Federal System firm loads grow at a rate of 1.0 percent annually from 1988 to 2010--from 7,801 aMW in 1988 to 9,698 aMW in 2010. Federal System loads are described in detail in 1989 Pacific Northwest Loads and Resources Study (BPA, November 1989).

Figure II-2
Federal System Firm Load
1989 Joint Forecast

Sources:

Forecasts: "1989 Pacific Northwest Loads and Resources Study,"
BPA, November 1989.

Historical Loads: BPA historical sales data adjusted to reflect
Federal transmission losses.

The draft 1990 joint forecast described above is expected to result in increases in projected Federal System loads in the medium-high, medium and medium-low forecast cases. In this most probable medium-high to medium-low range, projected Federal System loads in year 2010 are expected to be 150 to 450 aMW (2 to 6 percent) higher than in the 1989 joint forecast. Loads in the early to mid 1990's are similarly expected to be 150 to 450 aMW higher than in the joint 1989 forecast. These expected changes result in roughly one to two tenths of a percentage point change in 20-year Federal System load growth rates.

This increase in Federal System loads reflects only load changes resulting from revised economic outlooks for public utilities and DSI's. Federal System loads may further change due to revisions in contractual obligations to deliver power outside the region and changes in dedicated resources. These changes, if any, will not be determined until fall 1990, and will be reported in the 1990 Pacific Northwest Loads and Resources Study.

3. BPA's Load/Resource Balance

BPA prepares the load/resource balance 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 loads are greater than firm resources, the Federal System is firm energy deficit. If firm resources are greater than firm loads, the Federal System may market the resulting firm surplus. A detailed analysis of the load/resource balance is presented in BPA's 1989 Pacific Northwest Loads and Resources Study.

Hydroelectric power comprises 87 percent of the Federal System firm energy resources. Eleven percent comes from nuclear projects and 2 percent from contractual rights. 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. The critical period is defined as the worst 4 years of hydro flows, which occurred during OY's 1928-1929 through 1931-1932.

BPA examined load/resource balances under a range of five load forecasts. The levels of firm surplus under the medium load forecast indicate that the Federal System is now in load/resource balance. Figure II-3 shows that under the high and medium-high forecast for loads and resources, BPA immediately becomes firm energy deficit. BPA remains in firm energy surplus for the duration of the planning period for the low and medium-low cases. Current draft load forecast studies indicate that loads may be growing at a more rapid rate. These studies find that the Federal System loads may in the near term be growing near the rate of the 1989 medium-high forecast.

4. Change in Loads and Resources Since 1988 Resource Program

Since the 1988 Resource Program was completed, the national and Pacific Northwest economies have enjoyed strong economic and load growth. Reflecting this recent growth, the 1989 joint forecast projects modestly

FIGURE 11-3
FEDERAL FIRM ENERGY SURPLUSES/DEFICITS
 20-Year Projection
 Assuming No New Resource Acquisitions

higher regional and Federal System loads than were projected in the 1988 Resource Program. Increases in loads are most significant in the early to mid-1990's. While the increases in projected loads are small relative to regional firm loads (roughly 3 percent higher in OY 1992 in the medium case), they have significantly reduced the amount of surplus firm energy in the near term.

As a result of these increases in projected loads, the firm energy under the medium forecast decreased at the end of the planning period (OY 2007) from a firm deficit of -206 aMW, as reflected in the 1988 Resource Program, to a firm deficit of -825 aMW, a decline of 619 aMW. In the near term, under medium loads the firm surplus declined from 817 aMW to a firm deficit of -11 aMW in OY 1991, a decline of 828 aMW. This loss of firm energy is made up of several components. The DSI loads increased in the short- to mid-term because of expected strong aluminum prices. The required load that public utilities place on BPA also is forecasted to be higher than the 1988 Resource Program forecast. In addition, BPA reduced the capacity factor of Washington Nuclear Project (WNP)-2 from 70 to 65 percent, thereby reducing the expected output by 56 aMW. Table II-1 shows what happened to the firm surplus between the 1988 Resource Program and the 1990 Resource Program under the medium forecast for OY 1991.

Recently, the Pacific Northwest has enjoyed strong economic and load growth. For example, BPA's loads grew at a 3.9 percent rate over the 12 months ending March 1990. Although BPA expects that national and regional economic growth will slow and result in a slowing of load growth, this recent strength in the national and regional economies suggests that loads during the early to mid-1990's are more likely to fall in the upper part of the 1989 joint forecast range than the lower part. BPA is currently reviewing how large an impact recent economic and load growth will have on near-term loads and evaluating the implications for long-term loads. As described above, the results of this review will be incorporated in the draft 1990 joint forecast to be released in summer 1990.

A preliminary load/resource balance using the draft 1990 joint load forecast shows that Federal system deficits increase by 100 to 300 aMW in the early 1990's under the medium load forecast compared to the 1989 forecast. This draft 1990 forecast also changes a 200 aMW surplus to a 200 aMW deficit by the year 2000. The deficit increases from 1,200 aMW to 1,800 aMW by OY 2010. To meet these near-term deficits, BPA would convert its out of region power sales immediately to capacity for energy exchanges, as described below. Previous planning assumptions had these contracts converting in OY 2000 under medium forecasts.

5. Contractually Available Resources

BPA has long-term surplus firm energy sale and exchange contracts with four Southwest utilities and one Northwest utility--Southern California Edison, the cities of Burbank, Glendale, and Pasadena, and Puget Sound Power and Light. These contracts contain provisions for complete or partial

TABLE 11-1

SUMMARY OF MAJOR CHANGES
OY 1990-1991 FEDERAL FIRM SURPLUS

<u>1988 RESOURCE PROGRAM PROJECTED SURPLUS</u>	817
- Load Change: DSI Forecast	-153
- Load Change: Public Load Forecast	-220
- Resource Change: Hydro FELCC	+129
- Load Change: Sales to Southwest	-179
- Load Change: Sale to Puget	<u>-75</u>
<u>DEC 1988: PROJECTED SURPLUS</u>	319
- Resource Change: WNP-2 Adjustment	-56
- Load Change: DSI Forecast	-81
- Load Change: Public Load Forecast	-220
- Net Miscellaneous Changes	<u>+ 27</u>
<u>NOV 1989: PROJECTED SURPLUS</u>	-11

termination of energy deliveries if the energy is needed to serve BPA's firm requirements customers. Under the medium load forecast, it is assumed that the Southwest sales and Puget sale will convert to capacity/energy exchanges and seasonal exchanges beginning in OY 2000. If loads grow at a faster rate, these energy sales may be converted earlier.

In the event that BPA converts the energy deliveries of these Southwest surplus sales to exchanges, exchange energy becomes available to BPA as a firm resource. BPA also may elect to purchase supplemental energy under these exchange contracts. Supplemental energy is considered a resource option and is not included as a firm resource. The Puget Sound Power and Light contract has a 5-year notice for terminating the surplus power sale. Termination of this sale at the earliest time, OY 1996, would make an additional 75 aMW available for BPA's firm loads.

Exercising of all Southwest contractual provisions would provide BPA with an additional 321 aMW. The 321 aMW is composed of 162 aMW of recallable sales to the Southwest, 50 aMW of payments for capacity, 38 aMW of supplemental energy, and 71 aMW of optional energy. Only the recallable sales and capacity payment, totaling 212 aMW, are used as firm resources. Under the high and medium-high load forecast these options are exercised in 1991. Under the medium load forecast these options are exercised in the year 2000. Under the low and medium-low forecast they are not exercised at all. The supplemental energy and option energy are treated as options and are not exercised under any forecast.

6. Regional Load/Resource Balance

The generation resources for the non-Federal system, the IOU's, and the public utilities, are 52 percent hydro resources and 47 percent thermal resources. These thermal resources primarily consist of the IOU's coal and nuclear plants. Therefore, the generation resource mix for the region, compared to the Federal System, consists of a larger percentage of thermal resources, 25 percent, and conversely, a smaller percentage of hydro, 63 percent. Imports into the region, CT's, and miscellaneous resources make up the remaining 12 percent of Regional resources.

Figure II-4 shows the regional load/resource balance. Figure II-4 indicates that under the low load forecast the region would be surplus through OY 2010--a surplus of between 2,000 and 3,000 aMW. Under medium-low loads, the region is surplus through OY 2001, and is deficit by 1,760 aMW by OY 2010. Under medium loads, the region is firm energy deficit (assuming no addition of new resources) beginning in OY 1994, with a 1,299 aMW deficit in OY 2000 that increases to 4,369 aMW by OY 2010. Under medium-high loads, the region is deficit in OY 1992; the deficit becomes 3,058 aMW by OY 2000 and increases to 7,294 aMW by the end of the planning period. Under the high load growth case (assuming no addition of new resources), the region is deficit 818 aMW immediately, increasing rapidly to over 6,202 aMW by OY 2000, and over 13,000 aMW by OY 2010.

FIGURE 11-4

REGIONAL FIRM ENERGY SURPLUSES/DEFICITS

20-Year Projection

Assuming No New Resource Acquisitions

The draft joint 1990 load forecast described above is expected to increase regional deficits by 300 to 500 aMW in the medium-high to medium-low forecast range. This change in projected deficits does not reflect possible resource changes that may occur based on Loads and Resources Study work to be done in the fall of 1990.

C. Revenue Situation

BPA's future revenue outlook is an important factor in developing the Resource Program. During almost a decade of surplus, BPA has constrained capital investments--including resource development--to strengthen the financial condition of the agency. The factors of greatest concern have been BPA's high level of fixed costs and obligations combined with a variable, sometimes volatile, revenue stream.

Revenues are dependent on the variables affecting loads and resources in the region. Those variables include: Northwest economic conditions, aluminum prices, streamflows, thermal resource performance, and fuel prices. BPA's revenues are especially dependent on streamflows and regional economic conditions. Low streamflows reduce the amount of power that can be sold and the revenues that BPA can earn from these sales. A strong regional economy increases sales and also revenues--when power is available.

BPA's revenue variability presents a continuing challenge to meet its financial obligations when adverse revenue conditions occur. This uncertainty makes it important to keep resource investments that add to BPA's fixed costs under tight control, and to focus on investments which enhance flexibility through reduced risk. BPA will continue to work with its customers and others as it continues to assess its financial situation and options.

CHAPTER III

DECISION FACTORS

Resource Program decision factors are the criteria BPA uses to evaluate resource alternatives and guide decisions on resource actions. These decision factors cover a wide range of concerns--from economic to environmental to institutional to social/political. The Resource Program describes these decision factors in an attempt to explain the rationale behind BPA's resource decisions.

A. Description of Decision Factors

For the 1990 Resource Program, BPA has identified eight decision factors to give direction to the selection of its Resource Program for FY's 1992 and 1993.

Minimize the Present Value of Total System Costs

Least-cost planning assures the lowest possible long-term costs to BPA's customers and assures that future Treasury payments are not jeopardized by expensive future resource acquisitions. The total system costs of each potential new resource alternative are evaluated to determine which resource additions result in the lowest long-run system cost. The following costs are included in estimates of system costs of a particular resource alternative: debt service costs for new generation, conservation, transmission, and distribution investments; operating costs; utility and consumer costs incurred for conservation measures; and quantifiable environmental costs.

Ensure That BPA Has The Ability To Meet High BPA Firm Loads In 1994-2000, If Necessary

BPA faces much uncertainty about what its future resource needs will be. BPA's obligation to meet the needs of its customers is not limited to a particular load forecast. Under medium load growth BPA believes it is in load/resource balance through the rest of the century. However, BPA's analysis projects that BPA faces nearly a 50 percent chance that existing resources will not be adequate to meet firm loads in the 1990's, and roughly a 10 percent chance of deficits of over 1,000 aMW in the mid-1990's. Each resource alternative is evaluated in terms of the ability it gives BPA to meet high firm loads, should those loads occur.

Minimize BPA Financial Risk

BPA operates in an uncertain business environment, with numerous factors affecting its ability to both maintain stable rates and provide the assurance of making its scheduled payments to the United States (U.S.) Treasury. A key indicator of the financial risk of each resource alternative is the magnitude and likelihood of net cash-flow shortfalls under that alternative.

Minimize Near-Term Rate Impacts

Resource actions require expenditures that must be recovered through revenues from rates charged to BPA's customer groups. An important goal for BPA is to keep rates low to: (1) be an attractive source of power to its customers, and (2) contribute to the health of the regional economy. This decision factor considers the near-term rate impacts of each resource alternative.

Minimize Long-Term Rate Impacts

The effects of alternative resource programs on long-term rates also are important to BPA's ability to remain an attractive provider to BPA's customers and to the health of the Pacific Northwest economy. This factor is listed separately because some alternative resource programs may result in a short-term rate increase in order to achieve a long-term rate decrease.

Minimize Exposure To Economic Risks Of Adjusting To Unplanned Changes In Load Growth, Resource Availability, And Costs

BPA operates in an environment with significant risks, including uncertainty about loads beyond 2001. In particular, BPA wants to avoid: (1) the high cost of acquiring an expensive resource that is not needed because of slower load growth, and (2) the high cost of acquiring expensive short lead-time resources required because of resource failure or more rapid load growth than expected. BPA's approach to risk assessment is to estimate a distribution of possible outcomes from a decision and to identify which of those outcomes might be unacceptable. This decision factor differs from the one minimizing total system costs in that it is used to identify those resource alternatives that may expose BPA to the risk of extremely costly outcomes. It also differs from the one ensuring BPA's ability to meet high loads--this factor addresses economic risk, whereas the other decision factor addresses the risk of being unable to meet firm load.

Minimize Local And Global Environmental Impacts From 1992-1993 Resource Actions

This decision factor focuses on nonquantifiable local and global environmental impacts of resource actions. Subsequent decisions on the acquisition of specific resources resulting from a Resource Program will include consideration of site-specific environmental impacts as well as compliance with other requirements of the National Environmental Policy Act (NEPA).

Maximize Resource Deliverability In View Of Social/Political Factors

Influences exist that are essentially social or political in nature which are fundamental to whether a project or resource is achievable. This factor refers to nonquantifiable regulatory factors that affect whether a resource will actually come on-line and remain on-line for as long as planned. Examples include local, State, or Federal actions affecting the completion and continuous operation of a large central-station thermal plant. These influences are evaluated in terms of their potential effect on the deliverability and long-run continuity of new resource alternatives.

B. Trade-Offs Among Decision Factors

Resource actions proposed through the Resource Program cannot satisfy all decision factors simultaneously, as a brief review of these eight decision factors shows. Trade-offs must be made among these decision factors. Examples of the choices that have to be made in deciding on a particular resource alternative include:

Minimize the present value of total system costs (or long-term rates) vs. minimize near-term rates. The resource alternative that minimizes near-term rates may defer investment in resources. Deferring resource investment keeps near-term costs and rates from increasing significantly. Deferring resource investment, however, may cause the present value of total system costs to increase because: (1) lost-opportunity resources may be forgone; (2) BPA may be forced to make more high-cost spot market purchases; or (3) there may not be enough lead-time to develop the least-cost resource alternative. Thus, higher long-run system costs and long-term rates may be a consequence of choosing to maintain the lowest near-term rates.

Minimize long-term rates and the present value of total system costs vs. minimize economic risk. There may be a trade-off of total system costs for resource flexibility if the least-cost approach creates unacceptable exposure to an extremely costly, but low probability outcome, i.e., dry hole risks. Therefore, BPA may need to adopt a Resource Program that minimizes such economic risks but at a higher net present value of total system costs. The Resource Program that minimizes economic risk may entail higher or lower near-term budgets than the least-cost approach.

Minimize the present value of total system costs vs. minimize environmental impacts. The trade-off here may be between a resource which has the lowest present value of total system costs, but which also has unacceptable nonquantifiable environmental costs. BPA could choose to substitute a resource with higher economic costs, but with reduced nonquantifiable environmental costs.

In the Draft 1990 Resource Program BPA solicited advice on these decision factors and how they should be used in choosing among alternative strategies. The majority of public comments were supportive of these decision factors as balanced and comprehensive. The total system cost criterion received the most

comment. While some commenters argued for increased emphasis on this decision factor, others suggested that minimizing near-term rate impacts was most important.

In deciding on the 1990 Resource Program, BPA carefully considered all of the public comment on decision factors. BPA remains committed to a balanced approach in comparing resource alternatives. In Chapter VII these decision factors are used in a quantitative and qualitative evaluation of resource alternatives and selection of the final 1990 Resource Program.

CHAPTER IV

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. BPA uses these estimates to plan acquisition of cost-effective resources to meet firm loads and to assist in conservation program design. The Northwest Power Act defines cost-effective, 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 of the consumers, as determined by the Council or the Administrator as appropriate, 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.

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 generating resources are relatively straightforward: timing, cost, and production. Forecasting conservation resources is more difficult because it requires additional assumptions about market penetration, market availability and the correct installation of measures. Costs related to replacement power are incurred when conservation is overestimated. If conservation is underestimated, there will be costs incurred relative to incorrectly timing the on-line date of a new alternative resource. Therefore, BPA has taken a conservative approach to forecasting the conservation resource.

Detailed draft technical publications documenting the conservation and generation estimates used in this Resource Program were published in January 1990. The Draft 1990 Conservation Resource Supply Document, and the Draft 1990 Generating Resource Supply Forecast are summarized in the following sections.

A. 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 can reduce the need for costly generation plants. Efficiency improvements are achieved by installing energy conservation measures (ECM's) that increase the productivity of electric energy.

Conservation resources are categorized according to sector: residential, commercial, industrial, and agricultural. The conservation potential for each sector is forecast by developing supply estimates that indicate the cost and savings of the ECM's within each sector. The sector potential is the sum of the savings from all of the ECM's within the sector. BPA, utility, and Council staff worked closely 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. ^{1/} 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 some base year dollar level (e.g., 1988 dollars) and the effects of inflation are removed from the stream of costs. The cost-effective limit for conservation resources is determined by evaluating the cost of the long-term alternative generation resource, which is a coal-fired generation plant. The real levelized cost of such a plant is estimated at 40 mills/kWh (1988 dollars).

This real levelized cost of an alternative generation resource is then adjusted to make the conservation and generation resource costs comparable. The Northwest Power Act provides conservation a 10 percent cost advantage over generation to compensate for some of the significant, but unpriced benefits of conservation, such as environmental benefits. An additional 7.5 percent is credited to offset energy losses avoided because of decreased transmission and distribution line losses associated with conservation. Finally, 2.5 percent is credited because of the avoided cost of constructing transmission and distribution lines to serve the load that conservation defers. The sum of these adjustments is a 20 percent increase in the 40 mills/kWh cost-effective limit which has been rounded off to 50 mills/kWh (1988 dollars). This 50 mills/kWh limit:

^{1/} The Council recently began reporting both "real" levelized and "nominal" levelized costs. The Council felt that nominal levelized costs were more comparable to rates. BPA continues to use real levelized costs because they have been the most useful summary of resource costs for BPA's purposes. 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 multiplying them by the following factors, which depend on the resource's lifetime. For resources with 20-, 30-, 40-, or 50-year lives, multiply real levelized costs by 1.53, 1.77, 1.97, or 2.14, respectively, to convert to nominal levelized costs. For the purpose of this report BPA calculated nominal levelized costs for a normalized 40-year resource life by multiplying each real levelized cost by 1.9.

- i. sets the cost limit on measures to be included in the conservation resource supply estimates, and
- ii. affects the relative placement of conservation in the resource stack (see Chapter VI-A).

1. Savings

The development of conservation supply estimates takes place in two steps. First, the technical conservation resource potential is established, and then 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. 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 of it can realistically be achieved. The first adjustment is a 7.5 percent increase in technical savings potential to account for energy losses which would occur during transmission over the lines if generation resources were acquired in lieu of conservation.

The second adjustment is a reduction of the technical potential to the percentage of the target market which realistically will acquire the conservation measures. This adjustment acknowledges that each conservation market has a saturation point below 100 percent, 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 estimate of 1989 achievable conservation potential those conservation savings that BPA expects to acquire through programs before the FY's 1992 and 1993 planning period begins. This adjustment includes savings acquired through existing programs, new budgeted programs, and codes and standards in place through 1989. These three adjustments produce an estimate of the conservation savings that will realistically be available for the planning period beginning in FY 1992.

2. Costs

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

Administrative costs are added to these resource costs to estimate the total costs required to provide the energy savings. Administrative costs include the costs of audits, inspections, and the program management required to ensure effective, responsible programs. Administrative costs are calculated as a percentage of the costs of the conservation measures. For

example, administrative costs for commercial programs are estimated, based on national program experience, to be 30 percent of the cost of the measures installed in the commercial program.

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 percent. The present value of this nominal payment stream is then calculated with an 8.15 percent discount rate. The resulting present value is then levelized over the term of the savings with a 3 percent 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 better predict 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 more discussion of this topic.

Tables IV-1 to IV-4 characterize the conservation resources. These resources are characterized in terms of the achievable potential and the average capital and operating and maintenance (O&M) costs needed to provide conservation savings 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 for the life of the home.

Conservation resources are further classified as lost-opportunity or discretionary/deferrable resources. This distinction reflects the timing of the resource's availability (these concepts are discussed in more detail in Chapter VI-C). Where appropriate, the seasonal distribution of savings is also specified. Finally, program ramp rates are determined. Program ramp rates describe the fraction of achievable potential that can be acquired annually, and reflect ease of access to the market.

3. Summary Presentation of Conservation Estimates by Sector

The Tables in this section summarize the achievable conservation potential for 1992-2010 from the medium load forecast for each of the major end-uses. The total regional achievable potential ranges from about 1,100 aMW for the low forecast, to 1,700 aMW for the medium forecast, to about 2,400 aMW for the high forecast. For BPA it is about 500 aMW for the low forecast, 760 aMW for the medium forecast, and about 1,100 aMW for the high forecast. (See the BPA publication Draft 1990 Conservation Resources Supply Document for a more detailed technical description of these resources and the estimation methods.) In comparison, for the 1988 Resource Program, the total achievable potential in the region under the medium case forecast was estimated to be 1,620 aMW.

a. Residential Sector

The residential sector is separated into three end-uses: space heating, water heating, and appliances. Assessments have not been performed for residential lighting and other end-uses. The space heating end-use is divided into single-family, multifamily, and manufactured housing. All measures that weatherize a house, such as storm windows or ceiling insulation, comprise the space heating resource. The potential energy savings in existing buildings comes from weatherization of existing homes. For new buildings, the resource potential is an estimate of the quantity of savings beyond 1989 State building codes up to the MCS. This estimate includes savings which will be realized through the adoption of MCS in Washington State. Solar access savings occur with the adoption of local building codes that require beneficial orientation to the sun and restrictions on surrounding building setbacks and heights. The potential savings from these codes are included with savings for new single-family buildings. Administrative costs are estimated to be 20 percent of the measure costs for all residential space heat programs. Table IV-1 summarizes the savings potential in this sector.

The water heating resource consists of several measures: energy-efficient water heaters, R-11 wraps for water heaters, low-flow showerheads, energy-efficient dishwashers, and energy-efficient clothes washers. The water heating savings are shown on Table IV-2.

At this time, the residential appliance supply estimate includes only refrigerators and freezers. Appliance savings come from commercially available measures that exceed the present National Appliance Efficiency Standards for Refrigerators and Freezers. See Table IV-2 for the appliance summary.

Administrative costs are assumed to be 22 percent, 19 percent, and 15 percent for refrigerators, freezers, and water heating, respectively.

b. Commercial Sector

The commercial sector is the fastest growing sector in the region in terms of energy consumption. Consequently, the commercial resource is important to BPA. As analyzed, this sector consists of 10 building types: offices, retail, restaurants, grocery stores, lodging, colleges, schools (primary and secondary), 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 this 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.

TABLE IV-1
ACHIEVABLE CONSERVATION RESOURCES - RESIDENTIAL SPACE HEAT
(Medium Loads) a/

	Existing Single Family	Existing Multi Family	New <u>b/</u> Single Family (MCS)	New Multi Family (MCS)	New Manufac- tured Houses
<u>SUPPLY</u>					
Regional supply (aMW)	102	36	116	32	96
BPA supply (aMW)	62	12	66	11	45
Term of savings (years)	50	50	70	70	45
<u>TOTAL REGIONAL COSTS <u>c/</u></u>					
Avg capital costs (1988\$/akW)	\$5,700	\$5,442	\$5,797	\$5,941	\$4,023
Avg admin costs (1988\$/akW)	\$1,140	\$1,088	\$1,115	\$1,188	\$805
Real Levelized cost (1988 mills/kWh) <u>d/</u>	33	31	29	30	24
Nominal Levelized cost <u>e/</u>	65	61	57	59	47

- a/ Report of achievable potential for FY's 1992-2010 which is the technical potential plus 7.5 percent transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rate (85 percent for new residential structures, 75 percent for existing residential structures, and 50 percent for new manufactured housing).
- b/ Includes savings (11 aMW) and costs from solar access codes.
- c/ Average costs have been financed over 20 years and levelized over the term of savings.
- d/ Real levelized costs assume 100 percent debt financing at a 9.2 percent nominal interest rate, levelized over the term of savings.
- e/ Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote d/.

Source: Draft 1990 Conservation Resources Supply Document, January 1990.

TABLE IV-2

ACHIEVABLE CONSERVATION RESOURCES - RESIDENTIAL APPLIANCES
AND WATER HEAT
(Medium Loads) a/

	Refrigerators	Freezers	Water Heating
<u>SUPPLY</u>			
Regional supply (aMW)	82	29	258
BPA supply (aMW)	34	12	114
Term of savings (Years)	22	22	12
<u>TOTAL REGIONAL COSTS <u>b/</u></u>			
Avg capital costs (1988\$/akW)	\$1,371	\$1,709	\$1,328
Avg admin costs (1988\$/akW)	\$302	\$325	\$199
Real Levelized cost (1988 mills/kWh) <u>c/</u>	13	16	19
Nominal Levelized cost <u>d/</u>	26	32	37

a/ Report of achievable potential for 1992-2010 which is the technical potential plus 7.5 percent transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rates (85 percent for refrigerators and freezers, and 77 percent for water heating).

b/ Average costs have been financed over 20 years and levelized over the term of savings.

c/ Real levelized costs assume 100 percent debt financing at a 9.2 nominal interest rate, levelized over the term of savings.

d/ Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote c/.

Source: Draft 1990 Conservation Resources Supply Document, January 1990.

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. Measure cost and savings data are derived from building prototype analyses. The cumulative electrical energy savings potential for FY's 1992 through 2010 is displayed in Table IV-3.

Much of the conservation potential in existing buildings comes from retrofit measures. Existing commercial buildings often undergo remodeling or renovation, which present 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. State-wide 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. Administrative costs for the commercial sector are assumed to be 30 percent of capital costs.

c. Industrial Sector

The industrial sector includes specific types of manufacturing firms (Standard Industrial Classifications, SIC, 20-39). The industries that consume the most electricity in this sector are pulp and paper, lumber and wood products, and chemicals. These industries' major electricity consumption is for the motors that power production lines, and for lighting. In addition, electricity is used for process heating and refrigeration, and as an energy source for the manufacture of chemical compounds.

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 1990. The model combines regional industrial load forecasts, data on end-use consumption by each industry, and estimates of percentage savings for the 53 available ECM's. The product of this model is a regional supply curve that lists the cumulative savings of these ECM's, in order from the least expensive to the most expensive. Displayed in Table IV-4 is the sum of the energy savings potential from the 53 ECM's considered in the model. The 120 aMW of industrial conservation is available to BPA at the very low levelized cost of 16 mills/kWh. Administrative costs are assumed to be 20 percent for the industrial sector.

d. Agricultural Sector

The conservation potential in the agricultural sector results from the implementation of low pressure irrigation on center pivot systems, mainline improvements, and fittings redesign. Technical potential is less than previous estimates because energy-efficient motors and irrigation scheduling have been excluded as energy saving measures due to recent evaluation data. (See the BPA publication Draft 1990 Conservation Resources Supply Document for a detailed explanation of evaluation results.) Administrative costs are assumed to be 20 percent of capital costs for the agricultural sector. Energy savings potential for the agricultural sector are displayed in Table IV-4.

TABLE IV-3
ACHIEVABLE CONSERVATION RESOURCES - COMMERCIAL
(Medium Loads) a/

	Existing Buildings (Discretionary)	Existing Buildings (Lost Opps) <u>b/</u>	New Construction (Lost Opps) <u>c/</u>
<u>SUPPLY</u>			
Regional supply (aMW)	162	149	317
BPA supply (aMW)	86	72	109
Term of savings (Years)	15	15	15
<u>TOTAL REGIONAL COSTS <u>d/</u></u>			
Avg capital costs (1988\$/akW)	2,212	1,477	1,433
Avg admin costs (1988\$/akW)	664	433	430
Real Levelized cost (1988 mills/kWh) <u>e/</u>	30	20	19
Nominal Levelized cost <u>f/</u>	59	39	37

- a/ Report of achievable potential for 1992-2010 which is the technical potential plus 7.5 percent transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rates (60 percent for all commercial buildings).
- b/ Costs for all lost-opportunity resources in existing commercial are based on costs of savings in remodeled and renovated buildings, which comprise the majority of lost opportunities in existing commercial buildings.
- c/ All potential savings in new buildings are now assumed to be lost opportunities.
- d/ Average costs have been financed over 20 years and levelized over the term of savings.
- e/ Real levelized costs assume 100 percent debt financing at a 9.2 percent nominal interest rate, levelized over the term of savings.
- f/ Nominal levelized costs are normalized to a 30-year resource lifetime. Otherwise, assumptions are the same as in footnote e/.

Source: Draft 1990 Conservation Resources Supply Document, January 1990.

TABLE IV-4

ACHIEVABLE CONSERVATION RESOURCES - INDUSTRIAL AND AGRICULTURAL SECTORS
(Medium Loads) a/

	Industrial	Agricultural (Irrigation)
<u>SUPPLY</u>		
Regional supply (aMW)	256	35
BPA supply (aMW)	120	14
Term of savings (Years)	20	20
<u>TOTAL REGIONAL COSTS <u>b/</u></u>		
Avg capital costs (1988\$/akW)	\$1,606	\$1,648
Avg admin cost (1988\$/akW)	\$321	\$329
Real Levelized cost (1988 mills/kWh) <u>c/</u>	16	16
Nominal Levelized cost <u>d/</u>	32	32

- a/ Report of achievable potential for 1992-2010 which is the technical potential plus 7.5 percent transmission and distribution savings, minus historical and budgeted program savings, and adjusted for assumed sector saturation rates (85 percent for industrial and 85 percent for irrigation).
- b/ Average costs have been financed over 20 years and levelized over the term of savings.
- c/ Real levelized costs assume 100 percent debt financing at a 9.2 percent nominal interest rate, levelized over the term of savings.
- d/ Nominal levelized costs are normalized to a 40-year resource lifetime. Otherwise, assumptions are the same as in footnote c/.

Source: Draft 1990 Conservation Resources Supply Document, January 1990.

B. Generation and Contractual Resources

This section describes the data sources and rationale used for determining the types and amounts of the generation and contractual resources included in BPA's resource supply estimates. BPA, the Council, and the PNUCC are continuing to cooperate in developing generation resource supply estimates. The three organizations have focused their efforts on specific resources and have used the Council's and BPA's existing public involvement processes. This collaboration has eliminated duplication of effort and has permitted more issues to be explored given the limited time and staff of each organization.

The complete menu of these resources considered for the 1990 Resource Program are documented in BPA's Draft 1990 Generating Resource Supply Forecast (January 1990). This section of the Resource Program summarizes the costs and characteristics of the resources used in the 1990 Resource Program analysis and incorporates several refinements that were made to the resource data contained in the January report. For some resources, significant assessment activity has occurred since the 1988 Resource Program was completed. Where this activity has resulted in changes, these changes have been reflected in the supply forecasts. Refinements continue to be made to resource projections. The resource data contained in this document reflect the status of this information at the time analysis was performed. Discussion is also presented regarding anticipated changes in some resource information.

Table IV-5, Generation Resource Summary, summarizes those resources that are included in the analysis for this Resource Program. Table IV-6, Financial Factors, lists the factors used to calculate the levelized costs for each resource type reported in this section. These levelized costs are stand-alone calculations useful for approximating the costs of resources relative to each other. With the exception of the CT's and displaceable purchases, these costs do not reflect the system costs associated with the interaction of resources when operated together and when operated with the existing BPA system.

1. New Hydro

The 1988 Resource Program used hydroelectric resource supply estimates that were developed for the 1987 Resource Strategy. This estimate included 850 aMW at a real levelized cost of less than 60 mills (1986 dollars). This estimate was the average of existing high and low estimates that were available at the time. There was considerable regional discussion regarding the hydro estimates and environmental concerns that would affect the amount of the resource that was estimated to be available for development. These discussions and the conflicting estimates resulted in the initiation of a number of activities which attempted to address the concerns in a systematic manner. The most notable were: (1) the Pacific Northwest Hydro Power Site Data Base, developed jointly by the Council, the U.S. Army Corps of Engineers (Corps), and BPA; (2) the Pacific Northwest Rivers Study, developed jointly by the Council, BPA, and the four Northwest States; and (3) the Protected Areas Study conducted by the Council. These three activities were conducted during the last 4 years. They formed the basis for, and provided the tools to develop, the current estimates of new hydroelectric resources.

TABLE IV-5

GENERATION RESOURCE SUMMARY

	Quantity (aMW)		Levelized Cost (Real 1988 \$)		Levelized Cost (Nominal \$)	
	Regional	BPA a/	Private	Public	Private	Public
New Hydro						
Hydro-1	91	23	22	18	43	35
Hydro-2	103	26	37	30	73	59
Hydro-3	126	32	50	40	98	79
Hydro-4	89	22	61	50	120	98
Cogeneration						
Cogen-1	125	31	30	30	59	59
Cogen-2	500	125	35	35	69	69
Cogen-3	1,000	250	40	40	79	79
Cogen-4	4,000	1,000	45	45	89	89
Transmission Efficiency Improvements	34	34	N/A	15-45	N/A	30-89
Hydro Electric Efficiency Improvements	112	112	N/A	13	N/A	26
Imports	c/	500	N/A	40	N/A	79
CT's and Displaceable Purchases	c/	1500	27-35 b/	25-33 b/	52-68	49-65
Large Coal	10,000	5,000	42	38	83	75
WNP-1	N/A	813	N/A	34	N/A	67
WNP-3	N/A	806	N/A	34	N/A	67

a/ Amount available to BPA for New Hydro and Cogeneration is estimated to be 25 percent of the regional amount. This estimate reflects BPA entering the market later than the IOU's.

b/ The cost of power resulting from using nonfirm energy with CT's is dependent on the amount of nonfirm energy available, the value of nonfirm energy, the cost and availability of fuel to operate such CT's, and nonfirm pricing policies. For a combined cycle CT running in baseload mode and using interruptible natural gas (NWPPC 1989 Supplement, Vol. 2, Table 4-7) the levelized cost equals 41 mills (public) and 43 mills (private). For the hybrid gas series, the cost is 43 mills (public) and 45 mills (private).

c/ Estimates for region not developed.

TABLE IV-6

FINANCIAL FACTORS USED IN GENERATION SUPPLY ESTIMATES

Factor	Percent
<u>REAL ESCALATION RATES</u>	
Capital	1.2
O&M	0.7
Fuel	
Coal	1.3
Natural Gas	2.3
<u>TAX RATES</u>	
Federal	34.0
State	3.7
Insurance	0.25
Gross Revenue	
Public	2.2
Private	2.1
<u>FINANCIAL ASSUMPTIONS</u>	
Price Level (year)	1988
Nominal Debt Interest Rate	
Public	7.4
Private	9.6
Nominal Return on Equity Rate	
Private	13.0
<u>REAL DISCOUNT RATE</u>	3.0
<u>INFLATION RATE</u>	5.0

The Pacific Northwest Hydro Power Site Data Base includes data on all projects that have been filed with the Federal Energy Regulatory Commission (FERC). The data base analysis system has the capability to estimate project cost, capacity, and output where this information was not provided by developers. The Pacific Northwest Rivers Study developed a methodology for assigning values to a variety of fish, natural resource, and recreation features by river reach. The Protected Areas identified by the Council defined those areas which should not be developed due to anadromous fish impacts.

Table IV-7, New Hydro, summarizes the results of exercising the Pacific Northwest Hydro Power Site Data Base using current project data along with information from the Rivers Study. All sites located in Protected Areas were screened from the analysis. The data base analyses were made in March 1989 and remain current because project activity has been small over the subsequent months. These same analyses were used by the Council in the 1989 Supplement.

2. Cogeneration

The 1988 Resource Program used cogeneration supply estimates that were used for the 1987 Resource Strategy. This estimate included 208 aMW at a real levelized cost of 35 mills (1986 dollars). This figure was extracted from the estimates produced for the 1986 Power Plan. It was recognized at that time that a good data base of potential cogeneration facilities, as well as a more rigorous methodology for developing a projection of developable supply, was required.

In 1987, BPA addressed this need by retaining ADM Associates to assess the potential for cogeneration in the industrial and commercial sectors in the Pacific Northwest. The results of this effort were presented at a public seminar in 1988. Based on feedback received from this presentation, BPA retained Techplan Associates to conduct additional analysis and further refine the methodology. The results of this refinement were presented at a seminar in May 1989. A summary presentation was also given to the Resource Program TRP.

Table IV-8, Cogeneration Supply Estimates, was developed based on data presented to the TRP. This Table reflects the cogeneration estimates used for the Draft 1990 Resource Program. Since no additional analysis was performed for the 1990 Resource Program, the figures in Table IV-8 represent the cogeneration assumptions for planning purposes.

The TRP suggested that advice be sought from the industrial and utility communities regarding key variables used in the Techplan analysis. As a result of this recommendation, BPA established two working groups, one representing utilities and one representing industry. BPA hosted the Industry Working Group and the PNUCC agreed to host the Utility Working Group. Each working group produced a report containing recommendations regarding assumptions used in the Techplan analysis. Additional analyses using the cogeneration model were prepared and results of these analyses were reported

TABLE IV-7
NEW HYDRO SUPPLY ESTIMATES

	Hydro-1	Hydro-2	Hydro-3	Hydro-4
<u>PLANT CHARACTERISTICS</u>				
Operating Life (years)	50	50	50	50
Unit Size-Net (MW)	10	10	10	10
Equivalent Availability (%) <u>a/</u>	-	-	-	-
Forced Outage Rate (%) <u>a/</u>	-	-	-	-
Planned Outage Rate (%) <u>a/</u>	-	-	-	-
Capacity Factor (%) <u>a/</u>	48%	36%	37%	36%
Heat Rate (Btu/kWh)	N/A	N/A	N/A	N/A
<u>COSTS (1988 \$)</u>				
Preconstruction (\$/kW)	74	93	128	155
Option Hold (\$/kW/yr)	3	3	4	5
Capital (\$/kW)	985	1235	1703	2061
Fixed O&M (\$/kW/year)	21	27	37	44
Variable O&M (\$/kWh)	N/A	N/A	N/A	N/A
Fixed Fuel (\$/kW/yr)	N/A	N/A	N/A	N/A
Fuel (\$/million Btu)	N/A	N/A	N/A	N/A
<u>LEADTIMES (years)</u>				
Preconstruction	3	3	3	3
Construction	3	3	3	3
<u>LEVELIZED REAL COST (mills/kWh)</u>				
Private Financing	22	37	50	61
Public Financing	18	30	40	50
<u>LEVELIZED NOMINAL COST (mills/kWh)</u>				
Private Financing	43	73	98	120
Public Financing	35	59	79	98
<u>SUPPLY FORECAST (aMW-incremental)</u>				
Regional	91	103	126	89
BPA <u>b/</u>	23	26	32	22

a/ Capacity Factor represents the firm energy output of the resource.
Availability and outage rates are imbedded in this figure.

b/ Twenty-five percent of the regional potential is considered available to BPA.

TABLE IV-8
COGENERATION SUPPLY ESTIMATES

	Cogen-1	Cogen-2	Cogen-3	Cogen-4
<u>PLANT CHARACTERISTICS</u>				
Operating Life (years)	20	20	20	20
Unit Size-Net (MW)	10	10	10	10
<u>LEADTIMES (years)</u>				
Preconstruction	2	2	2	2
Construction	2	2	2	2
<u>LEVELIZED REAL PRICE (mills/kWh)</u>				
Private Financing	30	35	40	45
Public Financing	30	35	40	45
<u>LEVELIZED NOMINAL PRICE (mills/kWh)</u>				
Private Financing	59	69	79	89
Public Financing	59	69	79	89
<u>SUPPLY FORECAST (aMW-incremental)</u>				
Regional	125	500	1000	4000
BPA	31	125	250	1000

in the Council's Issue Paper #89-45, Potential Cogeneration in the Pacific Northwest, which was jointly prepared by BPA and the Council. This issue paper was circulated throughout the region as well as to the cogeneration working groups.

Table IV-9, New Cogeneration Supply Estimates, reflects the figures reported in Council Issue Paper #89-45. Two factors affecting the cogeneration potential bear elaboration. First, it should be noted that prices are reported rather than costs. This reflects the methodology used to develop cogeneration estimates, as well as the likely mechanism that will be used to acquire this resource (i.e., third party developers). The use of prices rather than costs has the effect of underestimating the quantity of supply. Second, it also should be noted that, subsequent to the distribution of the cogeneration issue paper, the Council further reduced its estimate of the quantity of the cogeneration resource from what had been derived in the joint assessment process by constraining the quantity of biomass fuel available for cogeneration applications. This reduction does not have an effect on prices less than 40 mills. For future analyses, BPA has elected to retain the estimates reported in the Power Planning Council's issue paper on cogeneration. The issue paper was widely distributed and appeared to provide a point of consensus in the region. BPA will continue to refine the cogeneration forecast as additional information is received and further analyses are performed.

3. Large Thermal Resources

a. Base Case for Resource Program Analysis. Table IV-10, Large Thermal, summarizes the plant characteristics and costs of WNP-1 and -3 as well as the single point estimate for large coal-fired resources. Except for escalation to 1988 dollars, the data are the same as those used for the 1988 Resource Program. No new capital or operating cost information has been developed for these resources. Cost for delivered coal (Powder River Basin to Eastern Oregon) begins at a slightly lower level (\$1.49/MM British thermal unit (Btu)), than in the 1988 Resource Program (\$1.58/MMBtu); however, the cost escalates at a higher average rate which results in a delivered cost in the year 2000 of \$1.74/MMBtu.

Coal plant capital and operating cost estimates are based primarily on the October 1987 report, "Comparative Electric Generation Study, Coal-Fired Power Plants," prepared by Kaiser Engineers. This report examined different sizes and types of coal-fired generation facilities. The cost reported in Table IV-10 is for a twin-650 MW (gross) project.

Coal cost estimates reflect the best available control technology for emission control. No adjustments have been made to reflect future emission constraints.

The costs to complete and operate WNP-1 and -3 were originally developed by the Washington Public Power Supply System (Supply System) for BPA's 1987 WNP-1 and -3 Study. No new cost information for these plants has been developed.

TABLE IV-9
NEW COGENERATION SUPPLY ESTIMATES

	Cogen-1	Cogen-2	Cogen-3	Cogen-4	Cogen-5	Cogen-6
<u>PLANT CHARACTERISTICS</u>						
Operating Life (years)	20	20	20	20	20	20
Unit Size-Net (MW)	10	10	10	10	10	10
<u>LEADTIMES (years)</u>						
Preconstruction	2	2	2	2	2	2
Construction	2	2	2	2	2	2
<u>LEVELIZED REAL PRICE (mills/kWh)</u>						
Private Financing	30	35	40	45	50	55
Public Financing	30	35	40	45	50	55
<u>LEVELIZED NOMINAL PRICE (mills/kWh)</u>						
Private Financing	59	69	79	89	98	108
Public Financing	59	69	79	89	98	108
<u>SUPPLY FORECAST (aMW-incremental)</u>						
Regional	40	400	360	500	1500	500
BPA */	10	100	90	120	380	120

*/ Twenty-five percent of the regional potential is considered available to BPA.

TABLE IV-10
LARGE THERMAL SUPPLY ESTIMATES

	WNP-1	WNP-3	Large Coal */
<u>PLANT CHARACTERISTICS</u>			
Operating Life (years)	40	40	40
Unit Size-Net (MW)	1250	1240	603
Equivalent Availability (%)	65%	65%	75%
Forced Outage Rate (%)	26%	26%	17%
Planned Outage Rate (%)	12%	12%	10%
Equivalent Availability (%)	-	-	-
Heat Rate (Btu/kWh)	N/A	N/A	10856
<u>COSTS (1988 \$)</u>			
Preconstruction (\$/kW)	0	0	23
Option Hold (\$/kW/yr)	4.0	4.4	0.8
Capital (\$/kW)	1205	1054	1211
Fixed O&M (\$/kW/year)	78.85	84.15	20.50
Variable O&M (mills/kWh)	6.75	6.75	1.90
Fixed Fuel (\$/kW/yr)	N/A	N/A	8.60
Fuel (\$/million Btu)	N/A	N/A	1.49
<u>LEADTIMES (years)</u>			
Preconstruction	N/A	N/A	4
Construction	5	5	6
<u>LEVELIZED REAL COST (mills/kWh)</u>			
Private Financing	N/A	N/A	42
Public Financing	34	34	38
<u>LEVELIZED NOMINAL COST (mills/kWh)</u>			
Private Financing	N/A	N/A	83
Public Financing	67	67	75
<u>SUPPLY FORECAST (aMW)</u>			
Regional	N/A	N/A	10,000
BPA	813	806	5,000

*/ See text (along with Table IV-11) for discussion of proposed five block description of the coal supply forecast.

b. New Coal-Fired Resource Forecast. The Council and BPA have collaborated on the development of a new forecast of large coal-fired resources. Although some adjustment of this forecast is expected, it is sufficiently defined to warrant discussion. BPA anticipates incorporating the refined version of the coal forecast in analyses conducted after the 1990 Resource Program is issued.

The single point estimate of coal has served two purposes. First, it has been an easy way to use single estimate of the average cost of expected new coal-fired generation, and, second, it has served as the region's long-term incremental resource. This new coal-fired forecast attempts to improve this single point estimate by approximating practical conditions that would be faced by the region if this resource were developed. These conditions include a limited number of sites, different sources of fuel, emission constraints, and a qualitative restriction on the quantity of coal-fired resource that can be developed at any one site.

Figure IV-1, Regional Coal-Fired Resource, New Supply Forecast, and Table IV-11, New Coal-Fired Resource Supply Forecast-Summary, show the results of this redefinition of the coal forecast. The resource is described as five blocks, each block containing a range of cost estimates (high and low cases). A "Base Case" is also developed for each block for analysis purposes. This Base Case is a composite of the high and low cases, and will be used in subsequent analysis.

The five blocks are distinguished by different sites. 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 the most inexpensive sources based on existing mining and transportation costs.

The factor that differentiates the high and low cases is the capital and operating costs of the conversion technology. The starting point for estimating these costs is the large and small coal-fired technologies described in the October 1987 report, "Comparative Electric Generation Study, Coal-Fired Power Plants," prepared by Kaiser Engineers.

The fuel costs and their associated escalation rates are summarized in Table IV-12, Derivation of Fuel Costs. These figures are based on DRI/McGraw-Hill Cost Information Service and Energy Review forecasts dated January 1990, as well as current intelligence from government and coal industry resources in the U.S. and Canada. A risk assessment model, incorporating the collected data, produced a range of possible future delivered coal costs.

The spreadsheet based model uses probability distributions and Monte Carlo simulations to produce five ranges of possible future coal prices for each new coal resource block. Published data on producer price indexes, coal spot prices, coal production costs, rail line-haul costs, and information

Figure IV - 1

Regional Coal — Fired Resource

New Supply Forecast

TABLE IV-11
NEW COAL-FIRED RESOURCE SUPPLY FORECAST
SUMMARY

	Coal-1	Coal-2	Coal-3	Coal-4	Coal-5
SURROGATE SITE	Colstrip	Creston	Boardman	Thousand Springs	Western WA/OR
ASSUMED COAL SOURCE	Colstrip	East Kootenay	East Kootenay	Uinta	East Kootenay
<u>LEVELIZED REAL COST (mills/kWh) a/</u>					
High Case	41	48	49	52	52
Base Case	37	45	46	47	49
Low Case	33	40	41	43	44
<u>LEVELIZED NOMINAL COST (mills/kWh) a/</u>					
High Case	81	95	97	102	102
Base Case	73	89	91	93	97
Low Case	65	79	81	85	87
<u>SUPPLY FORECAST (aMW-incremental)</u>					
Regional	1800	750	750	750	750
BPA <u>b/</u>	450	190	190	190	190

a/ Fifty percent private/50 percent public financing assumed.

b/ BPA portion of resource assumed to be 25 percent of regional potential.

TABLE IV-12

**NEW COAL-FIRED RESOURCE SUPPLY FORECAST
DERIVATION OF FUEL COSTS
(1988 Dollars)**

	Coal-1	Coal-2	Coal-3	Coal-4	Coal-5
SURROGATE SITE	Colstrip	Creston	Boardman	Thousand Springs	Western WA/OR
ASSUMED COAL SOURCE	Colstrip	East Kootenay	East Kootenay	Uinta	East Kootenay
<u>COST OF FUEL (\$/MMBtu)</u>					
Minemouth	0.48	0.88	0.88	0.98	0.88
Track Upgrade	0.00	0.07	0.00	0.00	0.00
Rail Haul	0.00	0.33	0.46	0.28	0.66
Rolling Stock	0.00	0.04	0.05	0.03	0.07
TOTAL	0.48	1.32	1.39	1.29	1.61
Fuel Escalation-Real (%)	1.0	1.0	1.0	0.5	1.0

from phone interviews are input to the model. The Monte Carlo simulations produce means and standard deviations for the price of delivered coal to each generation site from 1990 to 2010. The figures in Table IV-12 represent the "most likely" estimate of fuel costs produced by the model.

4. Transmission and Distribution (T&D) Efficiency Improvements

Table IV-13, Other Planned Resources, shows 34 aMW available through BPA transmission system efficiency improvements at a cost of 15 to 45 mills (1986 dollars). The 34 aMW figure was first reported in the 1986 Power Plan and is based on improvement projects identified by BPA. BPA reexamined the list of projects that were included in the 1986 Power Plan. While some modification and adjustment of this project list appears to be warranted, BPA believes that the 34 aMW figure is still a credible overall estimate of the improvements available on the Federal system. Rather than expend the effort to refine the estimate of this relatively small resource, BPA is identifying two to four clearly cost-effective projects and is presently budgeting for their implementation in the FY's 1992 through 1997 budget period.

BPA, working with the Power Planning Council (PPC) and PNUCC, has developed a regional estimate of customer utility distribution system efficiency improvements (including conservation voltage regulation) of 265 aMW. As in most conservation resources, this resource is not available directly to BPA because it requires modification and operation of BPA's utility customer distribution system. BPA is currently participating in the evaluation of specific pilot projects in the Northwest and will be assessing what actions it can take that will encourage development of cost-effective efficiency improvements on its customer's systems.

5. Hydropower and Thermal Efficiency Improvements

Table IV-13, Other Planned Resources, shows 100 aMW available from hydro efficiency improvements. These improvements consist mainly of electronic 3-D cam installation on existing Kaplan hydropower turbines. These savings estimates were first discussed by BPA in 1985 (Generating Resource Supply Curves, DOE/BP-473, July 1985). Most of the turbines that could be modified are located at Corps of Engineers (Corps) and Bureau of Reclamation (Bureau) projects.

Approximately 15 aMW of additional efficiency improvements consist of proposed improvements at the Supply System's WNP-2 facility. These improvements consist of a high pressure turbine upgrade, turbine valve operating optimization, and circulating water pump adjustable speed drivers.

Since the real levelized cost of the hydropower and thermal improvements is very low (less than 13 mills/kWh), they are clearly cost-effective. Implementation, however, requires close coordination with the Corps, the Bureau, and the Supply System relative to the planned maintenance activities on the projects. Consequently, the acquisition of this resource is spread over a number of years. Specific schedules and acquisition mechanisms have yet to be established.

TABLE IV-13

OTHER PLANNED RESOURCES SUPPLY ESTIMATES

PLANT CHARACTERISTICS		T&D Eff Improv	Hydro Eff Imp	Imports	CT's and Displaceable Purchases
Operating Life (years)		30	40	20	30
Unit Size-Net (MW)		1	1	-	420
LEADTIMES (years)					
Preconstruction		2	1	-	2 a/
Construction		1	1	-	3 a/
LEVELIZED REAL COST (mills/kWh)					
Private Financing	N/A	N/A	N/A	N/A	27-35 b/
Public Financing	15-45	13	40	25-33 b/	
LEVELIZED NOMINAL COST (mills/kWh)					
Private Financing	N/A	N/A	N/A	53-69	
Public Financing	30-89	26	79	49-65	
SUPPLY FORECAST (aMW)					
Regional		34	100	c/	c/
BPA		34	100	500	1500

a/ Leadtime listed for CT's. Displaceable purchases could be substantially less.

b/ The cost of power resulting from using nonfirm energy with CT's is dependent on the amount of nonfirm energy available, the value of nonfirm energy, the cost and availability of fuel to operate such CT's, and nonfirm pricing policies. For a combined cycle CT running in baseload mode and using interruptible natural gas (NWPPC 1989 Supplement, Vol. 2, Table 4-7) the levelized cost equals 41 mills (public) and 43 mills (private). For the hybrid gas series, the cost is 43 mills (public) and 45 mills (private).

c/ Estimates for Region not developed.

6. Imports

Two sources of extra-regional contractual resources are potentially available to BPA: (1) imports from the Pacific Southwest, and (2) extra-regional energy from Canada. Because of anticipated high operating costs of firm energy imports from the Pacific Southwest, it was assumed that any resources available from the Southwest would be of greatest benefit to the Federal System when used in conjunction with BPA's nonfirm energy. This is discussed in the section on CT's and displaceable purchases. Energy from Canada is potentially available from two sources: (1) increased coordination of storage, and (2) repurchase of the Canadian entitlement or purchase of new resources.

a. Increased Coordination of Storage. BPA continues to negotiate with a number of interested parties in Canada and the U.S. about expanded coordination of hydropower operations on the Columbia River. Additional coordination on the Columbia would be accomplished through expansion and extension of the existing Non-Treaty Storage Agreement (NTSA), which expires in 1993.

New agreements between BPA and British Columbia Hydro (BC Hydro), and between BPA and the mid-Columbia utilities, would govern the release, storage, and replacement of water, over and above water governed by the Columbia River Treaty at the Mica Dam in British Columbia, and the generation of power produced by this water at dams downstream. An expanded and extended NTSA could make up to 150 aMW of additional firm energy available to the Pacific Northwest.

Discussions of non-Treaty storage are occurring as part of larger discussions about expanded coordination between the Pacific Northwest and British Columbia. If an agreement could be reached with BC Hydro on full coordination of the Peace River, as well as full coordination of the Columbia, an additional 150 aMW, or a total of 300 aMW of firm energy could be added to the Northwest system (one-half of the 600 aMW for the combined Canadian and Pacific Northwest systems). No new construction costs would be involved.

For purposes of analysis in this Resource Program, additional energy from non-Treaty storage is not assumed to be available as firm power until negotiations are completed and a contract is in place.

b. Entitlement or New Resources. Under the Columbia River Treaty (Treaty) of 1961, Canada built three large storage projects on the upper reaches of the Columbia River. In exchange, Canada received rights to half of the downstream power produced as a result of regulation of the storage added under the Treaty.

Canada did not need the additional power at that time and sold its share to U.S. utilities for 30 years. The Canadian share of this additional power is called the "Canadian Entitlement." These contractual sales to the U.S. expire in stages between 1998 and 2003, after which the respective amounts of entitlement power revert to Canada. In 2003, the amount

of firm energy to be delivered to Canada is estimated at 600 MW. BPA considers a major portion of this as a Federal obligation in the 1998 to 2003 period.

At this time BPA does not know what share, if any, of these or other resources Canada will be willing to sell, or at what price. Canada's decision will be made in the context of evaluations of their future domestic resource needs, costs of developing new resources, and other opportunities in the export market. BPA may know more about Canada's intentions regarding possible resale of this power by 1992 with delivery dates occurring after 1998. BPA is pursuing an early resolution of these issues with Canada.

The 1988 Resource Program used the same import supply estimates that were used for the 1987 Resource Strategy. These estimates included 200 aMW at a real levelized cost of less than 30 mills (1986 dollars). On the basis of information available to date, 500 aMW of imports from Canada is included in the 1990 Resource Program analysis at an assumed cost of 40 mills/kWh.

7. CT's and Displaceable Purchases

The amount of power available from the Pacific 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 additional energy beyond firm energy. Any generation in excess of firm energy is called "nonfirm" energy. The Federal hydro system produces between 2,600-3,000 aMW of nonfirm energy in an average year. Over the past 10 years BPA has sold an average of over 1,000 aMW outside the region and 550 aMW within the region as nonfirm power, in addition to serving the DSI top quartile. One proposal for meeting load is to use more of the available nonfirm energy in conjunction with another resource to serve BPA's firm loads.

Use of nonfirm in conjunction with other resources can be accomplished with a number of strategies. These include coordination with Canada; additions of displaceable firm resources, such as CT's, 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 operating the strategy.

The 1988 Resource Program used supply estimates that were developed for the 1987 Resource Strategy. This estimate included 600 aMW of CT's operated in conjunction with BPA's nonfirm energy. In February 1989, BPA completed a draft study which further evaluated the use of CT units to meet future load growth on the Federal System (Draft Firming Nonfirm, Combustion Turbine Report, February 1989). This study concluded that combined-cycle CT's are cost competitive with coal plants for serving BPA loads.

This study, along with input from the Firming Nonfirm Ad Hoc Work Group formed from the 1990 Resource Program Technical Review Panel, is the basis of the CT and displaceable purchases supply estimates shown in Table IV-13, Other Planned Resources.

BPA's estimate of this resource is composed of 1,000 aMW of Pacific Northwest combined-cycle CT's, and 500 aMW of extra-regional resources. Extra-regional resources consist of contractual arrangements with out-of-region parties, specifically those in the Pacific Southwest. BPA could arrange to purchase energy from the Pacific Southwest when water conditions on BPA's 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, BPA's analysis assumes the costs are equal to building a CT in the Pacific Northwest.

The cost of power resulting from using nonfirm energy with CT's is dependent on the amount of nonfirm energy available, the value of nonfirm energy, and the cost and availability of fuel to operate such CT's. Estimates of this amount vary depending on these conditions. However, for this analysis, this cost has been estimated to range from 25-33 mills assuming public financing and 27-35 mills assuming private financing. The lower numbers assume that nonfirm pricing is cost-based, whereas the higher numbers assume nonfirm pricing is market-based. For a combined-cycle CT running in baseload mode and using interruptible natural gas (Council's 1989 Supplement, Vol II, Table 4-7) the levelized cost equals 41 mills (assuming public financing) and 43 mills (assuming private financing). The hybrid gas series (which is a composite of firm and interruptible natural gas prices and escalation) yields a levelized cost of 43 mills (public) and 45 mills (private). The interruptible gas series begins at \$2.72/MMBtu and escalates at 2.8 percent annually. The hybrid gas series begins at \$3.16/MMBtu and escalates at 2.3 percent annually.

8. Promising Future Resources

a. Generation Resources. Several resources are not included in the analysis used for the 1990 Resource Program. These include geothermal, wind, and solar electric. The wind and solar resources are not included because of high costs, uncertain resource availability, or other factors which contribute to significant uncertainty regarding their availability or costs.

Geothermal was not included in the analysis because of the unconfirmed nature of the resource. However, data from BPA's Four-State Geothermal Study, as well as data developed for the Council, indicate that geothermal has the potential of being developed at costs that would be competitive with coal. A pilot project is proposed that would address the confirmation issue.

Substantial information is available on geothermal wind, and solar resources. Updated information on these resources is presented in detail in the Draft 1990 Generation Resource Supply Forecast, January 1990.

b. Contractual Resources. Another type of resource not included in the analysis of the 1990 Resource Program is the capacity-for-energy exchange. The capacity-for-energy exchange is an exchange of surplus capacity from BPA for firm energy. On a resource planning basis, exchanges provide a means of acquiring firm energy as an alternative to the construction of new firm resources.

Capacity-for-energy exchanges may take many forms. At BPA, a typical exchange transaction provides for the delivery of a fixed maximum amount of peaking energy to the purchaser. This fixed maximum amount is usually 3 hours times contract demand on a daily basis and 50 hours times contract demand weekly. The purchaser must return this peaking energy to BPA during off-peak hours within 24 hours of its delivery, or sometimes within 7 days. In addition, the purchaser must deliver to BPA, in exchange for the capacity service, another block of off-peak energy to be received in equal weekly installments throughout the contract year. The return of the peaking energy is designated replacement energy. The additional block of energy is designated exchange energy and constitutes a firm energy resource addition to the BPA system.

BPA's planning studies show a 2,600 MW capacity surplus over the 20-year planning horizon, ending in the year 2010. This amount of surplus capacity is the minimum available in the summer months near the end of the planning horizon; considerably more surplus capacity is available at other times during the year and earlier in the 20-year period. Contracts currently under negotiation would significantly reduce the amount of firm surplus capacity in the BPA system. Generally, any long-term sale of surplus capacity will allow for the conversion to a capacity-for-energy exchange when BPA reaches energy load/resource balance. Exchanges, unlike capacity sales, also may continue in effect should BPA ever reach capacity load/resource balance. However, the ability of BPA's system to absorb off-peak energy is not infinite. Minimum flow constraints on the hydro system, rate-of-change constraints, the amount of BPA's off-peak load, South to North transmission limits, and many other factors limit BPA's ability to accept off-peak energy without causing forced sales or spill.

This suggests that exchange energy cannot always be regarded in its entirety as a firm resource. Further studies on this subject are warranted to more precisely determine an availability factor for exchange energy.

Capacity/energy exchanges are the product of negotiations between BPA and other utilities. The outcome of such negotiations cannot be predicted with enough accuracy to warrant including such exchanges in BPA's resource supply curves. However, the Resource Program serves as a benchmark for valuing the firm energy obtained through such exchanges. If ongoing negotiations reveal an opportunity to arrange exchanges which are more economic than acquiring additional resources, BPA may enter into such exchanges, thus deferring the need to acquire more expensive new resources in the future. However, BPA does not anticipate that such exchanges would affect the cost effectiveness of the relatively low-cost resources proposed for development in the 1990 Resource Program.

CHAPTER V

ANALYTICAL APPROACH

The following is a general description of the tools, the assumptions, and the objectives of the analysis for the 1990 Resource Program.

A. Overview of Approach and Analysis Tools

The analytical approach used in the 1990 Resource Program is similar to the one used in past BPA resource analyses, including the 1986 and 1987 Resource Strategies, the 1988 Resource Program, and the 1987 WNP-1 and -3 Study. The resource analysis identifies the economic effects of various resource choices and the impacts of those choices on operation of the Pacific Northwest power system. In general, decision analysis methods are used to estimate the total system costs and rate impacts of these resource choices. Decision analysis is an appropriate and useful technique for incorporating uncertainty into BPA's resource analyses.

BPA uses the decision analysis model, Integrated System for Analysis of Acquisitions, or ISAAC, to model the power system in the Pacific Northwest. The Northwest utility community cooperatively developed ISAAC, which will be used extensively by BPA in Resource Program analyses and by the Council in developing its 1990 Power Plan.

ISAAC simulates the effects of different resource decisions by acquiring resources in response to various load forecasts and ways of operating the power system. It then calculates costs, ensuing rates, and BPA's revenue requirements and net cash-flows resulting from different acquisition decisions. ISAAC allows BPA to test a variety of resource alternatives with different combinations of assumptions. The model simulates how loads and load forecasts evolve over time, how future resource decisions would be made in response to load forecasts, and the costs of making "wrong" resource decisions in response to those forecasts.

ISAAC is also designed for risk analysis: it produces both an "expected value" estimate of the impacts of an alternative and estimates of the likelihood that the cost and rate impacts of any particular action might be much higher or lower than the "expected value" estimate. This likelihood/probability provides important information about the relative riskiness of the alternative resource actions.

In simulating the effect of resource decisions, ISAAC explicitly handles uncertainty by introducing randomness in several variables: (1) the region's load growth; (2) the amount of water available to the hydro system each year; (3) and aluminum prices (which introduces randomness into the DSI load). Each pass through the entire study period (1988 through 2034) is one "game." Each game uses a new series of random selections of values for the uncertain variables for each year. Usually many games are run (100 is standard for this analysis) to ensure that a wide range of uncertainty is modeled, and the

probability of different outcomes can be determined. The analysis also may include single games, that is, single values for the random variables, to test the viability of a resource decision under a specific condition or set of conditions.

ISAAC produces expected values for the principal variables by averaging the outcomes of the 100 games; it also produces the variance of these expected values over the 100 games. Outputs include the present value of total system costs, year-by-year revenue requirements, consumer costs, Federal System rates, resource scheduling, and loads and markets served.

Table V-1 shows some of the basic assumptions used in ISAAC for the 1990 Resource Program analysis.

B. Key Assumptions

1. Treatment of IOU and Generating Publics' Load

The 1990 Resource Program analysis maintains BPA's strategic choice first implemented in the 1987 Resource Strategy: for resource planning purposes, BPA assumes that it will serve only the load growth of customers whose net requirements are currently served by BPA. More specifically, since the IOU's are required to give BPA 7-years' notice of their intent to place load on BPA, and since no notice has been made (with one exception), the resource analysis for the 1990 Resource Program assumes no IOU load placement on BPA. The one exception is Puget Sound Power and Light, which has placed a firm load on BPA through FY 1993.

Planning on the basis of only committed loads implies that BPA will not take risks and spend money now for resources to serve future load that may not be placed on BPA. BPA will limit its resource development to meeting existing obligations, plus any long-term obligations that may result from new power sales arrangements.

The analysis does assume, however, that the generating public utilities will buy power from BPA to serve their loads over and above what is available from their own currently declared resources. Several public utilities ("generating publics") meet some of their own load with their own resources, and plan to meet at least some of their load growth by adding more new resources, rather than by buying more from BPA. Future BPA surpluses or deficits account for known resource additions. Resources which the utilities are considering, but are not committed to, have not been reflected in forecasts of BPA surpluses and deficits. These resource additions by the public utilities would not significantly change BPA's load/resource outlook, and many of these utilities have expressed interest in claiming billing credits for the resources they do add. Though granting billing credits is not the same as acquiring resources, the total costs to BPA of meeting load growth tend to be similar under either approach.

TABLE V-1

1990 RESOURCE PROGRAM ANALYSIS
BASIC ASSUMPTIONS

Study horizon	September 1988 - August 2034
Price level (inputs and outputs)	January 1988 dollars
Real discount rate	3 percent
Inflation	5 percent
Medium gas price escalation	2.3 percent (above inflation)
Curtailement costs (Short-term purchases)	50-75 mills

A recent survey of planned resource acquisitions by the PPC showed budgeted acquisitions by public utilities to be about 15 aMW in the next 5 years (over and above the planned resources already reflected in ISAAC), with further additions of up to 45 aMW likely.

To summarize, in ISAAC the IOU's acquire resources to meet their own load growth, and BPA acquires resources to meet load growth of the nongenerating publics, generating publics, Federal agencies, and DSI's. Consequently, any resource alternatives or choices studied in this analysis are choices for BPA only--the IOU's resource acquisitions are not affected by changes BPA makes in its resource choices.

2. Treatment of Loads Beyond the Year 2001

Another significant policy assumption concerns treatment of BPA's obligations past 2001. The year 2001 is important because all of BPA's current requirements contracts with utilities and DSI's expire in that year. For purposes of the analysis, it is assumed that these existing contracts are renewed in kind in 2001. The only exception is an alternative case where it is assumed that no DSI load is placed on BPA past 2001. This situation could occur due to changed contract conditions past 2001 or loss of industry load due to economic conditions.

The intent in the 1990 Resource Program is not to resolve any post-2001 contract issues, but simply to examine the effect of a substantial future loss of load such as the DSI's on the recommended Resource Program for 1992 and 1993. The Resource Program questions whether alternative actions would be better than the final Resource Program if BPA unexpectedly suffered a substantial loss of load in 2001.

C. Four-Stage Analysis

The analyses for the 1990 Resource Program consists of four stages. The objective of the analysis is to recommend resource program levels for FY's 1992 and 1993, including MW, costs, and general acquisition approach, by resource type and sector (i.e., residential, commercial, and industrial conservation, and generation resources). The following pages describe the four analysis stages.

1. Stage 1 - Macro Trade-Off Analysis

The macro trade-off analysis assesses the performance of general resource preferences under a wide range of future conditions. The product of Stage 1 provides insights and broad policy guidance concerning general resource preferences. For example, certain resource preferences will be greatly affected by gas prices, whereas other resource preferences will be greatly affected by the likelihood of a major loss of load. These insights are used to guide development of resource alternatives in Stage 3. Chapter VI-B describes the macro trade-off analysis.

2. Stage 2 - FY's 1992 and 1993 Cost Limits

The purpose of Stage 2 is to develop short-term cost limits to guide resource acquisitions in FY's 1992 and 1993. In other words, how inexpensive does a resource need to be for BPA to be willing to acquire it in FY's 1992 and 1993? Cost limits are developed using ISAAC. The cost limits represent a willingness-to-pay for resources considering load uncertainty and the other uncertainties considered. In addition, the limits depend on other model assumptions such as resource costs, availability, and gas prices.

3. Stage 3 - FY's 1992 and 1993 Resource Alternatives

The purpose of Stage 3 is to develop alternative sets of BPA resource actions for FY's 1992 and 1993. Stage 3 uses guidance provided by the Stage 2 cost limits as well as insights obtained from the Stage 1 Macro Trade-Off Analysis. The alternatives vary by the number of aMW of each resource type developed and when those aMW are acquired. Each alternative will also contain BPA's costs for its implementation. Specific alternatives considered are described in Chapter VI-D.

4. Stage 4 - Recommended Resource Program

Stage 4 brings together all the analysis results and other information from Stages 1 through 3, as well as public comments to determine the recommended resource program for FY's 1992 and 1993. In this stage, the decision factors described in Chapter III are used to assess the value of particular alternatives. Given this assessment, and using judgment, a particular set of resource actions are selected. These actions are described by numbers of aMW acquired by resource type and sector, the general acquisition approach to be used to acquire these aMW, and the proposed BPA budget associated with each resource. Following evaluation of the proposal and alternatives, the product of this stage is BPA's recommended Resource Program, consisting of recommended programs and budgets for FY's 1992 and 1993.

CHAPTER VI

DEVELOPMENT OF ALTERNATIVES

This chapter describes the steps used to develop the draft proposal, and five alternatives to the Draft, and ultimately the final 1990 Resource Program. The first Section presents the resource stack used in the analysis. The resource stack consists of a set of resources (generation and conservation) available to BPA from 1992 through 2010 with their amounts and costs. The second Section presents the macro trade-off analysis, which analyzes the performance of general resource preferences in the face of a range of future conditions. The third Section explains the development of the final program, while the fourth Section presents the alternatives to the program.

A. Resource Stack

Previous sections have described the conservation and generation resource supplies available to BPA for meeting load growth. Table VI-1 shows the estimates of BPA resource supply and costs. This listing of resources in order of cost-effectiveness is often referred to as a resource "stack." The resource stack is a menu of supply and demand options available for meeting load growth. For the Resource Program analysis, the resource stack is the menu of supply options that ISAAC chooses from to meet BPA load growth.

The resource stack contains the amount of each resource available to BPA in aMW, under both medium and high load growth, and the real levelized cost of each resource in mills/kWh. The real levelized cost of a resource is an indicator of all direct costs of that resource over its effective life. Using real levelized costs allows different types of resources to be compared consistently, since resources have different lead times, unit sizes, lifetimes, cost streams, and other characteristics. Levelized costs convert uneven streams of annual costs into an equivalent "level" stream of equal annual payments, such that the present value of the stream of levelized costs is the same as the present value of the original uneven stream. Levelized costs are usually expressed in constant dollars, i.e., estimates of inflation have been removed from the calculation of real levelized cost. Real levelized costs in Table VI-1 are expressed in 1988 dollars. The Council recently began using both real and nominal levelized costs to report resource costs. To enable easy comparison to Council documents, the nominal levelized cost of each resource is shown in the resource stack.

As a first step, BPA's resource stack is ordered on the basis of levelized cost, with the lowest levelized cost resource at the top of the stack and the highest levelized cost resource at the bottom. However, other considerations go into determining the order of the final resource stack used in the 1990 Resource Program analysis. These considerations are listed below.

TABLE VI-1

BPA'S RESOURCE STACK

Resource	Real Levelized Cost a/ mills per kWh (88\$)	Nominal Levelized Costs	b/ b/	BPA Supply 1992-2010 Med Loads	BPA Supply 1992-2010 High Loads
Hydro Efficiency Improvements	13	26		112	112
Conservation:					
Refrigerators c/	13	26		34	45
Freezers c/	16	32		12	16
Industrial	16	32		120	191
Irrigation	16	32		14	14
New Commercial	19	37		109	207
Water Heat c/	19	37		114	152
Small Hydro 1	20	39		23	23
Conservation:					
Existing Commercial Remodel and Renovation	20	39		72	72
New Manufactured Housing	23	45		45	47
New Single-Family Residential (MCS) d/	27	53		66	162
New Multifamily Residential (MCS)	28	55		11	12
Existing Multifamily Residential	29	57		12	12
Existing Single-Family Residential	30	59		62	62
Existing Commercial Discretionary	30	59		96	86
Cogeneration 1	30	59		31	31
CT's and Displaceable Purchases	26-34	51-67		1500	1500
Small Hydro 2	34	70		26	26
Cogeneration 2	35	69		125	125
BPA Trans Efficiency Improvements	36	71		34	34
WNP-1 and -3	34 e/	67		1619	1619
Cogeneration 3	40	79		250	250
BC Hydro Imports	40	79		500	500
Coal	40	79		5000	5000

- a/ Year 2000 real levelized cost in 1988 mills/kWh. Levelized costs for generating resources assume 50 percent public and 50 percent private financing. Levelized costs for conservation resources assume 100 percent debt financing at a 9.2 percent nominal interest rate.
- b/ Nominal levelized costs have been normalized to a 40-year operating life. Financing assumptions are the same as those used for real levelized costs.
- c/ Achievable aMW's are for 1995-2010.
- d/ Includes 11 aMW of solar for Medium loads and 14 aMW of solar for High loads.
- e/ Assumes all public financing.

1. Conservation Cost Advantage

The Northwest Power Act mandates a 10 percent cost advantage to conservation resources relative to generation. The purpose of this advantage is to recognize some of the additional benefits of conservation, such as more benign environmental effects. This advantage is accounted for when determining the order of conservation resources in the resource stack. Conservation resources are ordered in the stack on the basis of levelized costs reduced by 10 percent. Therefore, conservation resources are "moved up" in the resource stack and are given priority when ISAAC selects resources to meet load growth.

2. System Considerations

Levelized costs represent the cost of a resource operating in a stand-alone mode, i.e., without considering how the resource might operate in the context of the larger power system. However, many resources have system cost advantages that are not captured by the calculation of stand-alone levelized costs. These system cost advantages are important and are taken into account in ordering the resource stack.

Some system cost advantages are important when considering load uncertainty. For example, when loads are uncertain, resources with short lead times are preferred to those with longer lead times--a decision on a resource can wait until load growth is more certain if lead times are shorter. Hence, a resource with a shorter lead time may "move up" in the resource stack even though its stand-alone levelized cost is higher than that of a resource with a longer lead time.

Other system considerations that can alter the order of the resource stack are unit size, seasonality, dispatchability, and the resource's ratio of fixed to variable costs. The latter consideration is especially important with regard to resources such as CT's, since these resources are often displaced when sufficient nonfirm energy is available. Stand-alone levelized costs, therefore, are not always a good indicator of the true costs of the resource when used in conjunction with nonfirm energy.

The system levelized cost of the use of CT's in conjunction with BPA's nonfirm energy has been estimated. This estimate is assumed to be a proxy for the other major displaceable resource, displaceable purchases. This cost estimate accounts for the costs of the resource as it operates in the context of the system. This cost depends significantly on the cost of fuel, the amount of time the CT's are used, and the method by which nonfirm energy is priced. Given medium gas prices, the estimates of system levelized cost of CT's ranges from 26 mills to 34 mills (using an average of public and private financing). The lower cost estimate assumes that BPA charges cost-based rates for nonfirm power. The higher cost estimate assumes that nonfirm pricing is based on the market value for power. The placement of CT's and displaceable purchases in the resource stack is done using these numbers as guidance, along with ISAAC model results (discussed below).

The ISAAC model is used to deal explicitly with load uncertainty, dispatchability and the other system considerations as described previously. Several iterations of the model are run to determine the most cost-effective ordering of the resource stack. Cost-effectiveness is determined by finding the resource stack that gives the lowest present value of total system costs under 100 games of load uncertainty. The resulting Base Case resource stack, shown in Table VI-1, is then used in the remaining analysis for this Resource Program.

B. Macro Trade-Off Analysis

The purpose of the macro trade-off analysis is to assess the performance of general resource preferences against a wide range of future conditions. In this analysis, a resource preference is an emphasis on a particular resource type. Resource preferences may consist of an emphasis on conservation; small, flexible resources; resources such as CT's that are readily displaced by BPA's nonfirm; etc. The preferred resource type is acquired before other resource types. Specifically, the preferred resource is moved to the top of the resource stack, but its supply is not expanded.

Each resource preference is examined under the same set of different future conditions and evaluated under these conditions. Future conditions include factors such as high and low fuel prices and high loads. The performance of the resource preferences likely would vary with different resources preferred under different future conditions. The macro trade-off analysis, therefore, provides guidance for the development of specific resource actions in Stage 4.

The resource preferences analyzed are described below, as well as the future conditions considered and the results of the analysis.

1. Resource Preferences

Each resource preference is implemented in ISAAC by moving the available supply of the preferred resources to the top of the resource stack. All resource preferences are compared against a Base Case where the resource stack is in cost-effective order given 100 games of load uncertainty and the other assumptions of this analysis. ^{2/}

The resource preferences analyzed are as follows:

a. Conservation. Under this philosophy, conservation is the preferred resource, even if its levelized costs are higher than those of other resources, and is placed at the top of the resource stack. As much conservation as possible is acquired before acquiring other resources. Budgets are assumed to be unlimited and BPA pays the full costs of the conservation resource.

^{2/} The Draft 1990 Resource Program was the Base Case used to prepare the macro tradeoff analysis.

b. Renewables. In this case, BPA emphasizes renewable resources that have relatively small unit sizes. Small resources are attractive when future loads are uncertain--they may more easily be scheduled to meet load growth. Renewable resources have minimal contribution to global warming and are priority resources under the Northwest Power Act. In this case, all small hydro and cogeneration resources are moved to the top of the stack. This case could be considered a proxy for what might be acquired should BPA obtain resources through a resource bidding process.

c. CT's and Displaceable Purchases. Under this philosophy, BPA makes maximum use of the existing hydro system by acquiring low-capital cost resources to replace nonfirm energy when it is not available (see Chapter IV-B for further details on this concept). Several resource types are possible for this purpose, and two are considered in this analysis.

The first resource type is combined-cycle CT's. They are run when water conditions are insufficient to meet firm load and are displaced when sufficient water exists. The other resource available for use in conjunction with nonfirm energy is contractual arrangements with out-of-region parties, specifically the Pacific Southwest. BPA could purchase energy from the Pacific Southwest when water conditions on BPA's system were insufficient to meet BPA's firm loads.

For analysis of this resource preference, the total supply of the CT's and displaceable purchases is moved to the top of the resource stack.

d. Nonfossil. In this case, BPA takes aggressive action to mitigate global warming. Resources that do not require fossil fuels are preferred. The focus is on conservation and the completion of WNP-1 and -3. In this case, all CT's are moved to the bottom of the resource stack, along with coal.

2. Future Conditions/Sensitivities

A number of future conditions are used to evaluate the performance of the above resource preferences. Since the future is uncertain, a variety of possibilities exist that affect the performance of the resource preferences. The question asked is: "Is there some resource preference that is better than all others under all future conditions?" The testing of a variety of future conditions is designed to answer this question.

The initial future condition considered is the situation where the preferences are compared assuming 100 games of load uncertainty and all other Base Case assumptions. By definition, the Base Case resource stack will look best in this circumstance, since it is in cost-effective order assuming this future condition. Other future conditions analyzed are: high gas prices (4 percent real escalation); low gas prices (0 percent real escalation); high, certain load growth; and loss of the DSI load beginning in 2001. The sensitivity of these resource preferences to changes in the assumed discount rate is also analyzed, with cases assuming a discount rate of 1 percent and 10 percent, in contrast to 3 percent in the Base Case.

3. Overview of Results

In each of these cases, the present value of total system costs of any given resource preference under a certain future condition is compared to the present value of total system costs using the Base Case resource stack under the same future condition. This present value of total system costs is the expected value over 100 different outcomes when the uncertainties described above are taken into account. They are obtained by discounting the yearly system costs to obtain the present value of total system costs over the entire study horizon.

Table VI-2 shows the differences in present value of total system costs, expressed in 1988 dollars, for each resource preference for each set of future conditions. All negative numbers indicate cost decreases compared to the Base Case, whereas positive numbers indicate cost increases compared to the Base Case. For example, the use of CT's and displaceable purchases in conjunction with nonfirm energy is \$173 million more expensive than the Base Case under high gas prices, but \$109 million less expensive than the Base Case assuming low gas prices.

Table VI-3 shows the impacts on rates of each resource preference and future condition. Rate impacts are expressed as changes in the PF rate when comparing any given resource preference to the Base Case. All negative numbers shown are rate decreases compared to the Base Case, whereas positive numbers are rate increases compared to the Base Case. Rate impacts are expressed in 1988 dollars, and averaged for two different time periods, 1992 through 1997 and 1998 through 2005.

A number of insights are obtained by examining the results of the macro trade-off analysis. Observations on total system cost results will be described first, followed by observations with respect to rate impacts and risk analysis.

4. Total System Cost Results

First, total system cost differences across many of the cases are small. Most of the resources available to BPA have a real levelized cost between 25 and 35 mills--a fairly narrow range of costs. Hence, emphasizing particular resource types in many situations does not make much difference in total system costs.

However, even if the differences are sometimes small, different resource preferences are more cost-effective than others under different future conditions. This situation makes resource choices more difficult--no one resource preference is best under all future conditions and indicates the importance of having a diversity of resources. Therefore, assessing the probability of various future conditions is important.

TABLE VI-2

MACRO LEVEL TRADE-OFF ANALYSIS

Resource Alternatives
 Expected Present Value of Total System Costs
 (Million 1988\$)

Changes from Base Case

Future Condition	Conservation	Renewables	CT's and Displaceable Purchases	Nonfossil
Load Uncertainty	+19	+198	+54	+192
High Gas Prices	-27	+174	+173	-10
Low Gas Prices	+49	+280	-109	+644
Discount Rate 1%	-17	+423	+198	+225
Discount Rate 10%	+37	-16	-47	+73
High Loads	-90	-21	+71	-297
Loss of DSI Load	+21	+131	-12	+192

TABLE VI-3
MACRO LEVEL TRADE-OFF ANALYSIS
Resource Alternatives
Average Priority Firm Rate Impacts
(1988 mills/kWh)
Changes from Base Case

Future Condition	Conservation	Renewables	CT's and Displaceable Purchases	Nonfossil
Load Uncertainty				
1992-1997	+0.2	-0.3	-0.2	+0.0
1997-2005	+0.1	-0.1	-0.2	+0.2
High Gas Prices				
1992-1997	+0.2	-0.2	-0.2	+0.0
1997-2005	+0.1	-0.1	-0.1	+0.1
Low Gas Prices				
1992-1997	+0.2	-0.3	-0.2	+0.0
1997-2005	+0.1	-0.1	-0.3	+0.3
High Loads				
1992-1997	+0.0	-0.1	-0.1	+0.0
1997-2005	+0.0	-0.0	-0.0	+0.2
Loss of DSI Load				
1992-1997	+0.2	-0.3	-0.2	+0.0
1997-2005	+0.1	-0.1	-0.1	+0.2

Specifically, the conservation alternative, as modeled, is slightly more expensive than the Base Case under conditions of load uncertainty, a 10 percent discount rate, low future gas prices, and loss of the DSI load. It is slightly less expensive than the Base Case with a 1 percent discount rate, high future gas prices, and high loads. These different changes are small because most of the conservation is already at the top of the resource stack. There are only a few resources that are lower cost than conservation. Moving all the conservation ahead of these few resources is slightly beneficial in some future conditions, and slightly more costly in others.

The renewable alternative is preferable to the Base Case under high loads and the 10 percent discount rate. This result is caused primarily by the cogeneration resource. Cogeneration is modeled as a resource with no capital costs and all operating costs as if purchased from an independent power producer under an output contract. Hence its costs expressed in real terms remain constant over time, with costs expressed in nominal terms rising through time with inflation. This pattern contrasts with a 100 percent capital cost resource (like conservation) whose nominal costs stay constant through time, while costs expressed in real terms decline over time. High discount rates favor resources with low capital costs and high operating costs. Hence, high discount rates tend to favor the renewable resources, as modeled.

The CT and displaceable purchases preference is better than the Base Case under low future gas prices, high discount rates, and loss of the DSI load. The costs of this preference, modeled as CT's, are mostly variable, rather than fixed, and depend significantly on gas prices. As in the case for cogeneration, high discount rates favor resources with low capital costs and high operating costs. In the case of loss of DSI load, when DSI load disappears, it is unnecessary to operate the CT's, yet little expense has been incurred to build them. So high variable, low fixed-cost resources are preferred in situations where major loss of load might occur.

Finally, the nonfossil alternative is more expensive than the Base Case, except with high loads and high gas prices. This alternative is preferred under high gas prices since all resources which depend on gas as a source of fuel are moved to the bottom of the resource stack (specifically CT's). What drives the results in the high load case is the fact that in this alternative, the nuclear plants are completed more often and sooner than in the other alternatives. The nuclear plants are cost-effective resources for BPA under conditions where loads grow rapidly and there is no load uncertainty. Under high load growth, all the energy from the plants is needed quite soon after the plants come on-line; no significant surpluses are created by completion of these large resources. Under conditions of load certainty, there is no risk that the energy from the plants will not be needed. Therefore, the nonfossil alternative looks especially good when high load growth is assumed.

5. Rate Impact Results

The impacts of these various preferences on rates tend to be fairly small. In no case do average impacts on rates exceed 0.3 mill/kWh. None of

the resource preferences show significant rate impacts compared to the Base Case under any future condition. This results from the fact that in a large number of games (those with loads below the medium load case) few resources are purchased through 2005; hence, rate results are diluted by these games. However, in general, rates are slightly higher than the Base Case in the conservation and nonfossil preferences, and slightly lower than the Base Case in the renewable and CT and displaceable purchases preferences. This difference reflects the capital-intensive nature of conservation and nuclear plants (the resources emphasized in both the conservation and nonfossil preferences) where most costs occur in the early years of the study and decline in real terms over time.

6. Risk Analysis

Different resource preferences are more risky than others when uncertainty is considered. Each resource alternative yields a range of potential outcomes when compared to the Base Case, with some outcomes showing the alternative to be less expensive than the Base Case, and some outcomes showing the alternative to be more expensive. This is illustrated by comparing the outcomes for the conservation preference with outcomes for the nonfossil preference. These results are shown graphically on Figures VI-1 and VI-2.

Focusing first on Figure VI-1, the distribution of system costs for the conservation preference case as compared to the Base Case is shown under the future condition of load uncertainty. There is a 55 percent chance that the conservation preference case will be less expensive than the Base Case, but a 45 percent chance that it will be more expensive. There is a 1 percent chance that it will be more expensive by more than \$640 million. Here the outcomes are in a fairly narrow range.

Contrast this with Figure VI-2, showing the distribution of system costs for the nonfossil preference case as compared to the Base Case. A wider range of outcomes is present. There is a 23 percent chance that the nonfossil preference case will be less expensive than the Base Case, but a 67 percent chance that it will be more expensive. There is an 11 percent chance that it will be more expensive by more than \$640 million, with a 5 percent chance that costs could exceed the Base Case costs by over \$1 billion. There is a 1 percent chance of cost savings in excess of \$1 billion compared to the Base Case. In this preference, there is reliance on construction of large nuclear plants, which can cause significant benefits in high load cases, but significant costs in low load cases. In general, this resource preference would be more risky in the face of load uncertainty than would a preference for conservation.

The renewable preference has a fairly narrow range of outcomes. The CT and displaceable purchases preference has a wider range, with some outcomes significantly less expensive than the Base Case. These results are shown in Figures VI-3 and VI-4.

Figure VI-1
Distribution of System Cost Differences
Conservation Preference

INTERVAL	PROB	CUM PROB	EXPECTED VALUE = 1936	STD DEV = 134.68	MAX OBS = 702.26	MIN OBS = 237.64
-2000	0.0	0.0	NUMBER OF OBSERVATIONS LESS THAN LOWEST RANGE (- 2000)			
-1920	0.0	0.0	NUMBER OF OBSERVATIONS GREATER THAN HIGHEST RANGE (2000)			
-1840	0.0	0.0				
-1760	0.0	0.0				
-1680	0.0	0.0				
-1600	0.0	0.0				
-1520	0.0	0.0				
-1440	0.0	0.0				
-1360	0.0	0.0				
-1280	0.0	0.0				
-1200	0.0	0.0				
-1120	0.0	0.0				
-1040	0.0	0.0				
-960	0.0	0.0				
-880	0.0	0.0				
-800	0.0	0.0				
-720	0.0	0.0				
-640	0.0	0.0				
-560	0.0	0.0				
-480	0.0	0.0				
-400	0.0	0.0				
-320	0.0	0.0				
-240	0.0	0.0				
-160	50	50				
-80	60	110				
0	440	550				
80	240	790				
160	110	900				
240	40	940				
320	20	960				
400	10	970				
480	20	990				
560	0.0	990				
640	0.0	990				
720	10	1000				
800	0.0	1000				
880	0.0	1000				
960	0.0	1000				
1040	0.0	1000				
1120	0.0	1000				
1200	0.0	1000				
1280	0.0	1000				
1360	0.0	1000				
1440	0.0	1000				
1520	0.0	1000				
1600	0.0	1000				
1680	0.0	1000				
1760	0.0	1000				
1840	0.0	1000				
1920	0.0	1000				
2000	0.0	1000				

Figure VI-2
Distribution of System Cost Differences
Nonfossil Preference

INTERVAL	PROB	CUM PROB
-2000	0.0	0.0
-1920	0.0	0.0
-1840	0.0	0.0
-1760	0.0	0.0
-1680	0.0	0.0
-1600	0.0	0.0
-1520	0.0	0.0
-1440	0.0	0.0
-1360	0.0	0.0
-1280	0.0	0.0
-1200	0.0	0.0
-1120	1.0	1.0
-1040	0.0	1.0
-960	0.0	1.0
-880	0.0	1.0
-800	0.0	1.0
-720	0.0	1.0
-640	0.0	1.0
-560	0.0	1.0
-480	1.0	2.0
-400	2.0	4.0
-320	2.0	6.0
-240	0.0	6.0
-160	2.0	8.0
-80	3.0	11.0
0	12.0	23.0
80	30.0	53.0
160	4.0	57.0
240	5.0	62.0
320	9.0	71.0
400	7.0	78.0
480	5.0	83.0
560	4.0	87.0
640	2.0	89.0
720	1.0	90.0
800	1.0	91.0
880	1.0	92.0
960	1.0	93.0
1040	2.0	95.0
1120	2.0	97.0
1200	0.0	97.0
1280	2.0	99.0
1360	1.0	100.0
1440	0.0	100.0
1520	0.0	100.0
1600	0.0	100.0
1680	0.0	100.0
1760	0.0	100.0
1840	0.0	100.0
1920	0.0	100.0
2000	0.0	100.0

EXPECTED VALUE = 192.58 STD DEV = 387.89 MAX OBS = 1337.84 MIN OBS = 1144.13
 NUMBER OF OBSERVATIONS LESS THAN LOWEST RANGE (- 2000) = 0
 NUMBER OF OBSERVATIONS GREATER THAN HIGHEST RANGE (2000) = 0

Figure VI-3
Distribution of System Cost Differences
Renewable Preference

INTERVAL	PROB	CUM PROB
-2000	0.0	0.0
-1920	0.0	0.0
-1840	0.0	0.0
-1760	0.0	0.0
-1680	0.0	0.0
-1600	0.0	0.0
-1520	0.0	0.0
-1440	0.0	0.0
-1360	0.0	0.0
-1280	0.0	0.0
-1200	0.0	0.0
-1120	0.0	0.0
-1040	0.0	0.0
-960	0.0	0.0
-880	0.0	0.0
-800	0.0	0.0
-720	0.0	0.0
-640	0.0	0.0
-560	0.0	0.0
-480	1.0	1.0
-400	0.0	1.0
-320	0.0	1.0
-240	0.0	1.0
-160	0.0	1.0
-80	3.0	4.0
0	5.0	9.0
80	14.0	23.0
160	24.0	47.0
240	15.0	62.0
320	9.0	71.0
400	14.0	85.0
480	9.0	94.0
560	4.0	98.0
640	0.0	98.0
720	0.0	98.0
800	2.0	100.0
880	0.0	100.0
960	0.0	100.0
1040	0.0	100.0
1120	0.0	100.0
1200	0.0	100.0
1280	0.0	100.0
1360	0.0	100.0
1440	0.0	100.0
1520	0.0	100.0
1600	0.0	100.0
1680	0.0	100.0
1760	0.0	100.0
1840	0.0	100.0
1920	0.0	100.0
2000	0.0	100.0

EXPECTED VALUE = 198.31 STD DEV = 191.21 MAX OBS = 775.84 MIN OBS = -480.57
NUMBER OF OBSERVATIONS LESS THAN LOWEST RANGE (- 2000) 0
NUMBER OF OBSERVATIONS GREATER THAN HIGHEST RANGE (2000) 0

Figure VI-4
Distribution of System Cost Differences
CT's/Displaceable Purchase Preference

INTERVAL	PROB	CUM PROB
-2000.	0.0	0.0
-1920.	0.0	0.0
-1840.	0.0	0.0
-1760.	0.0	0.0
-1680.	0.0	0.0
-1600.	0.0	0.0
-1520.	0.0	0.0
-1440.	0.0	0.0
-1360.	0.0	0.0
-1280.	0.0	0.0
-1200.	0.0	0.0
-1120.	0.0	0.0
-1040.	0.0	0.0
-960.	1.0	1.0
-880.	0.0	1.0
-800.	0.0	1.0
-720.	1.0	2.0
-640.	0.0	2.0
-560.	0.0	2.0
-480.	2.0	4.0
-400.	0.0	4.0
-320.	3.0	7.0
-240.	5.0	12.0
-160.	9.0	21.0
-80.	7.0	28.0
0.	20.0	48.0
80.	20.0	68.0
160.	18.0	86.0
240.	8.0	94.0
320.	2.0	96.0
400.	2.0	98.0
480.	1.0	99.0
560.	0.0	99.0
640.	1.0	100.0
720.	0.0	100.0
800.	0.0	100.0
880.	0.0	100.0
960.	0.0	100.0
1040.	0.0	100.0
1120.	0.0	100.0
1200.	0.0	100.0
1280.	0.0	100.0
1360.	0.0	100.0
1440.	0.0	100.0
1520.	0.0	100.0
1600.	0.0	100.0
1680.	0.0	100.0
1760.	0.0	100.0
1840.	0.0	100.0
1920.	0.0	100.0
2000.	0.0	100.0

EXPECTED VALUE = 54.06 STD DEV = 234.32 MAX OBS = 706.25 MIN OBS = -998.33
 NUMBER OF OBSERVATIONS LESS THAN LOWEST RANGE (-2000.) 0
 NUMBER OF OBSERVATIONS GREATER THAN HIGHEST RANGE (2000.) 0

7. Conclusions

The macro trade-off analysis is designed to examine the performance of particular resource preferences under a variety of future conditions. The results support the current order of resources in the resource stack, in that no other order tested was more robust in dealing with future uncertainties. However, the preference for CT and displaceable purchases did perform well under a variety of future conditions. In addition, the conservation preference case, consisting primarily of giving the residential weatherization program higher resource priority, also showed small benefits in several of the future conditions. Steps 3 and 4 of this analysis considered these implications more specifically.

The macro trade-off analysis also supports the notion of consideration of risk in determining resource preferences. Even though resource preferences may perform similarly when the expected value of total system costs is considered, examining the range of outcomes may lead to a different conclusion. Consideration of these ranges will be important in the later stages of the Resource Program analysis.

C. Development of Final Resource Program

BPA's challenge is to develop a resource program proposal that uses the resources in Table VI-1 to fill BPA's resource needs, while attempting to meet the eight decision factors described previously. BPA staff have identified a final resource program which is evaluated against the Draft proposal.

The following are some of the considerations reflected in the final Resource Program:

- BPA should focus on an aggressive conservation program. This approach is least cost and captures the best conservation opportunities. These opportunities include incorporation of energy efficiency measures in the construction of new buildings, during the remodeling and renovation of existing commercial buildings, and during equipment replacement cycles in the commercial and industrial sectors. While it may be possible to retrofit such measures after new construction or remodeling/renovation is completed, it typically is prohibitively expensive to do so, and thus could render the energy efficiency gain uneconomic. If BPA failed to capture these cost-effective resources now, BPA likely would be forced to pay a steep premium to replace these resources later with more costly resources. In addition, because in many cases the supply of conservation resources fluctuates with economic growth, focusing on these resources minimizes BPA's economic risk.
- It is important that BPA have a diversified resource portfolio. BPA should not overemphasize one segment of the resource marketplace. It is particularly important that BPA gain experience in acquiring generation resources. For BPA the early 1990's will be a period of testing and refining its generation resource acquisition capability.

- It is important that BPA commit to a predictable, stable conservation program aimed at achieving a specified minimum level of savings by a particular time. While conservation does offer flexibility through development in small increments, stability is important because conservation cannot be quickly ramped up or down to meet changing resource requirements cost-effectively. In addition, long-term achievement of savings is harmed by frequent changes in program direction. Also, those who deliver the conservation resource--utilities, contractors, and governments--need to be able to look ahead with some certainty while carrying out their work. Finally, having a specific target gives the overall effort a goal and a standard by which to be judged. BPA has determined that a target of at least 200 aMW of conservation savings from 1992 through 1997 is prudent. ^{3/} BPA views this 200-aMW figure as a floor. If market conditions change or the ability to acquire conservation savings becomes greater, BPA will adjust its efforts to capture more of this cost-effective resource. BPA is committed to purchasing as much cost-effective conservation as can be reliably delivered in this period.
- Some generation resources should be made ready to meet extraordinary resource requirements. This means developing the capability to option and acquire them, and gaining actual experience in doing this.

With these considerations in mind, BPA set out to construct a proposal that implements the Council's guidance and at the same time comes as close as possible to meeting the decision factors.

The proposal is described in the following section. Tables VI-4 and VI-5 identify BPA's resource acquisition goals for the 1990's as adopted in the final 1990 Resource Program. Although the Resource Program is focused on FY's 1992 and 1993, the savings and expenditures for FY's 1990 and 1991 have also been included to set a context for the resource program efforts.

Table VI-4 provides a detailed breakdown of the resource program components for the years 1990 through 1993. Table VI-5 shows the aMW targets for FY's 1990 through 1997.

1. General Direction of the Final Resource Program

The final Resource Program presents specific budgets for FY's 1992 and 1993, and sets a course of action through 1997. Starting with the increased program budgets for FY's 1992 and 1993, FY's 1994 through 1997 show a steadily increasing resource acquisition effort. Compared to the current (1990) program budgets, BPA's annual resource acquisition budget will increase roughly 53 percent from FY's 1990 to 1993, to \$167 million/year.

^{3/} This target does not include additional conservation which may be acquired using "all sources" acquisition methods (i.e., billing credits and competitive acquisitions).

FINAL RESOURCE PROGRAM, FY 1990 THROUGH FY 1993
(Nominal dollars in millions and incremental AMW) 1/

	1990		1991		1992		1993	
	\$\$\$\$	MW	\$\$\$\$	MW	\$\$\$\$	MW	\$\$\$\$	MW
CONSERVATION								
COMMERCIAL								
Energy Start Design for Commercial	\$7	1	\$8	2	\$10	3	\$10	3
Commercial Acquisition Support	\$4	1	\$5	2	\$6	2	\$7	3
Commercial Technical Activities	\$2	0	\$2	0	\$3	0	\$3	0
CLPP (FY 1990 is the last year)	\$6	1	\$0	0	\$0	0	\$0	0
Commercial Acquisition Incentives	\$1	1	\$10	2	\$14	4	\$16	4
Commercial Subtotal	\$20	3	\$26	5	\$33	8	\$36	10
INDUSTRIAL								
Conservation Modernization	\$6	25	\$7	25	\$7	6	\$6	0
Energy Savings Plan Thru 1991	\$3	2	\$5	5	\$0	0	\$0	0
Energy Savings Plan After 1991	\$0	0	\$0	0	\$8	5	\$9	5
Major Plants	\$0	0	\$1	1	\$1	2	\$2	4
Industrial RD&D	\$3	0	\$1	0	\$1	0	\$1	0
Industrial Subtotal	\$12	27	\$14	31	\$18	7	\$20	9
RESIDENTIAL								
Residential Weatherization	\$15	4	\$16	4	\$18	4	\$19	4
Northwest Energy Code Program	\$26	1	\$33	3	\$25	4	\$24	5
Super GOOD Cents	\$10	2	\$7	1	\$5	1	\$5	1
New Manufacturing Housing	\$1	0	\$2	0	\$3	0	\$4	1
Water Heating	\$0	0	\$0	0	\$6	2	\$8	3
Solar Access	\$0	0	\$0	0	\$1	0	\$1	0
Residential RD&D	\$2	0	\$3	0	\$3	0	\$4	0
Blue Clue	\$1	0	\$1	0	\$1	0	\$1	0
Eugene Water & Electric Board Bonds	\$2	0	\$2	0	\$2	0	\$2	0
Residential Subtotal	\$57	6	\$65	8	\$64	12	\$67	14
Agriculture Subtotal	\$1	<1	\$2	<1	\$2	<1	\$2	<1
Conservation Subtotal	\$90	37	\$107	43	\$117	28	\$126	32
GENERATION								
Hydro System Efficiency Improvements	<\$1	0	<\$1	20	<\$1	25	<\$1	25
Resource Contingency Plan	\$0	0	\$4	0	\$12	0	\$1	0
Geothermal	\$1	0	\$1	0	\$1	0	\$1	0
Other 2/	\$11	0	\$10	0	\$9	0	\$10	0
Generation Subtotal	\$13	0	\$15	20	\$23	25	\$13	25
ALL SOURCES								
Billing Credits Test	\$1	0	\$0	0	\$2	9	\$5	6
Competitive Acquisition Test	\$2	0	\$7	0	\$8	0	\$20	30
All Sources Subtotal	\$3	0	\$7	0	\$11	9	\$25	36
State and Local Government	\$3		\$3		\$3		\$3	
TOTAL 3/	\$108	37	\$132	63	\$153	62	\$167	93
Plus: Support Services and Corporate Overhead	\$10		\$14		\$15		\$16	
GRAND TOTAL	\$118	37	\$146	63	\$167	62	\$183	93

1/ Forecasted resource planning costs are incorporated into estimated expenditures in each sector.

2/ Other includes Idaho Falls payment and generation support.

3/ Numbers may not add due to rounding.

TABLE VI-E
RESOURCE PROGRAM ACQUISITIONS, BY SECTOR, FY 1990 THROUGH FY 1997
(savings in aMW)

Resource Type	1990	1991	1992	1993	1994	1995	1996	1997	Cumulative 90-97 92-97
CONSERVATION									
Commercial	3	5	8	10	8	9	10	13	65
Industrial a/	27	31	7	9	11	12	13	15	124
Residential	6	8	12	14	14	15	15	16	98
Agriculture	<1	<1	<1	<1	<1	<1	<1	<1	6
Conservation Subtotal	37	43	28	32	33	36	39	44	293
GENERATION b/	0	20	25	25	25	27	10	10	142
ALL SOURCES c/	0	0	9	36	40	40	20	5	150
TOTAL d/	37	63	62	93	98	103	69	60	585

a/ Includes 25 aMW/year from Con/Mod in FY's 1990 and 1991.

b/ Reflects only generation resources to be acquired in this Resource Program; does not reflect generation resources which may be acquired in subsequent resource programs to meet projected load growth beyond the early 1990's.

c/ Competitive Acquisitions and Billing Credits processes.

d/ Numbers may not add due to rounding.

The final program establishes a very ambitious course for resource acquisitions. To accomplish this large task BPA proposes to move toward substantially greater resource flexibility developed in close partnership with its customers. BPA will emphasize the sharing of responsibility and authority for conservation programs with its customer utilities, while also providing them more flexibility than BPA-designed programs alone can offer. Through these efforts BPA will be expanding resource development beyond the programs designed, implemented, and funded up-front by BPA that were prevalent during the 1980's.

The period 1991 through 1997 will see a transition from the current approach to a blend of BPA-designed, utility-designed, and developer-initiated programs. Crucial to this transition will be the refinement of methods to verify contracted-for conservation savings, a market-oriented pricing system, and the development of new business relationships between BPA and its partner utilities.

The movement away from reliance on BPA-designed programs is not a radical departure for BPA's customer utilities. Many utilities have operated some of their own conservation programs in recent years. Creative financing of conservation investments was used by the Eugene Water & Electric Board (EWEB)--EWEB undertook the financing, with debt service provided over time by BPA. BPA worked with several utilities to enable the transfer of conservation savings from three public-owned utilities to an investor-owned utility.

Although much attention will be given to collaboratively designed approaches, BPA will continue to offer technical support and other "value-added" services. BPA is committed to working with its customers in new, flexible, and creative ways to meet their power needs. BPA also will encourage partnerships between its customers and other entities to develop the resources where necessary.

BPA remains committed to the least-cost approach for acquiring resources. This means acquiring all cost-effective conservation. In the Draft 1990 Resource Program BPA proposed to focus on lost-opportunity resources. However, BPA is interested in all cost-effective conservation. Typically lost-opportunity conservation is lower cost because it is an incremental cost to the cost of pre-planned construction or equipment replacement. It is cost-effective because of its relatively low cost. But other low cost conservation is also cost-effective (e.g., much industrial conservation). The idea is to capture cost-effective conservation savings when the opportunities for acquiring them are best. This includes securing the resource not only in new construction but also in existing buildings when they are undergoing renovation/remodeling and at the time of replacement of equipment in industrial/commercial applications. BPA does not want to forego a cost-effective resource that would be too costly to acquire later.

Cost-effective conservation resources provide reliable energy savings for the BPA system at or below the cost of other available resources (given the Northwest Power Act 10 percent conservation cost credit). BPA's current estimate of the cost-effectiveness threshold for resources is represented by the Alternative Cost for Billing Credits Resources (July 1990). Resource

characteristics, such as on-line date, availability, useful life, seasonality, etc., affect the relative value of each resource for the electric system. The alternative cost for a particular resource represents the stream of costs for resources BPA would otherwise have to acquire to meet its load obligations.

The final program increases conservation budgets but not to the point that reliable, effective delivery is compromised. In FY's 1992 and 1993, BPA estimates it will acquire 30 to 35 aMW/year from programs specific to conservation; these acquisitions increase to 40-45 aMW/year by FY 1997. This final program is a commitment that conservation efforts through 1997 will not be reduced except for an extreme change in circumstances. By itself, conservation can meet much of the likely range of load growth that BPA faces.

Over the period FY's 1992 through 1997, the real levelized cost to BPA of the conservation portion of the final program averages about 13 mills/kWh, while the total cost (i.e., to all parties, including BPA, utilities, and consumers) averages about 22 mills. The estimated BPA cost included in the final program provides for research and development, pilot programs, market research, and other activities related to understanding the resources.

2. Conservation Acquisition Efforts

The following is a brief description of the resource acquisition efforts by sector:

a. Commercial Conservation

The commercial sector presents significant opportunities for cost-effective resource development. Since there is much new construction in the sector and a great deal of remodel and renovation activity, it is important that this sector be as energy-efficient as possible. BPA plans to acquire 8 aMW in FY 1992 and 10 aMW in FY 1993 from this sector. The expected total acquisition from commercial sector programs is 58 aMW for FY's 1992 through 1997. For FY's 1992 and 1993 the final budgets are \$33 and \$36 million, respectively.

The total funding for the commercial sector will increase significantly between 1990 and 1993. Numerous commenters on the Draft 1990 Resource Program were concerned that a dip in funding level for 1991 would seriously inhibit meeting the acquisition targets for FY's 1992 and 1993. BPA has added an additional \$10 million to the previously proposed FY 1991 budget, most of which will be devoted to testing enhancements to the Energy Smart Design and the development and testing of acquisition payments.

Commercial sector activities include: Energy Smart Design, Commercial Acquisition Incentives, Commercial Acquisition Support (which includes Model Conservation Standards and research, development and demonstration), and the Commercial Incentives Pilot Program through the contract closeout in 1990.

BPA believes it can successfully bridge between its current efforts and competitive acquisitions. BPA will continue to test enhancements for Energy Smart Design in 1991. Every effort will be made to move toward alternative acquisition methods (billing credits, targeted acquisitions) in 1992 to more fully leverage the capabilities of utilities and the private sector. BPA's priority is to fully implement a cooperatively designed program and to offer price/proof-of-delivery contracts to interested utilities or others. These actions will be the highest priority because, once established, they have the highest likelihood of allowing the region to rapidly increase production of the commercial conservation resource without stressing the delivery infrastructure beyond its limits.

b. Industrial Conservation

The industrial sector also offers significant opportunities for cost-effective resource acquisition. The industrial sector activities in the final Resource Program include: Energy Savings Plan (E\$P), the Major Plants Program 4/, Conservation Modernization (Con/Mod), and the research, development and demonstration efforts.

BPA will acquire 7 aMW in FY 1992 and 9 aMW in FY 1993 in this sector. The budgets for FY's 1992 and 1993 are \$18 million and \$20 million, respectively. These budgets include an estimated \$7 million/year for the Con/Mod program. The expected total acquisition for FY's 1992 through 1997 from this sector is 67 aMW.

Planned future industrial conservation efforts represent a substantial increase in the pace of acquisitions in this sector. The early years will be a period of transition as new business relationships are developed and energy savings verification methods are refined. Future efforts will feature: (1) increased reliance on utilities (because they are best positioned to tap the unique industrial conservation opportunities that are available in their service territories); (2) streamlined program management; (3) risk sharing; (4) BPA playing an important role in providing a stable market for industrial energy efficiency improvements; and (5) BPA payments over time, as savings accrue.

The initial phase of BPA's accelerated effort in the industrial sector will focus on (1) expanding the E\$P to include new and expanding industries; (2) adding a motors rebate element; (3) providing for audits to find potential projects; (4) permitting operation of the E\$P by firm power customers; and (5) beginning work on the Major Plants Program.

4/ The Major Plants Program is a new effort by BPA to purchase energy savings at an established unit price from the largest industrial firms and the major Federal installations in the service areas of BPA's firm power customers.

c. Residential Conservation

The activities in this sector include: the Northwest Energy Code Program, Super GOOD Cents, New Manufactured Housing, Residential Weatherization, Solar Access, Blue Clue for Appliances (including water heating efficiencies), and research, development and demonstration. BPA will also continue debt service payments in the EWEB Financing Agreement.

Residential sector programs will acquire 12 aMW in FY 1992 and 14 aMW in FY 1993. The residential sector budgets for FY's 1992 and 1993 are \$64 and \$67 million, respectively. The expected total acquisition for FY's 1992 through 1997 from this sector is 84 aMW. These budgets reflect the expected cost of implementing State-wide codes. Table VI-5 shows the incremental energy savings by year, but it should be acknowledged that after codes are in place, additional increments of savings continue far into the future. Therefore, the total energy savings from these expenditures are somewhat understated in the Tables.

The final program shows a strong commitment to meeting the Council's objectives for the residential sector. It includes efforts in the areas of existing residences, new residences, new manufactured housing, appliances, and water heating. Programs in all but the existing residential area are aimed at gaining lost-opportunity resources. Finally, BPA continues its substantial support for State-wide adoption of MCS.

d. Agricultural Conservation

From the irrigated agricultural sector, the final resource program acquires less than 1 aMW in FY's 1992 and 1993. The expected total acquisition for FY's 1992 through 1997 from this sector is approximately 5 aMW. The FY's 1992 and 1993 budgets are about \$2 million/year. This is a discretionary program, but the resource is estimated to cost 16 mills/kWh, which makes this program very cost-effective. This program promotes installation of low-pressure devices on center pivot irrigation systems, mainline improvements, and fitting redesign. The final Resource Program meets the Council's guidance to maintain programs to assist with implementation of cost-effective efficiency improvements for irrigation.

3. All Sources Acquisition Approaches--Competitive Resource Acquisitions and Billing Credits

a. Billing Credits

Billing credits is another mechanism that will be relied upon to help BPA meet its more ambitious resource acquisition goals in the 1990's. Section 6(h) of the Northwest Power Act directs BPA's Administrator to grant billing credits to customers upon request for resources that reduce BPA's obligation to serve loads. Billing credits are based on the premise that independent utility action to develop conservation or generation resources reduces BPA's need to acquire resources. BPA developed a Billing Credits Policy in 1984. Discussions with utilities have convinced BPA that the

Billing Credits Policy is flexible and can provide a workable mechanism for resource acquisition. Therefore, BPA has decided to go forward with a 50 aMW billing credits test in the final Resource Program.

BPA's objective in this first use of billing credits is to ensure that this mechanism is workable for resource developers. If needed, the Billing Credits Policy will be revised based on the results of this test.

BPA will have a solicitation for billing credits resources in the summer of 1990 and anticipates that a portion (about 9 aMW) of these resources will become available by 1992. In the final Resource Program \$2 million is budgeted for billing credits in FY 1992 and \$5 million is budgeted for FY 1993. It is expected that additional conservation (beyond BPA's target of at least 200 aMW from FY 1992 through FY 1997) will be acquired from this solicitation since, all other things being equal, conservation will be selected prior to generation.

b. All Sources Competitive Acquisitions

As the Federal System approaches load/resource balance, BPA believes that it is important to develop proven capability to acquire resources as needed. The competitive acquisition will provide BPA with the ability to systematically solicit, evaluate, and select resource proposals that are offered for purchase. In addition, it will enable BPA to compare diverse resource alternatives while providing developers with an opportunity to propose creative projects or measures. The final Resource Program includes an initial competitive solicitation for a minimum of 100 aMW. This is double the size of the resource acquisition test proposed in the Draft 1990 Resource Program. BPA has concluded (with the support of many commenters on the Draft 1990 Resource Program) that a 100 aMW effort is needed to demonstrate this approach and fully capture its advantages. BPA also concluded that it should be expanded to include demand-side measures in a parallel solicitation. The increased size of this effort is expected to attract greater interest and higher quality resources. A 100 aMW effort may be particularly important in light of preliminary information indicating that Federal System loads are expected to grow at a somewhat faster rate for the next few years than was assumed in the Draft. The inclusion of demand-side measures will assure that BPA does not overlook viable, cost-effective conservation measures that might not be captured in its other programs. BPA plans to issue a solicitation for resources in the fall of 1990, and begin taking delivery of part of the power in FY 1993. Budgets of \$8 million in FY 1992 and \$20 million in 1993 are included for this acquisition test in the final Resource Program.

4. Generation

A modest quantity of new generation resources are proposed in the near-term, but generation resources play a more important role in providing the flexibility to respond to changing load circumstances. With an aggressive, stable conservation effort, BPA proposes to develop generation resources in varying amounts depending on changing load and resource

situations. These resources will come from three sources, those submitted under the competitive acquisition and billing credits solicitations, and specific resource actions that BPA is in a unique position to initiate.

The competitive acquisition solicitation will provide the vehicle for acquisition of generation resources that can be most effectively developed by customers or independent developers. This includes resources such as cogeneration, hydroelectric, or other conventional and nonconventional generating technologies.

The generation resource actions included in the final Resource Program consist of three components, each intended to meet a particular objective. A discussion of the components and their objectives follows.

a. Hydro, Thermal, and Transmission Efficiency Improvements

Efficiency improvements consist of control system improvements at several major Federal hydroprojects as well as improvement projects at the Supply System's WNP-2 facility. These improvements are estimated to have an average real levelized cost of less than 13 mills/kWh and could yield approximately 115 aMW (100 aMW of hydro, 15 aMW of thermal) to the Federal System. The final Resource Program includes capturing these efficiencies over a 5-year period to allow time for developing institutional arrangements with the Corps, the Bureau, and the Supply System, and coordination with their maintenance activities. The budgets for hydro efficiency improvements in FY's 1992 and 1993 are \$0.3 million/year. ^{5/} In addition, there are an estimated 10 aMW of low-cost transmission efficiency improvements on BPA's transmission system. Although these transmission efficiency improvements are identified as resource acquisitions, presently they are to be budgeted and implemented through BPA's Transmission System Development Program (\$4 million/year in FY's 1992 through 1997).

b. Geothermal Pilot Project

The Pacific Northwest is thought to have large geothermal resources. Estimates of developable resources are in the thousands of megawatts. Due to the high risk and costs of geothermal exploration, and because the region's longtime power surplus has precluded power purchases, developers have had little incentive to confirm resources. Even if resources are found, land use issues must be resolved in many areas before power plants and transmission lines can be built. Confirming the existence and developability of this low-cost, renewable resource at several of the largest, most promising sites in the region would have great value to BPA and Northwest utilities because it would help prevent unnecessary commitments to more expensive power sources.

^{5/} The majority of the costs of these improvements are budgeted by the Corps and the Bureau, and later repaid by BPA with interest.

Consistent with previous suggestions by the Council, BPA will participate in pilot projects aimed at confirming resources and determining developability at three of the largest, most promising sites in the region. BPA will do this by purchasing--in joint ventures with regional utilities--up to 10 aMW of energy from each of the three projects. Contracts with developers will pay only for electricity delivered (in other words, BPA will not finance the projects). If joint ventures can be arranged, power contracts may be awarded as soon as FY 1991, with power deliveries commencing about 1995. Since no payments will be required until plants come on line, the final Resource Program requires no outlays for acquisition during FY's 1992 and 1993.

c. Resource Contingency Plan

The first four elements of the final Resource Program--conservation, the 150 aMW of billing credits and competitive resource acquisitions, efficiency improvements, and the geothermal pilot project--would be sufficient to cover the deficits shown in Figure II-3 for the 1989 medium-high load forecast through 1997. However, as Figure II-3 also shows, deficits of over 1,000 aMW by 1996 are possible under the high load forecast. There is roughly a 10 percent chance of load growth of this general magnitude. Furthermore, preliminary results from the 1990 joint load forecast suggest that the medium-high load forecast should be about 200-400 aMW higher, with the draft 1990 medium case falling close to the 1989 medium-high. The Council has advocated the development of flexible resource options to cover the risk of large, but fairly unlikely, near-term deficits. BPA developed a Resource Contingency Plan (described in Chapter VIII) to put this concept into practice. The Resource Contingency Plan is the source of the fifth major component of the Resource Program.

The Resource Contingency Plan concludes that it appears worthwhile to take actions now, at reasonable cost, to reduce this risk of deficits. The most promising action appears to be to start soon to option about 800 aMW of resources which, if necessary, could be brought on line by 1996. This will likely, but not necessarily, be the siting and licensing of two combined-cycle CT's with a total capacity of over 800 MW. Another possibility may be the optioning of cogeneration potential. This action will significantly increase BPA's assurance of having sufficient cost-effective firm resources on-line if loads grow much faster than the medium forecast, or if a major resource fails. The cost of this action in FY 1992 is estimated to be approximately \$12 million, and the continuing cost of maintaining an "optioned" status would be about \$1 million per year. Only if the option were exercised would acquisition costs be incurred and energy received. Locating these resources in the Puget Sound area also may help address the peak load problem in that area if the resources are eventually acquired.

BPA intends to proceed with the implementation of this contingency plan through a solicitation in early 1991. The solicitation will seek optionable resources that meet the criteria for BPA's contingency plan in a flexible, cost-effective manner, but will not categorically exclude any resources. In the interim, BPA will seek to resolve several remaining questions regarding short lead-time displaceable resources, including the future cost and availability of natural gas.

Summary of Conservation Programs For 1990 Through 1993

Commercial

1. Commercial Energy Smart Design. This program is a program for new commercial buildings or commercial buildings undergoing renovation or remodeling. The objective of the program is to encourage pre-design planning for these commercial buildings so that efficiency is included as a design criterion. This program will provide design assistance to 1,700 building through 1993 and test design assistance enhancements (e.g., account executives and building commissioning). Financial incentives will be offered to help building owners that may not have the financial resources to implement the recommended regionally cost-effective measures.

BPA will continue to: (1) use Alternative Service Providers to support program delivery for small utility operators; (2) provide training support through the State Energy Offices and others; and (3) provide promotional activities. The program is targeted at commercial building designers, developers, professional educators, financial institutions, and property managers, to make them aware of the benefits of energy efficiency measures in their projects. Design assistance will be provided through electric utilities or, if utility staffing resources are limited, through Alternative Service Providers under separate contract to BPA. This program also offers utilities an option to support adoption of the commercial MCS and thereby avoid surcharge. The program will also provide information on energy-efficient products and technologies through the Electric Ideas Clearinghouse.

2. Commercial Acquisition Support. These activities support the commercial sector through technical support to programs, and acquisition of savings through codes. Technical support includes the Lighting Design Lab, Electric Ideas Clearinghouse, and education and technical assistance. The MCS support effort is intended to help insure adoption and enforcement of a revised commercial MCS through financial and/or technical assistance. BPA is developing a strategy for increasing the participation of jurisdictions in the Northwest Energy Code Program (NWECP) by the end of FY 1992.

3. Commercial Research and Demonstration and General Technical Support. This effort encompasses a series of research and demonstration projects that are underway or are being considered to support commercial sector acquisition efforts. These items include: advanced refrigeration design and development, direct use of water for space conditioning, lighting, environmental issues, motors research and demonstration, and evaluation of energy management systems.

4. Commercial Incentives Pilot Program. This program is now being examined for cost-effectiveness through an impact evaluation. A draft of the evaluation was available in May 1990. Early indications are that the program as a whole will cost approximately 40 mills, although the rebate portion of the program may be significantly more expensive. The program is completing its last full year of operation. Approximately 230 building retrofits will be completed in FY 1990, with obligated funds carried over to complete an

additional 150 buildings during FY 1991. No additional expenditures, besides the personnel needed to complete contract management and closeout for FY 1991, are planned.

5. Commercial Acquisition Approaches. These efforts are intended to acquire cost-effective energy savings from new commercial buildings in the 1990's. Activities include proposals submitted under billing credits and competitive bid solicitations, and targeted acquisition contracts.

These acquisition elements of BPA's commercial conservation efforts will allow utilities to design their own energy conservation efforts independent of BPA's standard collaboratively designed, centrally managed programs. These approaches will encourage innovation and decentralized decisionmaking to assure a viable and reliable program at all implementation levels.

BPA will limit its control to two essential functions: price and measurement. For billing credits and competitive bids, BPA will simply set the price they are willing to pay. For targeted acquisitions, the price will be negotiated to reflect shared responsibility between BPA and the utility.

For measurement of savings, BPA will work with utilities and others to establish a measurement tool or methodology as sufficient proof of delivery of the resource.

Industrial

1. Conservation/Modernization. The purpose of this program is to promote the efficient use of electricity in the production of aluminum in Northwest aluminum smelters. This program is designed to help keep regional smelters from being operated as swing plants, which cause instability in BPA revenues. This program offers regional smelters 5 mills/kWh saved through efficiency improvements undertaken by the smelters. The smelters have until June 30, 1991, to make the improvements. At that time, total savings will be established, contract demand reduction amounts will be established at each plant, and payments of 5 mills/kWh/year will be made to the plants for 10 years. Improvements to date have resulted in efficiency increases of over 120 aMW. By June 30, 1991, it is expected that improvements will realize a total of about 175 aMW of increased efficiency improvements.

2. Energy Savings Plan Through 1991. This program is designed to promote electric energy efficiency in both new and existing industrial plants. E\$P has been operating largely as a direct BPA-industry program, with limited utility involvement. Under the existing program, industrial firms submit proposals for electric energy conservation projects directly to BPA for funding consideration. (Many firms work closely with their electric utility to prepare proposals.) If BPA approves the firm's proposal, a contract between the two parties is negotiated. The serving utility is often involved in the negotiations but is not a party to the contract.

In the current program only projects at existing industrial plants are eligible. Upon completion of a project, an energy savings verification test is performed, and the project is inspected. If the project has been satisfactorily completed, BPA pays the industrial firm according to terms of the contract.

The BPA incentive payment is tied to energy savings. It equals the lesser of 10 cents/kWh times the estimated first-year kWh savings or 80 percent of the Project cost, not to exceed \$250,000. An adjustment is also made for "cost sharing" to reflect the degree to which the serving utility purchases firm power from BPA.

Since the start of E\$P in 1987, BPA has contracted to save approximately 8 aMW of energy. These contracts have obligated about \$2.5 million to fund efficiency improvements at about 30 industrial plants.

The description above applies to the existing E\$P. There are three phases of transition envisioned for the program for the 1990's. Phase 1 will be the change described in the E\$P redesign process begun in the fall of 1989. Phase 2 will add a "billing credit" type incentive option for utilities. Phase 3 will eliminate the current "up front" incentives with complete dependence on "credits" as incentives.

3. E\$P After 1991. Phases 2 and 3 of E\$P will start in FY 1992. Phase 2 will be a first step toward a utility billing credits approach by offering this option to utilities after 1 year's experience with the new E\$P contracts. Along with this offering, BPA will make a change in the method of payment of the incentive.

In the proposed redesign of the program, payments to utilities or industrial participants will be made at the time the project is completed. An alternative would be payment when the savings are actually realized, as they accrue, rather than when the project is completed. By FY 1994, it is expected that Phase 3 will be completed and all E\$P incentives will be paid as they accrue.

4. Major Plants Program. This program will purchase energy savings (as they are realized) at an established unit price. Through this program, BPA will seek to establish a long-term business relationship with each of the largest industrial firms and the major Federal installations in the service areas of BPA's firm power customers.

Nonaluminum direct service industries, Federal installations, and those served through firm power customers will be eligible. Starting with direct-service industries and major Federal installations, a power sales contract will be negotiated which establishes that BPA will pay a set unit price for all savings realized by the firm or installation. Savings will be verified over time by a mutually acceptable method. Payments will begin when a verification method is in operation.

BPA also will initiate an effort, through the major plants program, to acquire energy savings through Customer System Efficiency Improvements (CSEI). This effort is designed to assist BPA's utility customers improve the efficiency on their transmission and distribution systems. CSEI will go through initial design stages over the next year. It is estimated that this effort will start phasing in during FY 1993.

5. Industrial RD&D. This involves a series of research and demonstration projects that are underway or are being considered to support industrial sector acquisition efforts. These items include the Electric Ideas Clearinghouse and other efforts to determine the potential costs and savings from efficiency improvements in industrial processes which apply to a wide array of industrial firms.

Residential

1. Weatherization. The objective of this program is to provide incentives to consumers or homeowners for the energy savings resulting from the weatherization of electrically heated homes in the Pacific Northwest.

Evaluation results of early Residential Weatherization Programs indicated the regional cost of the program was about 26 mills. In 1985, the regional cost had risen to approximately 38 mills, creating a cost to BPA of about \$4.0 million/MW. A 1987 cost-effectiveness analysis showed that windows were very expensive and that reduced incentives were needed on all measures to make the program more cost-effective.

Under the Dipstick version of this program, the nonlow-income program cost is estimated at \$2.4 million/MW or about 16 mills (based on \$820/house and savings of 3,000 kWh/house). Including the low-income sector, the average program cost is about \$3.3 million/MW (22 mills/kWh). Based on these evaluations, the mix of measures installed was re-examined and significant changes in the form of two amendments were offered. The Dipstick amendment and window separation amendment prohibit windows entirely.

Most recent analysis indicates that these two amendments and voluntary cost reductions taken in the past 2 years have dropped BPA's cost to 27-28 mills/kWh. This is the basis for the incentive structure in the post-1990 contract.

This program will provide direct financial payments through participating utilities to homeowners for the installation of cost-effective weatherization measures in existing homes that use electric heat. The incentive payment is based on the cost of the job and the anticipated energy savings. Low-income homeowners usually receive 100 percent of the actual job costs. The post-1990 contract takes effect October 1, 1990. Multiple options are available under this contract, giving contractors the flexibility to determine what weatherization approach best meets their needs.

2. Northwest Energy Code Program (NWECP). This program is consistent with Action Item 1.0 of the 1986 Northwest Conservation and Electric Power Plan. The objective is "to improve the efficiency with which new residential . . . buildings use electricity and to ensure that buildings converted from other fuels use electricity efficiently." This program involves builder payments and direct BPA financial assistance for adoption and enforcement of codes in State and local jurisdictions where MCS has been adopted.

This program provides financial assistance to local jurisdictions who adopt the MCS as a building code or utilities who adopt the MCS as a mandatory service hookup standard for electrically heated homes. It includes support for start-up costs, technical assistance and inspections necessary to enforce MCS-level codes. In 1990, BPA will support at least 90 local jurisdictions that have adopted the MCS.

The current NWECP solicitation expires in December 1991. At that time, local jurisdictions in Washington will be phased into the Statewide program and a follow-on program will be offered to other jurisdictions in the region.

Enforcement support for Statewide MCS will be offered in Washington beginning FY 1991. An "umbrella" contract may be used to disburse these funds to local jurisdictions. Enforcement support for Statewide MCS is budgeted for Oregon in FY 1992 and Idaho in FY 1995 based on projected Statewide adoption dates. Enforcement support levels for Statewide programs are considerably lower on a per-house basis than the NWECP program due to efficiencies realized from larger numbers of houses.

This program also provides builder payments set according to BPA cost-effectiveness levels. Payments are made through local jurisdictions. These payments decline each year relative to increases in MCS penetration. Statewide payment levels are lower than NWECP payments, and are set by Statewide legislation for a fixed time period (e.g., in Washington, July 1, 1991 through July 1, 1995).

As with enforcement, local jurisdictions in Washington will be phased into the Statewide builder payment levels after December 1991 when the NWECP project period expires. Similarly, NWECP jurisdictions in other States will be phased into Statewide payment levels as each State adopts MCS.

3. Super GOOD Cents (SGC). This program includes promotion, marketing, and financial assistance support for residences built to the MCS. This program is designed to increase consumer awareness and the demand for MCS homes, thereby encouraging acceptance of MCS by home builders and code-setting officials.

BPA provides advertising, marketing, and promotion of MCS homes by providing utility and builder training, paying a cooperative advertising allowance to each utility, conducting a regional advertising campaign, and purchasing the licensing rights to SGC program logos and trademarks. SGC promotion ends in Washington in 1991 with the beginning of Statewide MCS.

BPA also provides funding for MCS payments to the utility, which in turn provides the payment to the builder or homebuyer after certifying that the residence meets all MCS requirements. Builder/consumer payments decline each year relative to increases in MCS penetration. The payments will end as each State adopts the energy-efficient code (e.g., they end in Washington effective July 1, 1991). Payments are cost-shared with utilities according to the percentage of firm power requirements purchased from BPA in the preceding year.

A new long-term SGC program will be offered beginning by 1991, and will provide technical assistance as well as an umbrella program for efforts funded through other efforts, such as energy-efficient water heating, appliances, and new construction technologies as they become available.

4. New Manufactured Housing. The final program for new manufactured housing initiates an effort targeted at manufacturers to improve efficiency at the construction phase. This program estimate is based on an annual allocation of achievable supply spread over 20 years, assuming a market penetration rate of 50 percent. As more is known about this resource, market penetration may exceed expectations. For FY's 1992 through 1997, approximately 40 percent of the available lost-opportunity conservation is targeted to be acquired.

The goal of this program is to achieve 90 percent of all technically achievable MCS savings in this subsector by 1997. Identification of metered savings began in FY 1987 with construction of 150 demonstration homes. By late 1990, metered savings data as well as cost data collected on these homes will be analyzed and the MCS for manufactured homes identified. This information, combined with informal process evaluations and discussions with the industry, will help shape payment amounts and program design features for FY 1992 and beyond.

Beginning in FY 1992, this program is expected to be offered as a competitive bid to manufacturers, industry associations, and others. Participating manufacturers will be awarded funds to conduct their own promotional campaigns, or their efforts will be supported or supplemented through a BPA-operated campaign.

Until FY 1992, manufactured homes will continue on the current track, which involves payments to manufacturers, dealers, and buyers of MCS HUD-code homes through Super Good Cents utilities.

5. Water Heating. A phased approach for the water heating program in the residential sector will allow the program to evolve through: (1) market development by establishing a working relationship with national manufacturers and regional distributors; (2) capability building by providing cooperative advertising funds to assist in developing a reliable infrastructure; and (3) resource acquisition by providing incentives (e.g., rebates) to acquire conservation savings. The program will be contracted through a regional clearinghouse to process rebates and pay consumers directly. Participating

utilities will maintain customer service contact in promoting the rebate, providing information about efficiency, and issuing a "coupon" redeemable through the clearinghouse. The coupon will identify the issuing utility (i.e., logo and telephone number), as the provider of the rebate.

6. Residential RD&D. This will involve demonstration projects and technical support for MCS, MCS compliance training and oversight, and environmental studies.

7. Appliance Efficiency - Blue Clue. The major activities in this area include maintenance of the appliance data base, program advertisement and promotion, maintenance of a toll-free telephone number, conduction of store visits, and ongoing process evaluations. This program responds to section 5 of the 1986 Northwest Power Plan and its 1989 Supplement.

Agriculture

Agricultural Programs. The expected total acquisition for FY's 1992 through 1997 from this sector is just under 5 aMW. The final program's budgets for FY's 1992 and 1993 are \$2.4 million each year. This is a discretionary program--this resource can be acquired in a subsequent budget period at no increase in cost. It is included here because it can be acquired at very low cost. This program promotes installation of low-pressure devices on center pivot systems, mainline improvements, and fitting redesign. This proposal meets the Council's guidance to maintain programs to assist with implementation of cost-effective efficiency improvements for irrigation. The scope of the program has expanded to include six more utilities and design assistance activities.

D. Description of Alternatives

Section C describes the development of the final Resource Program, delineating resource additions to BPA's system in FY's 1992 and 1993. This final Resource Program is a revision of that proposed in the Draft 1990 Resource Program.

In Chapter VII the final 1990 Resource Program will be compared to the Draft using the decision discussed previously. In addition, the analysis presented in the Draft Technical Report that compared the Draft Resource Program to five alternatives is repeated, since it also supports the selection of the final 1990 Resource Program.

The final Resource Program, the Draft proposal, and its five alternatives each prescribe a specific set of resource actions for FY's 1992 and 1993, with conservation actions continuing through 1997. In the analysis, however, the time period under study goes well into the next century. Therefore, some assumptions are needed to govern resource acquisition after FY 1992 for generation and after FY 1997 for conservation.

Beginning in 1993, generation resources are assumed to be acquired to meet needs in cost-effective order. Due to the 3- to 10-year lead time for generation resources, no other generation comes on-line before 1996 at the earliest.

In addition, this analysis considers the generation acquired through a test of billing credits and competitive acquisition process as well as the hydro system efficiency improvements. The geothermal pilot project is not included because it is not considered to be an acquisition, but rather a research and development project.

The alternatives that include conservation have specified acquisitions through 1997. Then, beginning in 1998, all remaining conservation resources are available and are assumed to be acquired in cost-effective order as prescribed or as needed.

The Alternatives

The Final Resource Program, as described in Section C, Table VI-4.

Alternative 1, the Draft proposal, represents the original Draft 1990 Resource Program. The Draft proposal, as described in the 1990 Draft Resource Program, included: 20-25 aMW of conservation per year from FY's 1992 through 1997 to a target of 200 aMW by 1997; a 50 aMW generation acquisition test, 100 aMW of hydro efficiency improvements, a 30 aMW geothermal pilot project, and acquiring options on two CT's.

Alternative 2 represents a minimal level of resource development. It includes none of the generation, no discretionary conservation, and only half of the lost-opportunity conservation of Alternative 1. Therefore, Alternative 2 results in the acquisition of no generation in FY 1992 or 1993 and only 79 aMW of conservation from FY's 1992 through 1997. This alternative will be referred to as the Minimal Conservation alternative.

Alternative 3, the Generation Only Alternative, shows the effect of excluding conservation resources. It includes the same actions for generation resources as Alternative 1, but no conservation. Therefore, the proposal includes hydro efficiency improvements, a 50 aMW generation resource acquisition test, and the siting and licensing of two combined-cycle CT's beginning in 1992. Conservation is unavailable until FY 1998 due to the assumed decision in FY's 1992-1993 not to start conservation programs.

Alternative 4 is the inverse of Alternative 3, and will be referred to as the Conservation Only alternative. It includes developing the same amount of conservation (both lost-opportunity and discretionary) as in Alternative 1, but no generation resources. Therefore, Alternative 4 includes 184 aMW of discretionary and lost-opportunity conservation acquired from FY's 1992 through 1997 and no generation in FY's 1992 and 1993. For analysis purposes, it is assumed that decisions can be made beginning in FY 1993 to acquire new generation resources.

Alternative 5 includes all of the generation and only the lost-opportunity portion of the conservation in Alternative 1. It defers acquisition of discretionary conservation in the residential and commercial sectors until FY 1998. This alternative acquires 157 aMW of conservation and has the potential to acquire 847 aMW of generation resources by FY 1997. This alternative will be referred to as the No Discretionary Conservation alternative.

Finally, Alternative 6 is the same as Alternative 1, except it excludes the siting and licensing of the two combined-cycle CT's, in order to test the economic impact of this action. This alternative will be referred to as the No CT's alternative.

CHAPTER VII

EVALUATION OF ALTERNATIVE SETS OF RESOURCE ACTIONS

The eight decision factors described in Chapter III are used to evaluate the final Resource Program, the Draft proposal, and the five alternatives to the Draft. Where possible, quantitative analyses are used in the evaluation and ranking of alternatives. For some decision factors, however, it is not possible to develop quantitative measures of performance. In these cases rankings are based on qualitative analysis regarding potential impacts of alternatives.

A. Assumptions for Quantitative Analysis

The evaluation of the Resource Program alternatives compares the final 1990 Resource Program to the Draft, and then the Draft (Alternative 1) to the other five alternatives. The analysis is similar to the Macro Trade-Off Analysis (Chapter VI-B). The final, Draft, and alternatives are compared using the ISAAC model under a Base Case and then under a number of different future conditions or sensitivity cases. The results of the analysis include total system cost impacts, budget and rate impacts, financial risk, economic risk, and risk of deficits.

The Base Case analysis of the alternatives incorporates load growth uncertainty, water uncertainty, and the other basic ISAAC assumptions described earlier in Chapter V-B. The sensitivity cases incorporate the same load growth and water uncertainty, but vary some of the other Base Case assumptions. The sensitivity cases analyzed include: high gas prices (4 percent real escalation), low gas prices (0 percent real escalation), high curtailment/short term purchase costs (100-150 mills), low curtailment/short term purchase costs (25-38 mills), and loss of the DSI load beginning in 2002.

B. Comparison of Final Resource Program Relative to the Draft Proposal

Following public comment, BPA modified the Draft 1990 Resource Program and created the set of resource decisions for 1992 and 1993 (and to 1997 for conservation) now presented as the final 1990 Resource Program. This section compares the final Resource Program with the Draft proposal according to the eight decision factors. Using the same data, assumptions, and ISAAC model as were used for the Draft analysis, this comparison indicates that the final Resource Program generally improves upon the Draft proposal. The evolution from the Draft proposal to the final Resource Program is based primarily on qualitative factors and judgment, rather than a completely new analysis similar to that done for the Draft proposal. Table VII-1 shows the result of this comparison.

1. Minimize the Present Value of Total System Costs. The present value of total system costs of the final Resource Program is \$102 million less than that of the Draft proposal. By increasing the size of the all sources competitive acquisition and the billing credits test, as well as expanding

efforts at capturing cost-effective conservation from 1992 through 1997, an additional \$102 million saving is realized over the Draft proposal. The other alternatives all result in higher total system costs than the proposal.

2. Ability to Meet Contingencies. The second column in Table VII-1 shows a 131 aMW energy surplus in FY 1997 resulting from actions specified in the final Resource Program (including the contingency plan acquisitions), assuming that high load growth occurs in the early 1990's. The final Resource Program puts BPA in an even better position for dealing with contingencies (such as prolonged high load growth) than did the Draft proposal due to additional resource acquisitions in 1992 and 1993. In this case it was also assumed that more conservation would be acquired from 1994 through 1997 due to high load growth and that 150 aMW of cogeneration would be acquired by 1997.

3. Minimize BPA Financial Risk. Financial risk is measured as the probability of BPA incurring significant negative cash-flows in a particular year. Significant negative cash-flows are judged to be cash-flow shortfalls of more than \$200 million. The final Resource Program decreases this likelihood by about 1 percent relative to the Draft proposal. This difference, however, is not statistically significant. Therefore, on the basis of financial risk, the final Resource Program and the Draft are ranked equally.

4. Minimize Near-Term Rate Impacts. The effect of the final Resource Program on rates in 1992 and 1993 compares favorably to the impact of the Draft proposal. Relative to the impact of the 1990 and 1991 budget, the final 1990 Resource Program causes a 0.1 mill/kWh smaller effect on rates than that caused by the Draft proposal. Thus, the contribution of the final Resource Program to an increase in the PF rate, assuming no other changes in BPA costs, is estimated to be 0.4 mills/kWh.

5. Minimize Long-Term Rate Impacts. The final Resource Program does not compare quite so favorably to the Draft proposal when considering effect on the average PF rate from 1998 through 2010. The final Resource Program causes a 0.2 mill increase in average long-term rates relative to the Draft proposal. This increase, in spite of the decrease in present value of system costs, results from the reduced sales caused by increased conservation acquisitions.

6. Minimize Exposure to Economic Risk of Unplanned Changes in Load Growth, Resource Availability, and Costs. Table VII-1 shows that the final Resource Program involves a slightly greater risk of an increase in present value of system costs greater than \$300 million. This slight increase in risk occurs because there is some chance that the increased expenditures on resources included in the final Resource Program will ultimately prove unnecessary.

TABLE VII-1

Decision Factor Scores for Final and Draft 1990 Resource Programs

	System Cost Minimization 1/ (millions \$8¢)	Ability to Meet Contingencies 2/ (aMW)	Financial Risk Minimization 3/ (%)	Near-Term Rate Minimization 4/ (mills/kWh 92¢)	Long-Term Rate Minimization 5/ (mills/kWh 92¢)	Economic Risk Minimization 6/ (f outcomes)	Environmental Impact Minimization	Deliverability Maximization
Draft Resource Program	0	+31	0	+0.5	0	0	N.Q.	N.Q.
Final Resource Program	-102	+131	-1	+0.4	+0.2	3	N.Q.	N.Q.

N.Q. Non quantifiable.

1/ Increases (+) or decreases (-) in the expected present value of total system costs compared to the Draft 1990 resource program.

2/ The BPA energy surplus (+) or deficit (-) in 1997 assuming high loads. High loads are a proxy for a variety of contingencies which could create deficits.

3/ The final 1990 resource program reduces the probability of negative cash flows in 1997 (in excess of \$200 million) by one percentage point compared to the Draft. These results are not statistically significant.

4/ The change in the PF rate for the 1992/93 rate period due to the proposed budget change (relative to 1990/91 program levels).

5/ The change in the average PF rate for 1998-2010 compared to the Draft, in 1992 dollars.

6/ The number of outcomes (out of 100) in which the final resource program causes an increase in total system costs of \$300 million or more, compared to the Draft.

7. Minimize Local and Global Environmental Impacts. The final Resource Program and the Draft are ranked against this decision factor based on the premise that conservation is relatively environmentally benign compared to generating resources. The final Resource Program acquires more conservation than the Draft. However, the additional all sources competitive acquisition in the final may result in more generation resources being acquired in the final compared to the Draft. Hence, the final Resource Program and the Draft are ranked about equally. Except for the Global Warming Analysis, which is described in the Technical Report, BPA did not conduct new environmental analysis of this Resource Program. BPA is planning to complete a Resource Programs Environmental Impact Statement (RPEIS) in 1992. The RPEIS is expected to be available for use in decisionmaking for the 1992 Resource Program.

8. Maximize Resource Deliverability in View of Social/Political Factors. The rankings are based in part on the premise that conservation has earned broad acceptance in the Pacific Northwest both by consumers and BPA's wholesale customers, and that reductions in conservation reduce the "deliverability" of the alternative. A stable conservation program also is believed to be a key to that resource's deliverability. In addition, there is broad public support for a diverse package of resource actions. Program emphasis on conservation and lost-opportunity conservation minimizes institutional and political barriers in light of BPA's growing resource needs. Also, broadening generation resource options through the test of the "all sources" resource acquisition process would improve the overall future resource deliverability. The final Resource Program is ranked slightly higher than the Draft because the final program includes a larger stable conservation program that captures the lost-opportunity conservation resource. In addition, the final Resource Program includes a larger competitive resource acquisition effort and a billing credits test.

C. Ranking of Draft Resource Program and Alternatives Against Decision Factors

The analysis presented in the Draft 1990 Resource Program Technical Report comparing the Draft Resource Program to five alternatives is repeated in this Section. The purpose of evaluating the alternatives is to understand the relative range of impacts surrounding the Draft proposal: e.g., the effects of focusing on lost opportunities and the effects of acquiring generation. These alternatives vary the level and composition of the acquisitions in the Draft proposal to test economic, rate and budget impacts as well as risk and developmental impacts.

1. Minimize the Present Value of Total System Costs

For each of the cases analyzed, the present value of total system costs of the alternatives are compared to the present value of total system costs of the Draft proposal. Table VII-2 shows the differences in total system costs for each of the alternatives under each of the cases analyzed. Positive numbers indicate cost increases compared to the Draft proposal while negative numbers indicate cost decreases compared to the Draft proposal. For example, using Base Case assumptions, Alternative 6, No CT's, has a total system cost of \$40 million more than Alternative 1, the Draft 1990 proposal.

TABLE VII-2

**SYSTEM COST IMPACTS OF RESOURCE ALTERNATIVES
CHANGE IN PRESENT VALUE OF TOTAL SYSTEM COSTS */
FROM ALTERNATIVE 1
(millions of 1988 \$)**

	Base Case	High Gas Prices	Low Gas Prices	High Curtailment/ Purch Costs	Low Curtailment/ Purch Costs	Loss of DSI Load
<u>Alternative 1:</u> Draft Resource Program	-	-	-	-	-	-
<u>Alternative 2:</u> Acquire Only Half the Lost-Opportunity Conservation Resources	+315	+335	+315	+355	+295	+185
<u>Alternative 3:</u> Acquire Generation Only	+200	+300	+80	+230	+185	+5
<u>Alternative 4:</u> Acquire Conservation Only	+175	+165	+220	+200	+165	+160
<u>Alternative 5:</u> Acquire Only Generation and Lost-Opportunity Conservation	-10	0	-10	-10	-20	-15
<u>Alternative 6:</u> Acquire All Conservation and Generation, except for the CT options	+40	0	+110	+45	+35	+85

*/ A positive sign indicates an increase in system costs and a negative sign indicates a decrease in system costs.

Under Base Case assumptions, Alternative 1, the Draft proposal, has a lower total system cost than all of the other alternatives except for Alternative 5, No Discretionary Conservation. The total system cost of Alternative 5 is only \$10 million lower than the Draft proposal, however. Most of the discretionary conservation included in the Draft proposal consists of residential weatherization, which is somewhat more expensive than the other resources available. However, as described in Chapter VI-C, dropping the residential weatherization program would hinder the accomplishment of lost-opportunity conservation--an effect not reflected in the analysis results. It also would seriously impair BPA's ability to acquire the remaining weatherization resource in a cost-effective manner should BPA later conclude that it needs the resource. In addition, the macro trade-off analysis results show that in some future conditions, giving residential weatherization a higher priority results in a reduction in total system costs. For these reasons, this discretionary conservation program is included in the Draft proposal, even though the total system costs with its inclusion are slightly higher.

The Base Case results also show that Alternative 2, Minimal Conservation (the alternative which eliminates the generation, discretionary conservation, and half of the lost-opportunity conservation), has the highest total system costs. Alternative 1, the Draft proposal, includes actions on many cost-effective lost-opportunity generation and conservation resources. When many of these actions are eliminated in Alternative 2, these resources must be replaced by resources that are significantly more expensive. Alternative 2's high total system cost demonstrates the longer run value of pursuing the resources specified in Alternative 1, the Draft proposal.

Eliminating the conservation resources in Alternative 3, Generation Only, and the generation resources in Alternative 4, Conservation Only, also increases total system costs compared to the Base Case. Again, the resources eliminated must be replaced with resources that are more expensive, leading to increases in total system costs. These alternatives provide further evidence that the actions in Alternative 1, the Draft proposal, are cost-effective.

Finally, Alternative 6, No CT's (which eliminates the siting and licensing of the CT's), has a higher total system cost than the Draft proposal, demonstrating that doing this preparatory work on CT's is cost-effective. Beginning siting and licensing of CT's allows these resources to be constructed, if needed, sooner than would otherwise be possible. This allows the deferral of other, more expensive resources, and leads to the total system cost benefits shown here. These results reinforce some of the results of the macro trade-off analysis, which show that the use of CT's and displaceable purchases in conjunction with BPA's nonfirm energy has system cost advantages in a number of future conditions.

The analysis finds that changes in the gas price forecast primarily affect the alternatives which include the CT's. The costs of CT's are predominantly fuel, so changes in gas prices have a large impact on this resource. Under high gas prices, the benefit of the CT's apparent in the Base Case is lost. For example, Alternative 6, No CT's, has the same total system costs as the Draft proposal. With high gas prices, CT's are much more

expensive to operate. Hence, the ability to build them more quickly by undertaking siting and licensing no longer has any value; other resources are just as cost-effective.

As would be expected under low gas prices, the benefit of the CT's is much greater. CT's now become even more cost-effective, since the cost of operating them has dropped significantly. The value of siting and licensing CT's, leading to an ability to construct them more quickly, has gone up. Eliminating the CT's in Alternative 6, No CT's, is \$110 million more expensive than Alternative 1, the Draft proposal, under low gas prices.

These results demonstrate the robustness of the decision to undertake siting and licensing of CT's. Even under high gas prices, the worst case future condition for these resources, total system costs do not increase when the CT options are included in the Draft proposal.

Under high curtailment/short-term purchase costs, Alternatives 2 through 4 all show increased differences in total system costs compared to the Base Case. This occurs because the alternatives all acquire fewer resources than the Draft proposal and, therefore, increase the likelihood of needing to make curtailments/short-term purchases. If low curtailment/short-term purchase costs are assumed, Alternatives 2 through 4 have somewhat lower differences in total system costs than in the Base Case. However, even with the ability to purchase power on a short-term basis at relatively low cost, the ranking of the alternatives, compared to the Base Case, remains unchanged. It is still cost-effective to undertake the actions proposed in Alternative 1, the Draft proposal.

Finally, the loss of the DSI load in 2002 makes the conservation resources acquired in the Draft proposal less valuable, and the CT's more valuable. The costs of the conservation resources are almost completely fixed, so the costs cannot be reduced when the DSI load is lost. Thus, Alternative 3, Generation Only, which eliminates all of the conservation resources, has an only slightly higher total system cost than the Draft proposal in this case. This contrasts with the results under the Base Case, where Alternative 4 has a much higher total system cost than the Draft proposal.

The CT's, on the other hand, have low fixed costs and high variable costs. When the DSI load is lost, the CT's can simply be shut down and relatively little cost has been incurred to build them. Thus, eliminating the CT's in Alternative 6, No CT's, increases total system costs more in this case than in the Base Case.

However, although the ranking of the alternatives compared to the Base Case is changed when loss of the DSI load is assumed, the Draft proposal, with the exception of Alternative 5, No Discretionary Conservation, is still preferred. This leads to the conclusion that the actions proposed in this Resource Program would not change even if loss of a large load in the future is assumed, though the value of the acquisitions would be reduced.

In summary, these results show that the Draft proposal has a significantly lower present value of total system costs than Alternative 2, Minimal Conservation, Alternative 3, Generation Only, and Alternative 4, Conservation Only; the Draft proposal has a slightly lower present value of total system costs than Alternative 6, No CT's, and roughly the same present value of total system costs as Alternative 5, No Discretionary Conservation.

The rankings for this decision factor are shown in Table VII-3 (which summarizes the rankings of all the alternatives against the decision factors).

These results are robust across all the sensitivities examined; in others words, in none of the cases studied is the Draft proposal significantly worse than the alternatives. The results point to a substantial total system cost advantage for the Draft proposal.

2. Ability to Meet High Loads

The first column in Table VII-4 shows the BPA energy surplus or deficit in FY 1997 assuming high load growth, given each alternative. For this analysis it is assumed that BPA could take actions to meet accelerating loads beyond those actions specified in each of the alternatives. These actions include additional conservation from 1994 through 1997 and 156 aMW of cogeneration (Cogen 1 and 2 in the Resource Stack).

Alternatives 1, 3, and 5 show BPA in near load/resource balance under high loads in FY 1997. Each of these alternatives include siting and licensing of two CT's as part of the Resource Contingency Plan. These put BPA in a good position for dealing with high load growth, loss of a major resource, or other contingencies that may occur.

However, Alternatives 2, 4, and 6 place BPA in a more precarious position with respect to possible resource contingency situations. This is largely because these alternatives do not include the siting and licensing of two CT's, leaving BPA unable to quickly bring on a major resource. More detail on this topic is presented in Chapter VIII, Resource Contingency Plan.

3. Minimize BPA Financial Risk

Financial risk can be evaluated by assessing the probability of BPA incurring significant cash-flow shortfalls. The results of this assessment are shown in the second column of Table VII-4. The Table shows the change in the probability of significant cash-flow shortfalls for BPA in FY 1997 for each of Alternatives 2 through 6 compared to the Draft proposal. Significant cash-flow shortfalls are arbitrarily determined to be cash-flow shortfalls in excess of \$200 million. For example, Alternative 2, Minimal Conservation, reduces the probability of cash-flow shortfalls in excess of \$200 million by 2 percentage points compared to Alternative 1, the Draft proposal.

As is readily apparent from these results, there is no significant difference across the alternatives in the frequency of cash-flow shortfalls. Therefore, at least by this measure, no significant difference in financial risk exists among the alternatives. Consequently, qualitative measures--resource diversity and resource flexibility--are used to rank the Draft

TABLE VII-3

Decision Factor Rankings for Alternatives

	System Cost Minimization	Ability to Meet Contingencies	Financial Risk Minimization	Near-Term Rate Minimization	Long-Term Rate Minimization	Economic Risk Minimization	Environmental Impact Minimization	Deliverability Maximization
Alternative 1 Proposed Resource Program	1.5	1	1.5	6	2.5	1	2.0	1
Alternative 2 Half of Lost Op. Conservation Only	6	6	4	2	5.5	6	5	5
Alternative 3 Generation Only	5	3	3	1	2.5	5	6	6
Alternative 4 Conservation Only	4	5	6	4.0	5.5	4	2.0	3.5
Alternative 5 Generation and Lost Op. Conservation	1.5	2	1.5	4.0	2.5	2	4	3.5
Alternative 6 Generation and Conser- vation w/o CT Options	3	4	5	4.0	2.5	3	2.0	2

NOTE: A fractional score indicates a "tie" among rankings.

TABLE VII-4
SUMMARY OF RISK ANALYSIS OF ALTERNATIVES

Description of Alternatives	Energy Surplus (+) or Deficit (-)	Financial Risk (%)	Economic Risk (# outcomes)
<u>Alternative 1:</u> The Proposed Resource Actions	+31	-	-
<u>Alternative 2:</u> Acquire Only Half the Lost-Opportunity Conservation Resources	-770	-2	44
<u>Alternative 3:</u> Acquire Generation Only	-19	-3	28
<u>Alternative 4:</u> Acquire Conservation Only	-750	-1	18
<u>Alternative 5:</u> Acquire Only Generation and Lost-Opportunity Conservation	+31	0	1
<u>Alternative 6:</u> Acquire All Conservation and Generation, except for C* Options	-650	0	11

proposal and the alternatives in Table VII-3. A diverse resource portfolio minimizes cost risks associated with a particular technology. Resource flexibility is the ability of the alternative to efficiently meet higher than expected loads.

The Draft proposal and Alternative 5, No Discretionary Conservation, are ranked equally superior because of their diversity. These alternatives call for acquisitions in all conservation sectors and generation resources. In addition, these alternatives have significant flexibility because they include the Resource Contingency Plan actions of siting and licensing two CT's. CT's are flexible because of the ability to avoid most of the resource's cost if loads drop. The costs of CT's when used are relatively high, but they need not be run if cheaper purchased power is available. Alternative 4, because it concentrates on conservation only, ranks the lowest for this decision factor because of its focus on one resource type and its inability to accommodate sudden increases in loads. Alternative 6, No CT's, is diverse, but is not flexible; Alternative 2, Minimal Conservation, is not flexible or diverse; and Alternative 3, Generation Only, is flexible, but not diverse.

4. Minimize Near-Term Rate Impacts

Alternatives 2 through 6 are compared to the Draft proposal to determine budget and rate impacts. These impacts are shown in Table VII-5.

Total proposed budgets for the FY's 1992 and 1993 for each of the alternatives are reported in the first three columns of Table VII-5. The split between the amount to be capitalized and the amount to be expensed is also shown. Budgets do not include overhead and do not reflect existing obligations for nuclear resources. More detail on the budget for the Draft proposal can be found in Chapter VI-C. Budgets are expressed in nominal dollars, i.e., in the year that the dollars will be spent.

The second set of columns in Table VII-5 shows the budget implications of the alternatives. The amounts shown are changes from the current FY's 1990 and 1991 budgets, also split between the amount to be capitalized and the amount to be expensed. The distribution between capitalized and expensed program costs is based on the distribution found in FY's 1990 and 1991 budgets. The splits vary by sector, are preliminary and subject to change.

These proposed budget changes produce the PF rate changes presented in the third column of Table VII-4, in 1992 mills/kWh. Rate changes are given relative to continuation of 1990 and 1991 program levels. These rate changes are for an assumed 2-year rate period covering FY's 1992 and 1993 and are estimated using approximate rules-of-thumb. It should be noted that these are estimates of rates based only on changes in resource acquisition budgets. They are not a projection of future actual rates.

TABLE VII-5
SUMMARY OF BUDGET AND RATE IMPACTS OF RESOURCE ALTERNATIVES a/

Description of Alternatives	Total 92-93 Budget b/ (millions of nominal \$)			Change from 90-91 Budget (millions of nominal \$)		Change in PF Rate for '92/'93 due to proposed budget chg (1992 mills per kWh)	Change in average PF rate for 1998-2010 from Package 1 (1992 mills per kWh)
	Cap	Exp	Tot	Cap	Exp		
<u>Alternative 1: The Proposed Resource Actions</u>	128	200	328	+59	+78	+0.5	-
<u>Alternative 2: Acquire Only Half the Lost-Opportunity Conservation Resources</u>	53	128	181	-16	+5	0.0	+0.1
<u>Alternative 3: Acquire Generation Only</u>	0	117	117	-69	-6	-0.1	0
<u>Alternative 4: Acquire Conservation Only</u>	128	177	305	+59	+55	+0.4	+0.1
<u>Alternative 5: Acquire Only Generation and Lost-Opportunity Conservation</u>	107	187	293	+38	+64	+0.4	0
<u>Alternative 6: Acquire All Conservation and Generation, except for CT options</u>	128	194	322	+59	+72	+0.4	0

a/ A positive sign indicates an increase in costs or rates and a negative sign indicates a decrease in costs or rates.
b/ Budgets are not loaded and do not include large thermal resources.

Alternative 1, the Draft proposal, produces the largest rate impact (an increase of 0.5 mills/kWh); Alternative 4, Conservation Only, Alternative 5, No Discretionary Conservation, and Alternative 6, No CT's, produce slightly lower rate impacts; and Alternative 3, Generation Only, actually shows rate decreases compared to the FY's 1990 and 1991 budgets. This is because this alternative actually requires lower budgets than the current budgets for FY's 1990 and 1991. These impacts are used to develop the rankings on near-term rate impacts presented in Table VII-3.

5. Minimize Long-Term Rate Impacts

The fourth column in Table VII-3 shows the change in the average PF rate from 1998 through 2010 for Alternatives 2 through 6 as compared to the Draft proposal, in 1992 mills/kWh. Alternative 3, Generation Only, Alternative 5, No Discretionary Conservation, and Alternative 6, No CT's, have long-run average rate impacts identical to Alternative 1, the Draft proposal. Alternative 2, Minimal Conservation, and Alternative 4, Conservation Only, show slight increases in PF rates for the later years compared to Alternative 1, the Draft proposal. This is because relatively inexpensive lost-opportunity resources have been eliminated from these alternatives. More expensive alternatives must be substituted for these lost-opportunity resources in the long run. Though the long-run rate differences are small, they translate into large present value differences because of the large number of kWh's over which the PF rate is charged, and the long period of time over which the rate differences occur. These quantitative results are used to develop the ranking of alternatives on the basis of long-term rate impacts as shown in Table VII-3.

6. Minimize Exposure to Economic Risk of Unplanned Changes in Load Growth, Resource Availability, and Costs

In this analysis, each alternative yields a range of potential system cost outcomes when compared to the Draft proposal; some outcomes show the alternative to be less expensive, and some outcomes show it to be more expensive. The range of outcomes is due to the analysis of uncertainty in future load growth and water conditions.

The third column of Table VII-4 shows the results of this assessment. This Table shows the number of outcomes (out of 100) in which each alternative is more expensive than the Draft proposal by more than \$300 million (selected somewhat arbitrarily as the threshold for a major loss). For example, in 44 out of 100 outcomes (44 percent), Alternative 2, Minimal Conservation, is more expensive than Alternative 1, the Draft proposal, by more than \$300 million.

The results show that in choosing Alternative 2, Minimal Conservation, or Alternative 3, Generation Only, BPA would frequently run the risk of encountering situations where significant cost increases would be incurred, compared to the choice of Alternative 1, the Draft proposal. These cost increases occur when the low-cost lost-opportunity resources which are

left out of Alternative 2, Minimal Conservation, and Alternative 3, Generation Only, must be replaced by higher-cost new resources. The risk is lower with either Alternative 4, Conservation Only, or Alternative 6, No CT's, but a number of such situations would still exist. Only in choosing Alternative 5, No Discretionary Conservation, would there be no significant economic risk compared to Alternative 1, the Draft proposal.

In looking at the other side of the distribution (though these results are not shown here) there were very few outcomes in which Alternatives 2 through 6 would be significantly less expensive than Alternative 1, the Draft proposal. Consequently, the Draft proposal is judged most beneficial for minimizing economic risk. The rankings of the alternatives against this decision factor are presented in Table VII-3.

7. Minimize Local and Global Environmental Impacts

There are no quantitative analytical results for this decision factor; rankings here are judgmental. As shown in Table VII-3, Alternative 1, the Draft proposal, Alternative 4, Conservation Only, and Alternative 6, No CT's (with similar amounts of conservation), are ranked highest because conservation is relatively environmentally benign compared to generation resources. Alternative 4, Conservation Only, has slightly less conservation, with Alternative 2, Minimal Conservation, having significantly less. Alternative 3, Generation Only, has no conservation and is ranked lowest. A further discussion of environmental concerns is presented in the Appendix, Global Warming Study.

8. Maximize Resource Deliverability in View of Social/Political Factors

Again, there are no quantitative analytical results for this decision factor. The rankings in Table VII-3 are based in part on the premise that conservation has earned broad acceptance in the Pacific Northwest both by consumers and BPA's wholesale customers, and that reductions in conservation reduce the "deliverability" of the alternative. A stable conservation program also is believed to be a key to that resource's deliverability. In addition, there is broad public support for a diverse package of resource actions. Thus, alternatives that are concentrated on one resource type are rated low on this decision factor. Program emphasis on conservation and lost-opportunity resources minimizes institutional and political barriers in light of BPA's growing resource needs. Also, broadening generation resource options through the test of the generation resource acquisition process would improve the overall future resource deliverability. Thus, the Draft proposal appears to be the most deliverable because it includes a stable conservation program capturing the lost-opportunity resources and the generation resources acquisition test.

D. Selection of Final Resource Program

The following are BPA's reasons for selecting the final 1990 Resource Program in view of the decision factors and the comparison of the final Resource Program, the Draft proposal and its five alternatives.

1. Least-Cost Approach. The proposal represents the least-cost approach for meeting BPA's load obligation. The Resource Program captures all the cost-effective resources that can realistically be acquired in FY's 1992 and 1993. However, if market conditions change or the ability to acquire cost-effective conservation or generation resources becomes greater, BPA will adjust its efforts to capture additional resources.

2. Budget And Rate Effects Are Within Bounds. Total capital and expense costs for the proposal, not including the large thermal budget and overheads, average \$160 million/year for FY's 1992 and 1993. This is roughly a 50 percent increase over expenditures in FY 1990; considering only these expenditures, this translates into roughly a 0.4 mill/kWh increase in FY 1992 over the current average PF rate. This rough estimate of the implications of the Resource Program on PF rates does not consider other BPA expenditure needs and therefore should not be interpreted as BPA's estimate of future rates. BPA's judgment is that these expenditures and rate impacts are acceptable, in view of the load/resource outlook.

3. Manages Risk Appropriately. The program includes capturing lost-opportunity and other low-cost resources that would keep BPA in load/resource balance under the 1989 medium-high forecast. In addition, it recommends low-cost actions, short of acquisitions, such as the acquisition of options on 800 aMW of short lead-time resources to prepare BPA to reliably and efficiently meet the high load growth contingency. The Resource Program imposes no increased financial risk on BPA, and minimizes the risk of large future system cost increases.

4. Stable Conservation Program Securing All Cost-Effective Conservation. The cornerstone of the Resource Program is a commitment to a steady ramp-up of the conservation programs to at least 200 aMW by FY 1997. This aspect of the program is key to achieving the least-cost approach to resource development, and to making the conservation resource deliverable in the long run.

5. Flexibility And Diversity. The program takes significant actions in a wide range of new resource types, without irrevocably committing BPA to major investments until the need for such investments becomes clearer. In particular, BPA will be gaining needed experience in acquiring generation resources to efficiently meet anticipated growth in Federal System loads later in the 1990's.

CHAPTER VIII

RESOURCE CONTINGENCY PLAN

A. Back to Basics

The rapid load growth of the last 2 years and the disappearance of BPA's energy surplus have reinforced the importance of planning flexibility for the future. The presence of a large energy surplus enabled BPA to meet a wide range of load growth without significant near-term resource additions.

Now that the surplus is gone, BPA must avoid being caught facing significant deficits without enough time to bring sufficient new resources on line to meet those deficits. This is the challenge addressed by the Resource Contingency Plan. Although unlikely, significant near-term deficits are possible if load growth is higher than expected and/or if existing or planned resources fail. Being caught short of resources to meet such deficits could be expensive and disruptive to BPA and its customers. The purpose of the Resource Contingency Plan is to find economical ways of avoiding or minimizing this risk.

B. What The Resource Contingency Plan Is

1. Part of a strategy for dealing with uncertainty. There is a limited amount of new low-cost resources that are cost effective to develop before there is a clear need for new resources to meet deficits. These resources cover some, but not all, of the range of uncertainty about the need for new resources. Covering the rest of the range of uncertainty is where the Resource Contingency Plan comes in. The Resource Contingency Plan defines actions BPA can take to prepare to meet the upper end of that range reliably and efficiently, with minimum near-term expenditures.

2. Council's guidance. This strategy builds on the approach to planning for uncertainty advocated by the Council. The Resource Contingency Plan helps put the Council's basic approach into operation for BPA.

3. Five questions define the Resource Contingency Plan. The Resource Contingency Plan can be boiled down to the answers to five basic questions. They are:

- How big is the risk of deficits due to some combination of rapid load growth and/or resource failure which would leave BPA short of power for an extended period of time?

- Is BPA prepared now to add firm resources to meet such deficits?

- Should BPA rely on existing operational options to cover this risk of deficits?

- What actions can BPA take to become better prepared?

- Finally, should BPA take any of these actions?

The Resource Contingency Plan, consists of BPA's answers to these five questions.

C. Question #1: How Big is the Risk of Deficits?

More specifically, how big is the risk that BPA could be caught facing a deficit and not have enough time to get new resources developed to meet the deficit? Two types of events can create this situation: resource failure and/or persistent rapid load growth.

Short-term deficits also can be caused by cold weather, short-term outages of generation plants, low streamflows, and/or transmission outages. But BPA has operational alternatives, as described below, for dealing with these events. Consequently, the "worst case" contingency for the Resource Contingency Plan does not include these events.

1. One Contingency: Rapid Load Growth

Load growth is uncertain. Over the last 15 years, Pacific Northwest load growth rates went from 5 percent per year in the late 1970's, to flat or declining loads in the early 1980's, then back up to almost 4 percent over the last 3 years.

Similar experiences across the country have led many forecasters and resource planners to conclude that developing a range of load forecasts is preferable to planning for a single forecast, since any single forecast is almost sure to prove wrong in the long run.

High rates of growth could continue. Few forecasters believe that the 3.4 percent growth rate in public utility loads over the 36-month period ending in March 1990 will continue indefinitely. BPA's medium load forecast for the next 20 years shows a 1.3 percent annual rate of public utility load growth; which is down considerably from the rate of the last few years. But there is a considerable chance that loads could exceed the medium forecast. For example, the high BPA load forecast rate is over twice as high as the medium--2.8 percent per year. The medium-high load growth rate for public utilities is 1.9 percent per year.

The following are examples of the types of events in the region's economy which could create sustained rapid load growth.

- Continued High DSI Loads. BPA's load forecast anticipates that firm DSI loads will decline by roughly 400 aMW by 1996. However, it is entirely possible that this decline will not occur. Several developments could keep DSI loads high. There could be substantially less aluminum smelting capacity added worldwide over the next 5 years than now predicted. The economy could do better than expected, avoiding any significant economic downturns over the next 4 years with a resulting higher demand for aluminum. And, the aluminum companies could decide to operate at high levels for a significant period even if aluminum prices fall.

- Sharp Increases in Gas Prices. Gas and oil prices could increase rapidly provoking a sharp increase in the use of electric space heaters in gas heated homes.
- Expanded Office Construction. The amount of new office construction could be much greater than expected if expanding office needs are met by significant new construction rather than by a decline in vacancy rates.
- Pulp and Paper Additions. Continued economic expansion along with further restrictions on the use of plastic and foam packaging could result in strong growth in worldwide demand for pulp and paper.

2. Proposed Resource Additions Cover Medium-High Load Growth

Figure VIII-1 compares BPA's new resource needs under the 1989 medium-high load forecast with the new conservation and generation resources included in the 1990 Resource Program. Although some very small deficits remain in some years, the proposed resource additions would be sufficient to keep BPA essentially in load/resource balance under the medium-high load growth scenario. However, preliminary estimates in the Draft 1990 Council Plan forecast indicate that the medium-high public utility loads should be raised by 200-400 aMW. Thus, while no Resource Contingency Plan actions appear to be necessary to cover the risk of deficits under medium-high load growth, the probability of loads exceeding the medium-high is presently estimated to be greater than 25 percent.

3. High Load Growth Could Mean Significant Deficits

The high load growth scenario presents a much different picture than the medium-high. As shown in Figure VIII-2, BPA deficits of about 1,000 aMW could result in the mid-1990's, if loads actually followed the high forecast. This is too soon for BPA to develop cost-effective new resources to meet these loads, unless BPA were to take effective action to prepare for this possibility.

Some important assumptions were made to develop this forecast of potential deficits under the high load growth contingency. These were:

- In 1992 it becomes clear that structural changes in the Northwest economy and demographics will result in persistent high load growth and in 1993 BPA begins to develop additional resources to meet the higher load. BPA does not take any "Contingency Plan" actions before 1993, such as the siting and licensing of CT's as specified in the recommended Resource Program.
- BPA develops conservation on the currently budgeted path in FY's 1990 and 1991. In 1992, BPA develops conservation per the recommended resource program described elsewhere in the 1990 Resource Program and this Technical Report.

FIGURE VIII-1
Proposed Resource Acquisitions Versus Need
(Medium-High Loads)

FIGURE VIII-2

Resource Availability Versus Need (High Loads and No Resource Contingency Plan)

- Also before 1993, BPA signs contracts to acquire 100 aMW of generation resources, using its acquisition process, 50 aMW of billing credit resources, and 30 aMW of geothermal resources in a Geothermal Pilot Program. Most of these 185 aMW are on-line by 1996.
- By 1997, 100 aMW of additional hydro efficiency improvements are achieved.
- Starting in 1993, BPA embarks on a program to develop all available cost-effective new resources as rapidly as possible. Specifically:
 - Firm power sales totaling 162 aMW to California utilities are converted to capacity/energy exchanges. Roughly 50 aMW of exchange energy is delivered to BPA.
 - The Option and Supplemental energy available under these contracts also is used to meet firm loads. This totals roughly 100 aMW until 1995, then roughly 40 aMW thereafter.
 - All conservation programs are accelerated. Since high loads mean more conservation opportunities, significantly more conservation is achieved than is predicted under the medium load forecast. Conservation savings total over 300 aMW by 1997.
 - All cost-effective new hydro and cogeneration is acquired as soon as possible, yielding approximately 150 aMW by 1997 in addition to the previously described 150 aMW billing credits and competitive acquisition, and 30 aMW of geothermal.
 - BPA moves to build new CT's as soon as possible, but they cannot be brought on-line until 1998.

Even with all these actions, the potential deficits of over 1,000 aMW shown in Figure VIII-2 occur, simply because the new resources cannot be developed fast enough to meet the rapidly growing load.

Another key assumption for Figure VIII-2 is that loads are not boosted by abnormally cold weather, and all existing resources perform as expected.

How likely is the High Load Growth contingency? BPA's load forecasters believe that there is roughly a 5 percent probability that load growth could be as high as, or higher than, the high forecast. In other words, there is roughly a 10 percent chance of loads falling in a narrow range somewhat above or somewhat below the high forecast.

4. Deficits Caused by Long-Term Resource Failure

Three types of significant long-term resource failure are conceivable for BPA: hydro plant failure, failure of planned new resources, or nuclear plant failure.

a. Hydro. BPA receives 85 percent of its firm energy from the hydro system. However, the possibility of low output from the hydro system is already addressed through BPA's critical water planning criterion, by which BPA counts on only the amount of hydro generation produced under extremely low water conditions. The global warming phenomenon could conceivably create even lower hydro output, but this possibility is currently too speculative to quantify as a contingency. Additional nonpower constraints on operation of the hydropower system also could reduce firm hydro generation, such as the designation of certain salmon strains as endangered species, but this also is speculative.

b. Planned new resources. Failure of planned new resources is not a significant issue for this year's Resource Contingency Plan, simply because BPA is not yet planning large increments of new resources of any one type.

c. Nuclear. This leaves the nuclear plants--WNP-2 and Trojan. BPA counts on these two plants for 945 aMW, or 11 percent of its total firm energy. Though very unlikely, long-term loss of one or both of these plants is possible. Such loss could result from regulatory action prompted by public opposition, by an accident at these plants or a similar project elsewhere in the country which prompted a decision to shut down similar plants, or simply by a major breakdown of one of the plants.

Figure VIII-3 shows that loss of both WNP-2 and Trojan, for a period of 5 years starting in 1992, would create deficits in the mid-1990's, even with medium load growth. The magnitude of the potential deficits is considerably smaller than in the high load contingency. The same assumptions about new resource development are used to draw Figure VIII-3 as are used for Figure VIII-2.

d. How likely is major resource failure? Long-term failure of major resources of the magnitude depicted in Figure VIII-3 is highly unlikely. Although there is no estimate of the probability of such an event, it is probably less likely than the high load growth contingency.

e. Resource failure and DSI restriction rights. BPA has contractual rights to restrict one quartile (roughly 600 MW) of firm DSI load in the event of resource failure. There are contractual limitations on the use of this restriction right. One limitation is that BPA must purchase all available power up to reasonable cost before restricting this DSI load. Another limitation is that BPA cannot restrict this DSI load if generation plants fail to perform due to a ballot measure or new law.

Despite these limitations, the DSI restriction rights somewhat mitigate the risk of deficits stemming from resource failure.

FIGURE VIII-3

Resource Availability Versus Need (Medium Loads and Loss of WNP2 and Trojan)

Note: Deficits decline in 1997 because of expiration of the WNP-2 Exchange Deliveries

5. Summary: How big is the risk of deficits?

Both the high load growth contingency and extended nuclear plant failure would create potential deficits in the 1990's. Making the high load growth contingency the focus of the Resource Contingency Plan also addresses the resource failure contingency, since resource failure appears to pose a smaller risk of deficits.

High load growth combined with extended failure of large generation plants could create even greater deficits. However, this contingency was judged to be too unlikely to warrant preparing for now.

D. Question #2: Is BPA Prepared for the Worst Case Contingency?

1. New resources cannot be added fast enough. As Figure VIII-2 suggests, BPA currently is not prepared to add sufficient new firm resources to meet the deficits under the high load growth contingency. Even after all available new resources are added as fast as practicable, for a total of more than 700 aMW by 1997, a deficit of 600 to 1,000 aMW still remains in the mid-1990's. To meet loads in this situation without a Resource Contingency Plan in place, BPA would have to rely on better-than-critical period hydropower output, short-term purchases, and/or some of the other operational options described below.

2. An acceptable risk? Is it prudent to simply rely on short-term spot market purchases and BPA's other existing operational options to cover the worst case contingency? This is the next key question.

E. Question #3: Are the Operational Options Enough?

1. BPA Has a Number of Operations Options

Operational options include making short-term spot market power purchases from other utilities, calling on power stored with other utilities, arranging for exchange with other utilities, using various other flexibilities under the Pacific Northwest Coordination Agreement, and using contractual rights to restrict deliveries of power to particular customers (primarily the DSI's). These operational options are effectively BPA's "aces in the hole" for dealing with any unexpected circumstances that threaten BPA's ability to meet its firm loads.

2. Should BPA Simply Rely on These Operational Options?

BPA could plan to meet the high load contingency simply by making short-term power purchases, or by using some of the other operational options. However, a number of factors make a Resource Contingency Plan preferable to relying on operational options, if a Resource Contingency Plan comes with a reasonable price tag. These factors are as follows:

a. Operational options have other uses: BPA frequently calls on its operational options, even in years when no firm energy deficits are expected. In such years, these options can be needed to cover shorter-term contingencies which are not addressed by the Resource Contingency Plan. These shorter-term contingencies include power supply shortfalls caused by winter cold spells, other temporary increases in loads, extremely low streamflows for a prolonged period, transmission limitations, short-term shutdowns of generation plants, unanticipated nonpower constraints on hydro projects, and similar events.

Last year was a good illustration of the use of operational options. At the beginning of OY 1989, BPA expected to have a substantial firm energy surplus. However, as the year progressed, a combination of load increases, cold weather, constraints on hydro system operation, and underperformance of thermal plants forced BPA to rely heavily on its operational options. From February 1 through March 18, 1989, BPA spent \$50 million to purchase 1.8 million megawatthours (MWh) of energy to meet its firm loads. Additional power purchases also were made outside this period, including the summer and fall of 1989. BPA also had to call on other available operational options to meet load in 1989, most notably restriction of the DSI top quartile for 6 weeks.

BPA would have faced a much greater challenge in OY 1989 if it had entered the year with a significant firm deficit, rather than a firm surplus.

b. Operational options can be expensive to use. The cost of calling on many of the operational options can be high. When short-term power supply becomes tight, prices for spot market energy tend to rise steeply.

c. Firm resources should equal firm loads. Finally, BPA has a general obligation to add sufficient firm resources to meet its firm loads. This does not mean that BPA must acquire sufficient firm resources in advance to meet every conceivable need. But it does mean that relying on short-term purchases and other operational options should in general be avoided, if steps can be taken at reasonable cost to provide for long-term firm resources.

3. Summary: Avoid Relying on Operational Options for High Load Growth Contingency

These factors point strongly toward using a Resource Contingency Plan to reduce the risk of unexpected long-term deficits, if such a Plan can be implemented at reasonable cost. While it is a good idea to avoid relying too heavily on these operational options, there also is a limit on how much can be spent prudently on a Resource Contingency Plan to avoid using them. Similar to a homeowner buying insurance, BPA must decide how much to spend now to reduce the risk of a large but unlikely future contingency.

F. Question #4: What Actions Can be Taken to Reduce the Risk?

1. Additional Resource Acquisitions are Too Expensive

The surest way to reduce the risk of deficits is simply to acquire more new resources now. This would provide a cushion of firm resources to absorb unexpected load fluctuations. Unfortunately, acquiring additional resources also tends to be a very expensive way of managing the risk of deficits, particularly when the probability of deficits is small.

As discussed in Chapter IX-A of this Technical Report, BPA conducted analysis indicating that simply acquiring additional resources to maintain a 200 aMW "cushion" of firm surplus would increase the present value of total system costs by \$350 million, even after allowing for the additional revenues derived from selling this surplus.

2. Low-Cost Resources

There are some low-cost new resources that are cost effective to develop ahead of need and BPA plans to take advantage of these opportunities. However, the 600 to 1,000 aMW deficit under high load growth remains even after all of these low-cost resources are developed. So, acquiring additional low-cost resources ahead of need does not appear to be an economic means of managing the risk of deficits, unless a significant amount of new low-cost resources are identified.

3. Shortening Lead Times

The main reason for the deficits predicted in the high load growth contingency is that cost-effective resources take several years to develop. For example, most of the generation resources in BPA's resource stack have lead times of from 5 to 7 years--too long to cover the deficits that can appear with higher-than-expected load growth. If these resource lead times could be shortened, the risk of deficits would be reduced.

Reducing resource lead times is the cornerstone of the Council's recommended approach for managing the risk of deficits. BPA's analysis confirms that this approach appears to have the most promise.

For many generation resources, it can take 2 or 3 years to locate an acceptable site, complete preliminary design and engineering work, obtain necessary licenses and permits, and examine environmental impacts. This crucial work is time-consuming, but it comprises only a small fraction of the total cost to construct a generation resource.

4. Siting and Licensing CT's

The concept of shortening resource lead times can be applied to CT's. Out of the 5 years required to bring a new combined-cycle CT on-line, 2 years are required for the pre-construction siting and licensing work, and 3 years for construction. By investing in the pre-construction siting and

licensing of two combined cycle CT's, BPA could reduce the lead time for these units to 3 years. This would enable BPA to significantly reduce the deficits in the high load contingency, as illustrated in Figure VIII-4.

Under this alternative, BPA would spend the funds required for siting and licensing the units, and then proceed with construction only if and when a need for the units became evident. If the units were built, BPA would intend to operate them to be displaced by BPA's nonfirm hydro energy when it is available.

As Figure VIII-4 shows, siting and licensing CT's would greatly reduce or eliminate the risk of deficits under the high load growth scenario. Risks of deficits of up to 900 aMW would still remain in years prior to 1996.

5. Import Purchase Options

Currently, California utilities have more than 20,000 MW of gas- and oil-fired generation capacity, and another 4,000 MW of coal-fired capacity. Utilities in the inland Southwest have additional generation capacity. For much of the year, this capacity is not fully used, especially in off-peak periods. Rather than building new capacity in the Pacific Northwest, it is possible that BPA could contract to receive off-peak firm energy from these plants when the energy is needed to meet BPA loads. Such purchase options are already in place with some California utilities, as part of existing power sales contracts.

To acquire such firm purchase options, BPA would probably have to pay some reservation fee. The size of the fee would be subject to negotiation, and cannot be predicted accurately. If the reservation fee were 0.5 mills/kWh, then the cost to BPA to reserve firm rights to purchase 800 aMW of energy would be \$3.5 million per year. If BPA chose to take delivery of the energy, payment would most likely be equal to the cost of generating the energy, plus some premium. BPA also might be required to purchase "emission credits" depending on the nature of future clean air legislation.

Figure VIII-5 shows how 800 aMW of import purchase options would reduce potential deficits under the high load contingency. As shown, purchase options could potentially eliminate virtually all of the deficits under the high load scenario.

6. CT's vs. Purchase Options

Both CT's and purchase options are similar because BPA would avoid running the CT's or purchasing power whenever lower value nonfirm energy is available. Beyond this similarity, there are a number of important differences. These differences include the efficiency of the generation plants, fuel costs, transmission losses, reliability, dispatchability, effect on BPA's transmission system, effect on the power system, fixed costs, air quality impacts and constraints, and others. For example, one constraint on purchase options is a limit to the amount of additional off-peak energy that can be brought into the BPA system at certain times of year, due to minimum generation requirements or transmission constraints.

FIGURE VIII-4

Resource Availability Versus Need (Option Two 420 MW Combined Cycle Combustion Turbines)

FIGURE VIII-5

Resource Availability Versus Need (800 AMW of Out-of-Region Purchase Options)

There is not sufficient room here for a full comparison of CT's to purchase options. BPA has examined these two alternatives, but many questions remain.

New CT's and purchase options are not mutually exclusive alternatives. It could make sense to use purchase options to cover the risk of deficits through 1995, and to use CT's to cover that risk for subsequent years.

7. Conservation

Conservation can make a major contribution to meeting the high load contingency. Programs which ensure that new structures and equipment are energy-efficient provide an automatic response to high load growth, since the source of load growth is in large part the addition of new structures and equipment.

As discussed elsewhere in this Resource Program, BPA is proposing to develop as much cost-effective conservation as is practicable. Much of this activity is focused on energy efficiency in new structures and equipment where it most contributes to meeting high loads.

Thus, conservation is a fundamental part of BPA's response to the high load contingency. However, as discussed above in the answer to Question #2, conservation by itself will not eliminate the risk of deficits.

8. Hydro and Cogeneration Options

As with CT's, the lead times for new cost-effective hydro and cogeneration projects can be cut by completing the pre-construction siting, design, and licensing activities ahead of need. Optioning hydro and cogeneration projects in this way can, at least in principle, help BPA respond quickly to the high load contingency.

So far, licensing rules of the FERC have limited hydro options, although this appears to be changing. Cogeneration options have been pursued by some other utilities in the Pacific Northwest, and have some promise. However, present information is too sketchy to allow the MW potential or costs of hydro or cogeneration options to be defined.

G. Question #5: Which Actions Should BPA Take?

As stated above, the risk of BPA deficits from the high load or similar contingency appears to be significant enough to warrant taking some action to reduce the risk, if such action can be taken at reasonable cost. Fortunately, some of the alternative actions described above could greatly reduce the risk, and have costs that appear reasonable.

1. The most clear-cut alternative. Performing siting and licensing work on two combined-cycle CT's appears to be the most clear-cut alternative. This is estimated to cut 2 years from the lead time for these units, at a total cost of \$6 million. As illustrated in Figure VIII-3, this would allow BPA to meet the potential deficits in 1996 and 1997 in the high load contingency.

2. Economic analysis of CT's is favorable. BPA has completed some economic analysis of the CT alternative. This analysis is presented in Chapter VI-B of this Technical Report. The analysis indicates that the cost savings created by the CT's when they are needed as early as 1996 or 1997 are probably large enough to more than cover the \$6 million cost for siting and licensing, even when these cost savings are discounted to reflect the low probability that the CT's would actually be needed in that timeframe.

3. More information needed on CT's. Before BPA could proceed with siting and licensing on new CT's, more information would be needed. Much more must be known about gas supplies to run such units. Pricing and reliability of gas supplies, and fuel storage options need to be explored further. Since BPA could not legally own new CT's, an organization to develop and own the units would need to be identified. Alternative locations for the units would have to be explored. Environmental effects, gas pipeline location, and impacts on the BPA transmission system would be key considerations in finding a location.

4. Other alternatives may be competitive with CT's. Although BPA's analysis supports the CT alternative, the other alternatives described above cannot be ruled out. BPA has conducted some analysis of the relative merits of acquiring firm energy purchase options from utilities outside the region, as compared with in-region CT's. Both alternatives have strengths and weaknesses; there is yet no clear basis for a choice between them. In fact, the alternatives may complement one another. Optioning cogeneration also has some promise, but relatively little is known about the potential for cogeneration options.

H. Conclusions

1. Pursue CT Siting and Licensing, With Further Examination of Other Alternatives

After considering the alternatives, BPA has decided that the 1990 Resource Program will include the optioning (siting and licensing) of approximately 800 MW of resources which, if actually completed, will likely be displaced by nonfirm hydro energy when it is available. The solicitation will take place early in 1991. The solicitation will not be specific to CT's, but will outline the characteristics of the resource or resources sought. Principal among these are cost-effectiveness when the resources are used in a firming nonfirm mode (e.g., low capital cost, flexible dispatch, and low fixed O&M), capability for long-term optioning, relative construction lead time, cost and reliability of fuel supply, and reliability of the project sponsor.

BPA is also proceeding to examine gas supply issues in more detail to reduce the uncertainty regarding the placement of gas-fired resources high in the resource stack. This will also facilitate a more informed evaluation of actual resource alternatives as a contingency plan resource.

Since it appears the new CT's could not come on line before 1996, BPA also will consider whether short-term purchase options or other actions should be taken to reduce the risk of deficits through 1995 under the high load growth scenario.

2. Develop Conservation and Other Low-Cost Resources

As shown above, much of BPA's ability to meet the high load contingency comes from the development of conservation and other low-cost generating resources. Developing these resources makes sense apart from the Resource Contingency Plan, but the Resource Contingency Plan makes it clear that these resources also are a key part of a risk management strategy.

Similarly, the Resource Contingency Plan supports BPA's resource assessment and R&D efforts, since these efforts equip BPA to develop the lowest-cost new resources quickly, when needed.

CHAPTER IX

OTHER RESOURCE PROGRAM ISSUES

There are a number of resource-related policy issues or specific program planning objectives that are not addressed explicitly in the Resource Program analysis. Even though not specifically addressed in the analysis these issues influence BPA's resource planning decisions. The following describes BPA's conclusions on these resource-related issues.

A. Planning for Surplus

Now that BPA is in load/resource balance and is projected to remain so through the turn of the century assuming the 1989 medium load forecast, suggestions have been made that BPA plan for a small surplus as a cushion against higher-than-medium load growth or resource failure. Currently, given the range of load uncertainty, BPA plans for enough resource additions to meet projected firm loads under critical water conditions at least cost. This least-cost planning includes adding all low-cost resources that can be sold for more than they cost.

BPA examined the cost of planning for at least a 200 aMW surplus in all load conditions. The analysis shows that the present value of total system costs would increase by approximately \$350 million, even after taking credit for the additional revenues received from selling the surplus. Thus, maintaining a surplus as insurance against higher-than-planned-for loads or other extreme conditions appears rather expensive.

A number of commenters continue to urge that BPA plan for a 200 aMW surplus despite this analysis of the increased costs of carrying such a surplus in all load conditions. Some additional information that should be considered in this debate is that under BPA's analysis in almost 80 percent of the 2,000 cases analyzed (100 games x 20 years) BPA has a firm surplus. This surplus averages 350 aMW. In cases where BPA fails to achieve load/resource balance, the firm deficit averages only 50 aMW. This surplus in most cases is the result of early commitment to large resources with long lead times. If BPA planned to always have a 200 aMW surplus, in most cases the surplus would be substantially higher than 200 aMW. Instead, a more prudent "insurance policy" appears to be the Resource Contingency Plan, as described previously.

B. WNP-1 and -3

In the Draft 1990 Resource Program BPA recommended starting a new comprehensive study of the future of WNP-1 and -3 beginning in July 1990. BPA's rationale was that many significant changes in issues surrounding the projects had occurred since the last comprehensive study in 1987. Among these changes were the reduced risk of default on outstanding bonds should the projects be terminated and the lower probability that either project would be needed to meet future load growth.

BPA received many comments on this recommendation, the majority of which suggested a new study was either premature or not needed at all. One reason given for postponing the next study was that a study in 1990 would divert regional attention from the Council's new Power Plan. BPA views this as a valid concern and considers input from the Power Plan to be important information that will complement the next study of WNP-1 and -3. Another reason given was that a study commencing in 1990 would not have the benefit of information from BPA's Puget Sound reinforcement study that currently is underway. In addition, the feasibility and cost-effectiveness of cogeneration and firming nonfirm are still uncertain and significantly affect the future of WNP-1 and -3. A clearer picture of the costs and availability of these competing resources should emerge as BPA proceeds with Billing Credits, competitive acquisitions, and implementation of the Resource Contingency Plan.

Some commenters suggested that the next study should focus on the institutional issues surrounding the projects, with less attention on economics. Reasons cited were that the economics are fairly clear--that the projects essentially provide no benefits on an expected value basis, but potentially would have high value if long-term load growth continues. The institutional issues BPA was encouraged to address are those dealing with the regional consensus on the projects, the process by which the projects would be terminated, BPA's relationship with the Supply System, and other broader policy issues. BPA agrees that any subsequent study of the projects should include a thorough evaluation of the relevant institutional issues.

BPA's final recommendation is to defer a new comprehensive study of the future of the projects until significant new information becomes available or conditions change sufficiently to warrant a new study. In the interim, there is no change in the status of WNP-1 and -3 within BPA's resource planning process. Based on current schedules for the Council's Power Plan and BPA's Puget Sound reinforcement study, it appears likely that a new study will be deferred at least until 1991.

C. Global Warming Insights

BPA received extensive public comment on its Draft Global Warming Study published in the Draft 1990 Resource Program. Many commenters applauded BPA's willingness to address the global warming issue. Some commenters, however, expressed concern about fuel switching as a global warming mitigation alternative. BPA views global warming as a serious environmental risk. As a Federal agency, BPA has a responsibility and a commitment to provide a reliable, cost-effective, environmentally sound electric power system. The 1990 Resource Program represents BPA's initial effort to examine the consequences of resource alternatives regarding emissions of greenhouse gases.

Carbon dioxide (CO₂), produced by combustion of fossil fuels, is the primary greenhouse gas. BPA's analysis examined a range of alternatives designed to reduce net carbon dioxide emission on the West Coast.

The results of the analysis suggest that increases in energy efficiencies are the most economic means of reducing CO₂ emissions. Specifically, the analysis found that switching from electric water heaters to gas water heaters would reduce CO₂ emissions significantly (because combustion-generated electricity would likely be displaced) and provide economic benefits as well. Prohibitions on fossil fuel resources and building WNP-1 and -3 ahead of need do not appear to be a cost-effective means of reducing CO₂ emissions. Strategies for mitigating global warming will be examined further in the RPEIS.

D. Fuel Switching

The Global Warming Analysis in the Draft 1990 Resource Program addressed the potential for switching water heating load from electricity to natural gas. Many utilities commented that fuel switching could threaten the financial health of individual utilities, and that any action in support of fuel switching should come from the local utility, not BPA.

Since the Draft, BPA has concluded that reductions in electricity consumption which result from switching water heating, space heating, or other end-use loads from electricity to natural gas or other alternative fuels do not appear to meet the Northwest Power Act's definition of a "resource." BPA also agrees that decisions on whether to try to influence end-use fuel choice should be left to the local utility. Hence, no BPA actions in support of fuel switching are included in this Resource Program.

However, the question remains whether BPA should support customers who choose, on their own initiative and using their own funds, to encourage fuel switching. Such fuel switching, when it is independently undertaken by customers, has the potential to reduce BPA's obligation to acquire new resources and transmission facilities, reduce BPA costs, reduce BPA rates, and reduce West Coast CO₂ emissions.

Though fuel switching will not be included in the first round of billing credits, BPA support similar to a billing credit may be appropriate in certain circumstances. A mechanism similar to billing credits could be appropriate because billing credits are granted only for independently-undertaken actions which reduce BPA's obligation to acquire resources, and because BPA rates are no higher with the billing credit than without it.

BPA intends to look into authorities and mechanisms for providing such support to BPA customers who choose to pursue fuel switching. BPA will provide additional opportunities for input from customers and other interested parties before implementing any strategy for providing support to independently-undertaken fuel switching.

E. Environmental Analysis of the Resource Program

Environmental effects of generating and conservation resources were considered when evaluating alternative program packages. Conservation measures in the recommended conservation packages have already been thoroughly analyzed in environmental documents. Environmental cost studies have also been performed for the generating resources included in the resource alternatives. Possible environmental effects of the other resource

recommendations, such as the resource acquisition test, the geothermal pilot project, hydro and transmission efficiencies, and possible resource options will be reviewed on a case-by-case basis. Global warming issues are examined in the Global Warming Study in Appendix A.

BPA has begun a RPEIS. Scoping for the RPEIS began in April 1990. A draft RPEIS is scheduled to be circulated for public review and comment in June 1991; the final RPEIS should be available in April 1992. The RPEIS will examine the environmental effects of individual resource types and the effects of adding different combinations of resources to BPA's existing system. Because the analysis will encompass a range of alternative plans for meeting future demands for electricity, the RPEIS will be broad enough to cover more than one Resource Program. BPA will begin using the RPEIS in 1992, along with the results of other analyses, to select the preferred resource plan for future Resource Programs. A Record of Decision for the 1992 Resource Program is expected to be issued in May or early June 1992. Following the selection of a specific resource plan in each Resource Program, individual resource acquisitions may be proposed. Separate action-specific environmental documents will evaluate the impacts of those specific acquisitions; the environmental trade-offs among the resource types will already have been covered in the RPEIS.

F. Resource Actions in the Puget Sound Area to Mitigate Peak Load Problems

Since the bitter cold spell of February 1989, BPA and other utilities have become increasingly concerned with the ability of the power system to deliver electricity into the Puget Sound area reliably. Loads have been growing rapidly in the Puget Sound area, causing greater needs for transmission from resources on the east side of the mountains to demand centers on the west side. As a result of these increased loads, the risk of voltage instability during line or generator outages is increasing.

To deal with this complex problem, BPA and the utilities of the Puget Sound area have begun a public process with the goal of completing an EIS in 1991. This process includes public meetings as well as working meetings with representatives of the utilities in the Puget Sound area. Work teams currently are addressing issues of future demand in Puget Sound, as well as quantifying the size and costs of measures available to mitigate the problem. Four areas of potential solution are: (1) load curtailment; (2) local generation; (3) conservation and load management; and (4) additional transmission.

The final 1990 Resource Program, as already described, includes siting and licensing two combined-cycle CT's, or optioning similar resources, with a total capacity of over 800 MW. If they were built in the Puget Sound area, these units could contribute substantially to relieving the immediate peak load problem in the Puget Sound area.

An appropriate resource question for the Resource Program is whether or not efforts should be made to locate or develop resources needed to meet Federal System energy needs in the Puget Sound area. Doing so could help increase system reliability by reducing the reliance on imports of power from

outside the Puget Sound area. A preliminary analysis, based on the current estimated direct cost of a cross-Cascades transmission line, indicates that a benefit of about \$100/kW exists for siting resources in the Puget Sound area rather than in some other part of the region. This benefit is rather small, compared to the capital cost of most power resources (CT's, for example, cost about \$600/kW) and does not provide a large incentive to locate a resource in the Puget Sound area rather than elsewhere in the region. However, since the construction costs of the CT's do not vary substantially with their geographic location, the economic advantage may be sufficient to warrant location of the CT's in the Puget Sound area.

The study of the peak load problem of the Puget Sound area is continuing in the context of work on an environmental impact statement. However, there is also a concern that winter peak loads in the Puget Sound area have already grown beyond the levels that can be reliably served by the existing transmission system. To mitigate this problem, short lead-time resources and/or load management may be necessary simply because a cross-Cascades transmission line cannot be built soon enough to solve the problem. For example, BPA is now working with the Supply System to study the feasibility of using the generator at WNP-3 as a synchronous condenser that could help alleviate the Puget Sound peak load problem in the near term.

G. DSI Load Uncertainty Beyond 2001

The assumption for most of the Resource Program analysis was that the DSI's would continue to receive the same type of service as they receive now after their contracts expire in 2001. There is some uncertainty about whether this assumption will hold true. BPA is moving to resolve this uncertainty. Changes in 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 conducted analysis to determine whether the Resource Program actions would still make sense even under the extreme case that all DSI load is gone in 2002. This analysis indicated that the Resource Program remains the best choice, even under this extreme scenario. That is, the resource actions in the program remain economic compared to the alternatives tested even if all the DSI load unexpectedly leaves BPA's system.

As the year 2001 approaches and BPA is faced with larger resource decisions, DSI load uncertainty is likely to play a bigger role in the Resource Program. This issue will require careful attention in the 1992 Resource Program.

H. R&D Project Evaluation

Currently BPA does not have a formal mechanism for evaluating R&D projects. It is important that R&D be efficient. Linking R&D projects to the directions established in the Resource Program will help insure that. Efficiency is also promoted by the explicit consideration of cofunding in evaluating projects. R&D project criteria would be used to judge the relative

merits of proposed projects. The most effective application of the criteria would be to motivate inclusion of important elements, to the extent practical, in any resource-related R&D project.

BPA plans to use the criteria and weightings outlined in Table IX-1 to make FY's 1992 and 1993 budget decisions for planned R&D projects.

TABLE IX-1
WEIGHTING FACTORS FOR EVALUATION OF
R&D PROJECT PROPOSALS

Criterion	Weighting Factor (%)
<u>SUPPORTS EXISTING AND PLANNED PROGRAMS</u>	
Solves problems encountered during program	15
Develops technology which would be supportive of program	10
<u>SUPPORTS LONG-TERM RESOURCE PLAN</u>	
Direct market impact potential	15
Preserves options	5
<u>LOAD/RESOURCE/TECHNOLOGY ASSESSMENT VALUE</u>	10
<u>SUPPORTS POWER PLANNING COUNCIL INITIATIVE</u>	10
<u>SHELF LIFE</u>	5
<u>CONTINUES EXISTING PROJECT</u>	5
<u>COST</u>	
Contract Cost	10
Cofunding Potential	10
Staff (FTE) Cost	5
<u>TOTAL</u>	100

GLOSSARY

1990 RESOURCE PROGRAM

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.)

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 maximum load that a machine or system can carry under existing service conditions. Equivalent terms: peak capability, peak generation, firm peakload, carrying capability. In transmission, the maximum load a transmission line is capable of carrying.

cogeneration

The simultaneous production of electricity and other useful energy from a fuel source, often accomplished by the recovery of excess "waste" 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.

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.

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 use of electricity during emergency conditions.

direct service industry (DSI)

An industry that buys power directly from the Bonneville Power Administration.

discretionary (or deferrable) resource

A resource that can be deferred for acquisition without cost or availability penalties. Resource cost is based on equipment or replacement cost.

end-use

Energy use categories, such as heating, cooling, ventilation, hot water, lights, and miscellaneous.

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.

Federal Base System

The system includes the Federal Columbia River Power System Hydroelectric projects, resources acquired by the Bonneville Power Administration 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 some rates.

firm energy

Electric energy which is intended to have assured availability to the customer to meet all or any agreed upon portion of his 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 1990-1991 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 in the earth's subsurface.

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 a cent. The cost of electricity is often given in mills per kilowatthour.

model conservation standards (MCS)

Energy efficient building standards (developed by the Council pursuant to section 4(f)(1) of the Northwest Power Act) for new electrically-heated commercial and residential buildings.

National Environmental Policy Act (NEPA)

An act passed by Congress in 1970 requiring that the environmental impact of most large projects and programs be considered.

nominal dollars

Dollars that include the effects of inflation.

nonfirm energy (or power)

Energy (or power or power-producing capacity) supplied or available under an arrangement which does not have the guaranteed continuous availability feature of FIRM POWER.

operating year (OY)

The 12-month period July 1 to June 30. For example, OY 1990-1991 is July 1, 1990 to June 30, 1991.

option

The purchase of a right to acquire a resources within a particular time on specified terms.

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.

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 Pacific Northwest Electric Power Planning and Conservation 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 Planning Act.

reliability

The ability of the power system to provide uninterrupted electric service.

renewable resource

Under the Northwest Power Act, a resource which utilizes solar, wind, water (hydro), geothermal, biomass, or similar sources of energy, and which either is used for electric power generation or 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.

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

The difference between assured system capacity and the system peak load for a specified period.

surplus energy

Generally energy generated that is beyond the immediate needs of the producing system.

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.

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.

wheeling

The use of the transmission facilities of one system to transmit power of and for another system.

APPENDIX A

1990 RESOURCE PROGRAM GLOBAL WARMING STUDY

I. INTRODUCTION

The 1990 Resource Program Global Warming Study examines potential Bonneville Power Administration (BPA) resource alternatives related to the risk of global warming. The study evaluates strategies for reducing net carbon emissions, and identifies the net carbon contribution of certain resource strategies designed to reduce those emissions. (Carbon dioxide (CO₂) is the "greenhouse gas" most associated with electricity production. The terms "carbon," "carbon dioxide," and "CO₂" are used interchangeably. This is discussed in greater detail in section II.)

BPA developed this study for several reasons. First, BPA must consider the environmental effects of its resource decisions. The Northwest Power Act, for example, requires BPA to consider environmental costs in its resource cost-effectiveness determinations. Moreover, one of the decision factors used to guide the Resource Program concerns the environmental effects of resource alternatives. Second, BPA must anticipate and respond to statutory and regulatory actions that may affect resource decisions. Many such proposed actions are described in this study. Third, BPA received comment from members of the public urging an analysis of global warming in the context of the Resource Program. BPA agrees that the risks of global warming, possible future constraints on fossil fuel resources, and BPA's environmental responsibilities all make a global warming study timely and valuable.

BPA views global warming as a serious environmental risk. As a Federal agency, BPA has a responsibility and a commitment to provide a reliable, cost-effective, environmentally sound electric power system. Moreover, BPA must consider environmental costs in determining the cost-effectiveness of new resource additions. Therefore, BPA will continue to address environmental issues, including global warming concerns, in its resource analyses and decision processes.

The main purposes of the study are to identify possible courses of action that BPA might take to reduce its contributions to the risk of global warming and to estimate the efficacy and costs of each approach. The study identifies possible actions that BPA might take in the context of the Resource Program for Fiscal Years (FY's) 1992 and 1993. Alternatives were selected to represent a broad range of approaches and to be suited for analysis with current analytical tools and readily available data. The principal measure of effectiveness is the reduction in total atmospheric carbon emissions compared to the proposed Resource Program as the Base Case.

Costs of alternative resource actions are measured primarily by the change in expected net present value of total system costs from a Base Case. This study differs from the rest of the Resource Program analyses in that it focuses on carbon reduction, not power production. The same load scenarios are used, so the analysis entails meeting the same load conditions but with lower CO₂ production. Cost differences represent the regional cost of achieving the CO₂ reductions.

II. BACKGROUND

The scientific community has raised alarming questions about the "greenhouse effect," the projected warming of the earth's atmosphere attributable to emissions of CO₂ and other gases. Although some broad conclusions are fairly widely accepted, much remains speculative. The specific consequences of continued greenhouse gas production and especially the timing of the consequences are largely a matter of scientific conjecture.

A. What Is Known

1. Greenhouse Gases

The atmospheric concentrations of greenhouse gases are a dominant factor determining global mean climate. Major greenhouse gases include CO₂, methane, tropospheric ozone, nitrous oxide, Chlorofluorocabrons (CFC's), and water vapor. There are 15-20 other greenhouse gases of lesser importance.

0 The atmospheric concentration of CO₂ has increased from 280 parts per million (ppm) in the 1890's to around 350 ppm in the 1980's. Electricity production is a factor contributing to the increase in human-caused CO₂. Currently, 64 percent of the world's electricity is produced using fossil fuels, accounting for 27 percent of global CO₂ emissions from fossil fuels (1.5 billion tons annually). Electric utilities in the United States emit 8 percent of the global total of human-caused CO₂.

Worldwide, about 5.5 billion tons of CO₂ were emitted through fossil fuel use in 1988. Emissions of 10 billion tons are expected in 2010 if emissions increase at just 3 percent annually.

The various electric power resources differ in terms of their relative CO₂ emissions. Natural gas combined-cycle combustion turbines (CT's) emit less than one-half the CO₂ of coal plants for each kilowatthour (kWh) produced. Geothermal energy produces minute amounts of CO₂. Other forms of energy production, including wind and solar, emit virtually no CO₂ directly. Nuclear energy production does not directly emit CO₂, but the fuel processing and enrichment stages require large indirect energy inputs that themselves result in CO₂ emissions, although their magnitude is not significant when spread over the units of final energy produced.

Hydropower supplies about 21 percent of the electricity produced worldwide, displacing 539 million tons of carbon that would otherwise be emitted each year.

2. Tentative Observations or Speculation

The global average temperature is likely to increase as a result of the extremely rapid increase in concentration of greenhouse gases. CO₂ is believed to account for about half of the expected global warming effect of the greenhouse gases. While North America now contributes 30 percent of the total human-caused CO₂ emissions annually, its emissions are expected to

increase by 125 percent by the year 2000, while the emissions from all other parts of the world are expected to increase by 700 percent. Most of that increase is due to population growth, industrialization, and economic growth foreseen for developing nations.

The average ambient temperature of the earth may rise between 3 and 9 degrees Celsius by the middle of the twenty-first century if current trends continue. It may take an additional 50 years, however, for the temperature increase resulting from the additional atmospheric CO₂ to be fully realized.

It is generally accepted that even a few degrees' rise in the temperature of the earth's surface would change the climate of most regions. This amount of warming could cause sea levels to rise by 1 foot or more by 2050. Regions of the earth that are now very wet could become much drier, and vice versa.

There is even some indication that the effect of CO₂ concentrations may soon begin to overwhelm the influence of naturally occurring cycles in global temperature. If this is so, streamflows in the Pacific Northwest may change significantly as early as the year 2000.

Although it is virtually impossible to be certain, it is reasonable to conclude that food production, water supplies, forest products industries, and fisheries will all be at risk if global warming accelerates during the next several decades. The Pacific Northwest is then likely to be affected because of the region's immense dependence on its natural resources: timber, agriculture, hydropower, fisheries, etc.

3. Effect on Hydroelectric Resources

Temperature increases in the Northern Hemisphere may reduce precipitation in the Pacific Northwest. A plot of the historical record suggests that a 1 degree Celsius increase in Northern Hemisphere temperature may be accompanied by a 31 percent decline in streamflow at The Dalles, which may be matched by an 18 percent decline in BPA sales revenues.

On the other hand, most of the global climate models predict an increase in precipitation as the earth warms, some predicting more precipitation in all seasons. Some climate models suggest that temperature increase is linked to an increase in Pacific Northwest precipitation.

A recent study by Dr. Dennis Lettenmaier of the University of Washington, who used climate change models to attempt to quantify changes in the West's water system, predicted the most likely change in the Pacific Northwest would be a decrease in snowfall and an increase in rain because of the general warming projected by the climate models. A possible result would be higher run-off in the winter, including more extreme flooding because there would be more rain than snow. Additionally, usable hydroelectric power in the Pacific Northwest could be affected because the region, having limited storage capacity in its reservoirs, historically has relied on a large snowpack for storage.

Although most climate models suggest that warming will be more pronounced in Canada than in the continental United States (U.S.), the Canadian contribution to Columbia River streamflow appears to be less susceptible to yearly variation than does the U.S. contribution.

4. Effect on Electricity Loads

An Environmental Protection Agency (EPA) report estimated that demand for electricity in the northern tier of States may decline by 5 percent while 25,000 to 55,000 MW's of additional capacity will be needed to meet summer demand in the southern U.S. An Electric Power Research Institute (EPRI) study suggests that a 1 degree Celsius warming by 2015 would increase energy demand by 10 to 20 percent.

Assuming that the average global temperature would be 1 degree Celsius higher by 2010 and 3 degrees Celsius higher by 2050, a study of the changes in average and peak electrical loads for California suggests that the incremental peak load caused by warming is likely to be 4 to 6 times the size of the incremental average load. This would exacerbate peaking capacity deficits in California, and enhance the value of Pacific Northwest capacity for sale to California utilities. Conversely, Pacific Northwest winter peak loads also could decline more rapidly than energy loads. However, changes in peak load depend on how the average temperature change is distributed over the seasons, and even more critically on how the change is distributed over a 24-hour summer day. It appears likely that the average winter temperature will rise more than the average summer temperature, and it may turn out that average nighttime minimums will increase more than average daytime maximums.

The range of possible outcomes suggests that BPA could feel impacts in many crucial areas of operation as a result of greenhouse-induced warming. A warmer climate may increase electricity demand on the west coast system while reducing supply. Global warming could change the amount and timing of hydroelectric power supply because of changes in spring and summer run-off patterns. Reduced hydroelectric generation could increase the cost of energy supplies if utilities replace hydropower with thermal generation plants.

B. Constraints on Current Knowledge

There is uncertainty over the extent to which human-caused greenhouse gas emissions contribute to global warming. The resolution and accuracy of the best of the global climate models is poor; they use grid points, each of which represents a 300 kilometer (km) by 300 km area. The models include only two grid points for each area (e.g., California) to represent two different layers of atmosphere. Moreover, interactions between surface and deep ocean and between the atmosphere and the hydrosphere are poorly understood and not yet adequately modeled.

The temperature record of the globe is very "noisy," and it is not certain that the warmth of the current decade indicates anything other than normal.

fluctuation. (The greenhouse signal may not yet have emerged from the background noise.) The climate models predict that with the current levels of CO₂ the temperature of the globe already should have warmed more than temperature observations indicate that it has. Either there is a longer lag between CO₂ build-up and temperature increase; the observed change is within the margin of error of the models; or, the models need to be reworked.

III. POLICY CONSIDERATIONS

A. Policy Observations

The greenhouse effect is not a local problem, and local responses, while essential, cannot be adequate. The climate in each part of the world is linked to climates in many other parts of the world, and causes of global warming are widely dispersed. If current atmospheric models are correct, stabilization of CO₂ concentrations in the atmosphere is an imperative goal--by some estimates, reductions of more than 50 percent of worldwide CO₂ emission levels are needed. Only a collective world effort would be effective in reducing these emissions significantly.

If global warming occurs, BPA will have to adapt to the physical effects on the power system and the larger environment brought about by climate change. Noticeable physical effects are most likely to appear beyond a 20-year planning horizon, but probably within a 45-year period. However, even if no physical effects are seen in the next 20 years, BPA may be forced to adapt to changing laws and regulations that affect the way the agency conducts its business.

Although there is much uncertainty and controversy regarding strategies for adapting to climate changes, some observations can be made. First, more and much better information about local effects is needed. Unfortunately, such information will not be available soon. Specific information may not be available until it is too late for effective action. Second, even if adaptive actions are undertaken, some changes will almost certainly be unexpected if global warming occurs. These changes may require expensive crisis responses which could result in increased competition for limited resources, straining the world economy and threatening our ability to respond.

Coping with legislative and regulatory changes can be equally unpredictable and expensive. Although regulatory change may seem less "real" than actual physical change, the responses required are equally unavoidable and sometimes more immediate.

Preventive strategies, in spite of their risks, probably make sense. William Moomaw of the World Resources Institute suggests a reasonable policy response which recognizes the uncertainty involved:

"What factors might we keep in mind as we attempt to set priorities for congressional responses? The seriousness of the projected consequences and their time frames and degree of irreversibility provide important yardsticks against which we can measure various policy proposals. Despite the irreversible, adverse consequences of our release of greenhouse gases, the focus of concern appears to be more on the irreversible impact of policy changes that might be enacted to solve these problems. What if we are mistaken and there is no global warming? One way to approach this

dilemma is to initially phase in those policies that are most easily reversed, that have the lowest negative impact on the current economy, are most effective in reducing greenhouse gas emissions, and which have additional environmental and economic benefits as well."

3. Recent Congressional Action. Many of the most promising mitigation alternatives (e.g., taxing CO₂ emissions) require at least national if not international governmental action. Several global warming measures that would affect BPA and the Pacific Northwest were introduced in Congress in 1988.

- Senator Stafford's Global Environmental Protection Act of 1988 (S.2663 & S.2666) proposed regulation and reduction of CFC's and CO₂.
- Senator Wirth's and Representative Au Coin's National Energy Policy Act of 1988 (S.2667 & HR.5380) directs the Secretary of Energy to develop a national least-cost energy policy, including a 20 percent reduction in CO₂ generation by the year 2000.
- Senator Chafee's & Representative Schneider's Global Warming Prevention Act of 1988 (S.2867 & HR.5460) proposes additional funding for alternative energy sources.
- Representative Jones' National Global Change Research and Policy Act of 1988 (HR.5421) would launch strong research and development efforts.
- HR.389 resolved that the Executive and Legislative Branches should jointly develop a national energy policy to deal with global warming.

None of these bills were passed in 1988. In 1989 Congressional interest in global warming continued to increase; however, no legislation was passed.

- Senator Hollings proposed a bill to improve coordination of Federal agencies working on global change (S.169). It was approved by the Senate Commerce Committee on April 18, 1989.
- Senator Gore introduced the World Environmental Policy Act of 1989 (S.201) which would phase out the use of CFC's, study ways to reduce methane emissions, raise vehicle efficiency standards, encourage recycling, protect tropical forests, and replace the Council on Environmental Quality with a Council on World Environment.
- Senator Moynihan introduced legislation to investigate potential global environment changes (S.251).
- Senator Wirth reintroduced his 1988 bill as the National Energy Policy Act of 1989 (S.324). Hearings were held in March 1989. Hearings are being conducted now on an amended version of this bill.

- Senator Chafee proposed a bill to prevent ozone depletion by reducing atmospheric pollution (S.491). Senator Baucus introduced legislation to reduce CFC's and halons (S.503).
- Representative Stark introduced legislation to require CFC labeling (HR.503) and to apply an excise tax to CFC's (HR.1112).
- Representative Jones sponsored a bill proposing a 10-year research plan to study global climate change (HR.980). This was approved by the House Merchant Marine committee on September 26, 1989.
- Representative Schneider reintroduced the Global Warming Prevention Act (HR.1078).
- Representative Roe introduced a bill to coordinate action on global change. Hearings were held by the House Science Committee in July 1989.
- Hearings on topics related to the global environment have been held by Senate Commerce, Environment, and Energy committees. In the House, hearings have been held by the Appropriations, Energy, Science, and Merchant Marine committees.

4. Council on Environmental Quality Draft Guidance on Global Warming

In addition to pending Congressional action, BPA may be affected by regulatory responses to the threat of global warming. The President's Council on Environmental Quality (CEQ) is responsible for implementing the procedural provisions of the National Environmental Policy Act (NEPA). CEQ has circulated a document for review which proposes that Federal agencies consider global climate change in NEPA documents. Under these guidelines, Federal agencies would be asked to analyze all proposed programs that may contribute to, or be affected by, emissions that contribute to stratospheric ozone depletion or global warming. While this guidance is still in draft form, it is reasonable to expect this is the direction Federal agencies will follow in future environmental reviews. The following requirements are proposed:

- a. Federal agencies would be required to determine to what extent their actions would cause emissions of stratospheric ozone depleting substances and to consider whether their actions may be affected by any future climate changes caused by global warming.
- b. Agencies would be asked to review the extent to which ongoing programs contribute to stratospheric ozone depletion or global warming.
- c. Agencies would need to review research to determine which effects have a "reasonable scientific basis."
- d. If relevant information could not be obtained or the costs of obtaining it were prohibitive, the agencies would demonstrate this in their NEPA documents.

e. The assessment would be made at the programmatic level, not the project level.

B. BPA's Current View of Global Warming

BPA views global warming as a serious environmental risk. As a Federal agency, BPA has a responsibility and a commitment to provide a reliable, cost-effective, environmentally sound electric power system. BPA will continue to address environmental issues, including global warming concerns, in its resource analyses and decision processes.

BPA acknowledges that both the timing and magnitude of future warming is uncertain. Potential consequences of future warming are also uncertain. Prudent resource planning, however, calls for continued examination and analysis of global warming concerns. These include anticipating Federal actions that may affect both the amount and the cost of fossil fuel resources.

BPA's actions will be consistent with Federal direction regarding global warming. BPA does not intend to preempt either Department of Energy (DOE) requirements or legislatively imposed responsibilities. BPA will continue to monitor research into global warming and participate in such efforts to the extent appropriate. Resource alternatives that provide system cost benefits as well as reductions in emissions of greenhouse gases will continue to be emphasized in all BPA resource planning efforts.

IV. ECONOMIC ANALYSIS

A. Study Design

1. Method

Several resource alternatives designed to reduce net carbon emissions to the atmosphere have been analyzed using the Integrated System for Analysis of Acquisitions (ISAAC) model. The Base Case is the proposed Resource Program described in Section VI-C. Briefly, the Base Case assumes that to meet firm loads the model adds resources in the order specified by BPA's proposed Resource Program. The results of the Base Case are provided for an expected value run over 100 different random load and water conditions. Results for the resource alternatives are expressed as changes from the Base Case.

Each alternative is structured to reduce carbon emissions by manipulating resource choices; for example, by making certain resources (such as coal) no longer available for acquisition, or by forcing additions of certain resources (such as conservation). The model runs as usual, adding resources to meet loads and operating the system with existing and new resources.

The annual energy production from fossil fuel resources forms the basis for estimates of carbon emissions associated with each alternative. Again, these are compared to the Base Case. This is accomplished by deriving an expected value of CO₂ emissions per average megawatt of coal and combustion turbine (gas) operations. Those values are multiplied by the expected value of energy output from fossil fuel resources to yield an estimate of CO₂ emissions in tons per year.

ISAAC's planning horizon extends from 1988 to 2034. Load growth paths through 2010 are used to generate resource needs. Resources are also added through 2010. After 2010, loads are frozen as are new resource additions. Through 2034 existing resources are replaced at the end of their lives with a generic new resource, but that does not affect the comparison of the resource alternatives to the Base Case. The model continues to operate the system until 2034 to ensure that end effects are properly accounted for. In the global warming analysis it is assumed that the resource operations in 2010 continue through 2034. This facilitates comparing the carbon emissions reductions to the present value of system costs calculated by ISAAC, because resource operations between 2010 and 2034 include the effects of the generic replacement resource. Including that resource would distort results of system operations. Freezing operations as of 2010 appears to be the best approach for estimating CO₂ emissions. Freezing loads and new resource additions at their 2010 level, however, results in an underestimate of the carbon reductions that would likely be achieved by each alternative. New resource additions at that time consist mainly of fossil fuel resources.

All costs are discounted to 1988. The model may initiate resource actions beginning in 1989. The global warming alternatives, however, are not scheduled until 1992. Assumptions applicable to each resource alternative are described separately.

2. Base Case

The Base Case is the benchmark alternative against which the resource alternatives are compared. It consists of BPA's Proposed Resource Program actions in 1992 and 1993 with subsequent resources added to meet loads in order of BPA's resource stack.

3. CO₂ Reduction Alternatives

Constrained New Fossil Fuel Resources

This alternative consists of two variants:

1a. No New Fossil Fuel Resources -- No new coal, gas, or oil-fired resources are permitted in the resource stack. Coal is replaced in the stack with 2000 aMW of geothermal resources costing 40 mills/kWh and an unlimited amount of a 60-mill, non-CO₂-emitting resource. Existing fossil fuel resources are permitted to operate throughout their lives. New cogeneration is permitted because it is assumed that fossil fuels would be burned to meet thermal needs anyway, so the addition of electrical generation capability only minimally increases the amount of fossil fuel use, and, hence, the total amount of CO₂ emissions. At the same time, cogeneration increases the efficiency of fuel-use so that less CO₂ is emitted per unit of energy produced.

1b. No New Fossil Fuel Resources Except Combustion Turbines (CT's)-- This alternative is the same as alternative 1a except that only new coal plants are prohibited. New combined-cycle CT resources are available to replace coal. The rationale for permitting CT's is that gas produces less CO₂ than coal, and CT's are much more efficient than coal plants. Thus, this alternative is expected to have smaller decreases in CO₂ compared to the no fossil fuel resources alternative, but higher costs as a result of operating CT's as baseload resources.

1d. Aggressive Conservation Additions -- This alternative is similar to the Base Case except that all deferrable conservation measures are added beginning in 1998, rather than adding them when as they are required to meet loads. Developing conservation ahead of need permits displacement of thermal resources and defers the on-line dates of new thermal resources. Both responses reduce the amount of CO₂ emitted from the system, and have the potential of producing economic benefits as well. The conservation measures available to the model are the same as in the Base Case, but they are forced in earlier. All cost-effective lost-opportunity conservation resources are acquired. This alternative does not differ from the resource program for years 1992-1997. Beginning in 1998, maximum ramp rates are applied to all conservation resources. Because no cost penalties are applied to the accelerated ramp rates this will result in a significant underestimate of system costs.

1e. Washington Nuclear Project (WNP)-1 and -3 Built Ahead of Need --
This alternative differs from the Base Case in the treatment of WNP-1 and -3. In the Base Case WNP-1 and -3 are added only when needed to meet firm energy loads. Resources with lower levelized costs are built prior to either plant. In this alternative, construction of WNP-1 is begun in 1992. WNP-3 is then made available to meet loads when needed. The early start of WNP-1 is ahead of BPA or regional needs under most load growth scenarios. Because no CO₂ emissions are directly associated with nuclear power production, this alternative is designed to displace and defer fossil fuel resources.

2a. End-Use Efficiencies Achieved By Reducing Electric Water Heater Loads (Electric Water Heater Penetration Reduced to 50 Percent) --
Current forecasts indicate that in BPA's service territory, electric water heaters would be installed in more than 85 percent of new single family residences and as replacements in existing single family residences. This alternative is designed to increase thermodynamic efficiencies by displacing fossil fuel electric generation by substituting natural gas water heaters for electric water heaters. The carbon emissions created by the gas water heaters are expected to be offset by greater reductions achieved through displacement and deferral of fossil fuel generation. The savings are computed in the following manner:

First the total number of new and replacement electric water heaters in single family residences in the region over the next 20 years are estimated from recent forecasts. (The medium load forecast from the 1989 Joint Residential Forecast is used.) A new estimate is then made assuming that only 50 percent of new water heaters would be electric, the remainder being natural gas heaters. (This is just an assumption to test the effect of a different water heater mix.) The difference represents an estimate of the total number of water heaters available in BPA's service territory if the electric water heater penetration rate were reduced to 50 percent. The number of water heaters is then multiplied by 4,534 kWh/year, the average electric energy consumption of an electric water heater. The result is the annual increment of load savings resulting from reducing electric water heater penetration to 50 percent. These savings are assumed to be permanent; that is, once the savings occur, they persist over the life of the study.

2b. End-Use Efficiencies Achieved By Reducing Electric Water Heater Loads (Electric Water Heater Penetration Reduced to 20 Percent) --
This alternative is identical to alternative 2a except that the electric water heater penetration rate is reduced to 20 percent.

B. Results

For each alternative, the following estimates are calculated: Change in net present value of total system costs compared to the Base Case; change in annual, total, and present value of CO₂ emissions compared to the Base Case; and, levelized cost per ton of CO₂ reductions. Results are shown in Table A-1.

The Base Case results are not shown because results for all alternatives are expressed as differences from the Base Case. Each alternative tested is shown in the first column. The next column displays the change in net present value of total system costs associated with each alternative. Results are given as changes in millions of 1988 dollars. Positive changes indicate an increase in total system costs compared to the Base Case. Negative changes indicate a decrease in total system costs compared to the Base Case.

The next column shows the change in total CO₂ reductions compared to the Base Case. The final column is the levelized cost or benefit of achieving the CO₂ reductions, also expressed in 1988 dollars. These values may be interpreted as follows: Positive values indicate that each ton of CO₂ reduction is achieved at some cost. For each alternative, it costs the system an average of the indicated amount to achieve the given level of CO₂ reductions. Negative values indicate the system benefit associated with each ton of CO₂ reduction. (NOTE: Calculation of the levelized cost column requires additional information not shown in the Table A-1. Values in the Table A-1 cannot be used to derive the levelized cost.)

1. Results for Each Alternative

1a. No New Fossil Fuel Resources -- Prohibitions on BPA's fossil fuel resource additions are costly to the system; the present value of total system costs increases by nearly \$500 million compared to the Base Case. The CO₂ reduction is significant, however. Approximately 76 million fewer tons of CO₂ are estimated to be emitted compared to the Base Case. This results in a levelized cost of CO₂ reductions of slightly more than \$15/ton. Estimates of costs for planting trees in the Pacific Northwest to offset CO₂ emissions are in the \$5/ton range. Thus, a ban on all fossil fuel resource additions costs about three times as much as tree planting for each ton of CO₂ reduced or abated. Conversely, scrubbers to remove CO₂ from stack gases are estimated to cost about \$30/ton of CO₂, about 50 percent more than this alternative.

Both the cost and the effectiveness of this and other CO₂ reduction strategies are limited by the assumed planning horizon, because only Federal System resource additions are changed, and because the Federal System does not need new resources under most load scenarios until the early years of the next century. The analysis permits new resource additions and estimates resource operations only until 2010, so there is little opportunity to reduce fossil fuel additions and operations compared to the Base Case. Although the resource operations estimated for 2010 are assumed to remain constant through 2034, providing additional CO₂ reductions compared to those available through 2010, the result is a underestimate of the effects if load growth and resource additions were allowed beyond 2010. Because both costs and CO₂ reductions would change significantly if post-2010 conditions were permitted to change, it is impossible to speculate on whether the levelized cost of CO₂ reductions would be greater or less than those shown here.

TABLE A-1

SUMMARY
COST OF REDUCING CO₂ BY ALTERNATIVE

Alternative	NPV a/ (1,000,000 1988\$)	CO ₂ Reduction b/ (1,000,000 tons)	COST PER TON REDUCED c/ (Levelized Cost 1988\$)
No Fossil Fuel			
CT's Only	+484	76.0	\$15.44
Aggressive Cons	e/	e/	e/
WNP Early	-363 d/	7.3	-84.03
Water Heater 50%	+1,106	129.1	16.70
Water Heater 20%	-467	42.9	-24.65
	-701	90.3	-17.41

a/ Change in net present value of system Costs compared to Base Case. Positive values indicate an increase in system costs. Negative values indicate a decrease in system costs.

b/ Changes in total carbon emissions through 2034 compared to Base Case. Expressed as reductions in CO₂ emissions.

c/ Levelized cost per ton of CO₂ reduction. Negative values mean that system costs decline by the indicated amount on a per ton of CO₂ basis. See Text.

d/ This figure should be interpreted as the system cost benefit of maximizing conservation ramp rates beginning in 1998. Acquisitions through 1997 are identical to Resource Program acquisitions.

e/ Results are undistinguishable from Base Case. See Text.

The results of this alternative are sensitive to the costs of the replacement resource. The resource used in this analysis is a 40-mill geothermal resource, with 2,000 MW of geothermal available. If less geothermal were available, or the cost were higher, this could be a more expensive alternative.

The effect of this alternative on resource additions and operations as of 2010 is shown in Table A-2. In the Base Case, only 23 average megawatts (aMW) of coal are added to the Federal System by 2010 on an expected value basis. (All resource additions are shown for the Federal System only. Resource operations are shown for the region.) This is only a small fraction of a conventional coal plant. CT additions, including imports from Pacific Southwest CT's, are reduced compared to the Base Case, declining by 162 aMW on an expected value basis. CT's are more strongly affected because they are cheaper than coal and can be brought on line more quickly. Thus, more average energy from CT's are added to the system in the Base Case compared to coal plants.

Coal plant operation is reduced by about 62 aMW per year in 2010 under this alternative. This corresponds to about 0.6 million tons/year of CO₂ less than in the Base Case. (Approximately 9,218 tons of CO₂ are produced per aMW of coal. Approximately 4,690 tons of CO₂ are produced per aMW of CT's.) CT operations also are reduced compared to the Base Case. Exports to the Pacific Southwest increase by 307 aMW compared to the Base Case. Exports are assumed to displace Pacific Southwest gas turbines having the same efficiency as new combined-cycle CT's. Exports therefore are treated as reductions in CO₂ emissions. (This is a conservative assumption; to the extent that coal or less efficient oil or gas burners are displaced, the total amount of CO₂ emissions reductions are underestimated.)

This alternative has little effect on conservation additions. Only about 8 aMW of additional conservation is added, a small amount.

Total system costs increase primarily because displacement of resources by BPA's nonfirm is not economic without low capital cost resources such as CT's and imports.

1b. No New Fossil Fuel Resources Except CT's -- Prohibiting coal plants but permitting CT additions has almost no effect on system costs or CO₂ reductions. This is because, on an expected value basis, no new coal is acquired in the base case until 2008. By 2010 only 23 aMW of coal is acquired. Since that amount is replaced by CT's which emit about half as much CO₂ per kWh as coal, no additional analysis of this alternative was conducted.

TABLE A-2

SUMMARY
BPA ADDITIONS AND REGIONAL OPERATIONS OF
SELECTED RESOURCES IN YEAR 2010

(INCREASES (+) OR DECREASES (-) FROM BASE CASE)

Alternative	Addition/ Operation	Cons. (aMW)	Coal (aMW)	Gas (aMW)	Nuclear (aMW)	Exports (aMW)
1a. No Fossil	ACQ	+8	-23	-162	-49	
1a. No Fossil	OPN		-62	-88	-48	+307
1b. CT's Only	ACQ	+3	-86	+8	0	
1b. CT's Only	OPN		-62	+7	0	+7
1d. Aggres. Con	ACQ	+95	0	-10	0	
1d. Aggres. Con	OPN		+2	-9	-8	+29
1e. WNP Early	ACQ	-83	-18	-95	+780	
1e. WNP Early	OPN		-66	-36	+780	+408
2a. Wtr Htr 50%	ACQ	+739	-23	-22	-25	
2a. Wtr Htr 50%	OPN		-42	-13	-24	+158
2b. Wtr Htr 20%	ACQ	+1077	-23	-56	-33	
2b. Wtr Htr 20%	OPN		-83	-24	-32	+357

NOTE: ACQ refers to the expected value of the amount of resources acquired by BPA as of 2010.
 OPN refers to the expected value of the amount of regional resource operation in 2010.

1d. Aggressive Conservation Additions -- Adding conservation resources prior to need results in a decrease in system costs compared to the Base Case. The expected value of the decrease is \$363 million. This alternative is identical to the Resource Program proposed action alternative, for years 1992-1997. Beginning in 1998 conservation ramp rates are accelerated to their maximum. Because no cost penalty is assigned to the higher ramp rates (i.e., it is assumed that ramp rates could be accelerated with no additional cost) this system benefit measures the value of the accelerated acquisition. The actual cost of accelerating ramp rates to their maximum is unknown. This alternative is fully consistent with the proposed Resource Program. Readers are cautioned not to assume that this represents a lower cost alternative than the Resource Program; the two alternatives are identical through 1997. The CO₂ emissions reduction is about 7 million tons. The levelized benefit associated with each ton of CO₂ reduction is high, about \$84. Although the CO₂ reductions are small, this alternative is clearly a cost-effective means of reducing net CO₂ emissions if ramp rates can be accelerated at costs less than the system benefit shown here.

As with most of the alternatives, the effect on fossil fuel resource additions and operations is limited by the relatively short planning horizon, and by the lack of need for coal plants to meet most load growth scenarios during the next 20 years. By 2010, conservation resource additions are 95 aMW greater than in the Base Case. Changes for acquisitions and operations of other resources are minimal. (See Table A-2.)

1e. WNP-1 and -3 Built Ahead of Need -- Building WNP-1 and -3 ahead of need, in contrast to building conservation ahead of need, does not appear to be a cost-effective strategy for achieving CO₂ emissions reductions. Present value of total system costs increases by about \$1.1 billion. Significant CO₂ reductions are obtained from operating the plants; the net CO₂ emissions reduction is 129.1 million tons. These values result in a levelized cost of CO₂ emissions reductions of about \$17/ton. That cost is comparable to the cost of reductions achieved through a prohibition on new fossil fuel resources.

This alternative does produce significant effects on resource additions and operations. The need for conservation additions as of 2010 would decline by 83 aMW. Coal plant additions decline by only 18 aMW while coal plant output declines by 66 aMW. CT additions also are lower--the expected value of CT additions declines by 95 aMW, while their output declines by a smaller amount, just 36 aMW.

Nuclear additions are, of course, much greater than in the Base Case, increasing by 780 aMW with a corresponding increase in output. Export sales increase by 408 aMW, the largest increase of any of the alternatives.

2a. End-Use Efficiencies Achieved By Reducing Electric Water Heater Loads (Electric Water Heater Penetration Reduced to 50 Percent) -- Replacing electric water heaters with gas water heaters appears to be an effective and economic means of reducing CO₂ emissions. Total system costs decline by nearly \$500 million. This value is the utility system cost savings minus the consumer costs of installing and operating gas water heaters. (Consumer costs include the costs of existing and extended local distribution systems.) The consumer costs of the additional gas service are estimated to be about \$1.5 billion, with the electric utility savings (including gross consumer benefits) estimated at about \$2.0 billion. Consumer costs consist of the following elements: 1) the difference in water heater purchase costs between gas and electric; 2) the additional cost of installing gas water heaters compared to electric water heaters; and, 3) the gas fuel costs over the life of the heater. The analysis assumes that no electric utility costs are associated with water heater changeovers. From a regional perspective, this is reasonable, but, at least in the short run, some rate problems could occur. By reducing loads significantly, as happens in this alternative, the utility's fixed costs must be spread over a smaller load, potentially increasing retail rates. This could affect the estimate of consumer savings if their resulting utility bills are higher, thereby offsetting the gas versus electricity savings.

Over the planning period, the electric system CO₂ reductions total 43 million tons. The CO₂ emissions from water heaters (those formerly using electricity in the Base Case now burning gas) are estimated to be 15.6 million tons. The net reduction in CO₂ emissions, therefore, is 27.3 million tons. This means that for each unit increase in CO₂ emissions from gas water heaters, somewhat less than three units from electrical generation are saved. This is clearly an improvement over the Base Case measured by both system cost savings and by CO₂ reductions. Methane emissions from leakage in the distribution system amount to 0.3 percent of fuel use. This is about 1413 therms per aMW of electricity displaced by fuel switching. The levelized benefit associated with each ton of CO₂ reduction is \$39.

Coal, gas, and nuclear additions decline compared to the Base Case, none by significant amounts. Conservation additions increase mainly because the water heater savings are modeled as conservation. Export sales increase by 158 aMW compared to the Base Case.

2b. End-Use Efficiencies Achieved By Reducing Electric Water Heater Loads (Electric Water Heater Penetration Reduced to 20 Percent) -- Reducing the gas water heater penetration rate to 20 percent results in additional system cost savings. The present value of total system costs declines by \$700 million compared to the Base Case. Reductions in CO₂ emissions total about 62 million tons compared to the Base Case for an expected levelized benefit associated with each ton of CO₂ reduction of \$25. Effects on resource additions are about the same as in the 50 percent case, while the operational effects are about double those of the 50 percent case.

C. Conclusions

Judged by changes in total system costs, the array of alternatives produces a wide range of cost-effectiveness for reducing CO₂ emissions. Three of the alternatives resulted in both lower total system costs and lower CO₂ emissions.

In reviewing the results it is useful to bear in mind two relevant costs. First, the cost of planting trees to sequester carbon emissions is estimated to be about \$5/ton. That is a minimum cost, and the availability of tree planting is limited by acreage availability. It takes roughly 2,000 acres of trees in the Pacific Northwest to offset the production of CO₂ from each average megawatt of coal plant output.

As an upper limit on costs, scrubbing CO₂ from plant stacks is estimated to cost about \$30/ton. Although that technology is unproven, the cost estimates provide guidance as to what CO₂ reduction costs are likely to be cost-effective.

Prohibitions on new fossil fuel plants are not likely to be economic given current estimates of resource costs. A ban produces significant CO₂ savings, but at a substantial total system cost penalty. Aggressive conservation makes sense economically and environmentally. Total system costs and CO₂ emissions are reduced. The system cost reductions are interpreted as the benefit of increased conservation acquisition ramp rates. This reinforces the case for the 1990 Resource Program alternative for 1992 through 1997, since that alternative is comparable to the aggressive conservation alternatives analyzed here.

In contrast, building WNP-1 and -3 ahead of need, while producing significant CO₂ reductions, appears to be costly. The assumptions of the analysis are too simple to provide a definitive answer to the question of cost-effectiveness, but the plants would not be likely to provide a cost-effective means of reducing CO₂ emissions in the near term. The levelized cost per ton of CO₂ reduction compares favorably to the cost of scrubbing CO₂ from fossil fuel plant stacks, and is close to the cost of prohibiting all new fossil fuel resources.

Finally, end-use thermodynamic efficiencies show large benefits. Decreasing the electric water heater penetration rate on BPA's system from more than 80 percent to 50 percent results in net total system cost benefits of nearly \$500 million. The net change in CO₂ emissions, after accounting for the increase in emissions at the water heater, is about 27 million tons. Each ton of CO₂ reduction is associated with a large levelized total system cost benefit of nearly \$40/ton. Conclusions based on the analysis presented here are the following:

- Because the Federal System will not likely be adding coal plants until well into the next century, CO₂ emissions from new coal plants are not a major resource planning concern for the 1992 and 1993 resource program period.

- Aggressive conservation is attractive from both an economic point of view as well as from a global warming perspective if its acquisition rate can be accelerated without a substantial cost penalty.
- Nuclear power could be a cost-effective means of achieving CO₂ reductions, but not at this time. Resuming construction of one plant in 1992 would significantly reduce CO₂ emissions, but would be expensive.
- Improving end-use thermodynamic efficiencies looks economically and environmentally attractive. Matching fuel switching with load growth could be one method of ameliorating adverse effects on individual utilities. However, the merits of this alternative also require additional exploration, particularly to ensure that adverse revenue effects on electric utilities are mitigated.
- It will pay to monitor development of both energy resource technologies and greenhouse gas abatement technologies. If a cost penalty of about 5 mills/kWh (comparable to the cost of tree planting) is added to coal to account for its CO₂ emissions, other resources may become competitive. Similarly, if other means of reducing CO₂, either at the source or subsequent to emission, were to become available, their costs also would affect the cost-effectiveness of CO₂ abatement alternatives.

V. FUTURE DIRECTION

A. BPA will continue to closely monitor the state of knowledge about the greenhouse effect. The most important sources of knowledge may be data collection efforts and global climate modeling.

B. Many of the actions Congress is being urged to take would affect BPA. It is worth considering the possibility that some resources BPA might now plan to build (especially coal plants) may be heavily penalized by those actions. If BPA can get a sense of which national actions are more likely, those insights can be used to inform ongoing planning processes.

C. BPA's past and current efforts to acquire conservation have reduced the amount of CO₂ that would otherwise have been emitted. Continued emphasis on the conservation resource will produce further global warming benefits.

D. BPA will continue to examine global warming issues in its resource analyses. More detailed analyses of CO₂ abatement costs are expected to be included in the forthcoming RPEIS.

REFERENCES

- Abrahamson, Dean E., ed., The Challenge of Global Warming, 1989.
- Brown, Lester, Christopher Flavin, Sandra Postel,
"Outlining a Global Action Plan," State of the World, c1989, pp. 174-180.
- California Energy Commission,
"The Impacts of Global Warming on California (Interim Report)," June 1989.
- Cohen, S. J. & T. R. Alsop, "The potential impacts of a scenario of
CO₂-induced climatic change on Ontario, Canada," Journal of
Climate, 1, pp. 669-681, 1988.
- Collette, Carlotta, "Global Warming: A Northwest Perspective,"
Northwest Energy News, March/April 1989, pp. 8-12.
- EPA, "Potential Effects of Global Climate Change on the United States,"
Draft Report to Congress, November 1988.
- Linder, K. P., M. J. Gibbs & M. R. Ingalls,
"Potential Impacts of Climate Change on Electric Utilities," EPRI Research
Project Report 2141-11, Electric Power Research Institute, 1988, Palo Alto.
- Muschett, F. Douglas, "The Greenhouse Effect: Challenge & Opportunity,"
Independent Power, March 1989, pp. 18-23.
- North American Electric Reliability Council, "Proceedings,
1989 General Meeting of the NERC Operating Committee," June 1989.
- Oregon State University, The Effects of Climate Change on Energy Planning
and Operations in the Pacific Northwest, Volume 1: Overview.
Report No. BPA 89-29, prepared for BPA by OSU's Energy Resources
Assessment Laboratory, the Office of the State Climatologist, and the
Water Resources Research Institute, September 1989.
- Pearman, G. I. and J. R. Garratt, "Global Aspects of Carbon Dioxide,"
Search, 3, 1972, pp. 67-73.
- Rind, David, "A Character Sketch of Greenhouse," EPA Journal,
Jan./Feb. 1989, pp. 4-7.
- Shepard, Michael, "The Greenhouse Effect: Earth's Climate in Transition,"
EPRI Journal, June 1986, pp. 4-15.

APPENDIX B

PRINCIPLES FOR RESOURCE ACQUISITION

There were many comments on the Draft 1990 Resource Program regarding the need for diverse resource actions that would incorporate a mix of approaches to acquire a range of cost-effective resources. Many commenters discussed different ways to acquire resources that could lead to a lower cost per average megawatt (aMW) saved or produced with higher reliability and quality. Bonneville Power Administration (BPA) supports and is responding to these expressions of a need for diverse resource actions. BPA will use the marketplace to develop a strong resource acquisition effort involving many actors, with varying needs and capabilities.

The Draft Resources Acquisition Approaches Plan (Draft Approaches Plan) was published as a supplement to the Draft 1990 Resource Program. The Draft Approaches Plan proposed a number of principles to guide the development of resource acquisition programs. As the final 1990 Resource Program was being developed, it became clear that some of these principles were the critical elements for any new, aggressive resource action. These principles are summarized below. These principles will help guide BPA's resource development as it moves from a time of constrained spending on conservation in a surplus period to an aggressive program of conservation acquisition combined with selective purchases of generating resources.

A. Get all customers to participate in a commitment to energy-efficient resource development. BPA will emphasize diversity throughout its resource acquisition activities to fully utilize the expertise of parties throughout the region and allow for greater customer creativity and ownership. BPA will develop a variety of acquisition tools and methods to meet changing resource circumstances and diverse utility needs and capabilities. Methods for resource acquisition will include those developed through past contracts as well as competitive acquisitions, billing credits, and targeted acquisitions. Utilities are encouraged to develop resources for billing credits.

B. Develop more cost-effective resource acquisitions. BPA will continue to actively incorporate and respond to the needs of its customers in resource planning, design, and implementation. With the needs of the Federal System in mind, BPA will acquire resources from others when it is most cost-effective.

C. Retain BPA's commitment to developing proven/quality resources. Energy resource acquisitions (both saved and, to the extent practicable, generated) must be measurable, and verification procedures must be included in all acquisition contracts. Metered energy savings will be given a greater weight than savings based on estimates. BPA payments or credits will reflect the certainty of achieving actual load reduction or energy production.

D. Create a partnership with resource developers by sharing, and managing risk. Those entities who take on risk will reap the rewards of controlling the mature operation of energy resources they have designed to meet their own specific needs.

Other principles included:

- Customer Service. Programs will be designed to meet statutory requirements of the Northwest Power Act and to respond to the diverse needs, objectives, and capabilities of BPA's customers and the region's consumers.
- Business Partnership. BPA will design and deliver resource acquisition programs in a manner that encourages and maintains cooperation and trust.

BPA intends to be a reliable business partner. This commitment includes making timely resource decisions and clearly articulating expectations and plans.

- Financial and Performance Risk and Control. BPA will attempt to evaluate resource development and allocate the associated risks in a manner that reflects the ability of the parties to control the risks.

BPA will recognize that an increase in the assumption of risk by an outside party should be accompanied by a corresponding increase in that party's control over the design, construction, and operation of the resource.

- Oversight. BPA will obtain oversight capability in contracts and conduct an appropriate oversight program commensurate with BPA risk, to assure quality, timeliness, and economic completion and operation of all resources.
- Environmental Quality. Resource development decisions will be made in accordance with appropriate Federal, State, and local statutes and regulations. Quantifiable environmental impact costs will be included in a project's total system cost, including mitigating actions for the protection and enhancement of fish and wildlife.
- Role of Utilities in Conservation Resource Acquisition. To the extent that the resource exists in their service areas and utility delivery offers the best value, utilities will be given the first opportunity to deliver acquisition programs and projects.

In all instances, activities will be coordinated with the utility, and the utilities will be kept involved and informed.

- Program Stability. Effective delivery systems will be maintained for long-term programs.

Test and pilot efforts will have clearly defined termination dates that are agreed to by all parties.

- Conservation Acquisition Incentives. Financial incentives will be set at levels required to meet resource goals. Incentive levels will consider the value of the energy savings to the consumer and the marketing environment.

Total projected program costs, including the cost of marketing, incentives, administration, environmental mitigation, and evaluation, can not exceed the regional cost-effective limit.

- Sharing Conservation Costs and Benefits for BPA. BPA conservation acquisition programs will be cost-shared in accordance with the Conservation Cost Sharing Principles.
- Structure of Conservation Programs. BPA conservation programs will be consolidated across and within sectors whenever it is practicable to do so.

BPA will standardize and simplify administrative processes for its energy conservation programs.

- Targeting Conservation Measures. BPA will target measures and end-uses when such targeting addresses market or segmentation needs and lost opportunities are not created.
- Generation Resource Financing. BPA assumes that resource proposers will use non-Federal financing for the offered resource. BPA does not intend to use its borrowing authority to assist developers in financing resources.
- Focus of Generation Acquisition. Efforts to develop technologies, achieve commercial viability of specific resource types, or build demonstration projects will be handled through test and demonstration programs and not through the acquisition process.
- Administrative Simplification. BPA intends to match its procedural and administrative requirements to the characteristics of the resources it seeks to acquire.

Using these principles and focusing on the need for a flexible mix of how cost-effective resources will be acquired in the 1990's, BPA categorized different acquisition approaches. These approaches and their accompanying characteristics are summarized below:

Resource Acquisition Approaches

<u>Approach</u>	<u>Characteristics</u>
BPA-Designed Programs	<ul style="list-style-type: none">- Noncompetitive- Conservation costs are largely financed by BPA (capitalized)- Payments for conservation based on estimated savings and actual project costs- Specifications developed by BPA- Performance risks assumed by BPA- Conservation requires intensive oversight
Targeted Conservation Acquisitions	<ul style="list-style-type: none">- Noncompetitive- Minimum performance standards set by BPA- Proposals accepted if requirements are met- Resource costs are largely financed by sponsor (expensed by BPA)- Specifications developed by sponsor- Payments based on measured results/savings- Performance risk shared
All Sources Competitive Acquisition	<ul style="list-style-type: none">- Competitive- Resource proposed by developers- Resource cost financed by developer (expensed by BPA)- Payment based on fixed rate and measured performance- Performance risk largely owned by developer- Resources selected based on price and non-price factors
Billing Credits	<ul style="list-style-type: none">- Limited Competitive- Resource proposed by utilities- Resource costs financed by utility or developer (expensed by BPA)- Credit provided for actual reduction in BPA requirement to serve load- Performance risk assumed by utility- Credit amount determined by formula

BPA intends to maximize the effective use of these (and others if applicable) resource approaches as it moves toward maintaining a flexible, reliable, and diverse system of resource review and acquisition. This represents a shift from acquisition efforts that traditionally have been viewed as resource programs designed and funded up-front by BPA to a combination of BPA-Designed Programs, Billing Credits, and All Sources Competitive Acquisitions which have verified savings and energy production as a main feature.

END

DATE FILMED

11 / 02 / 90