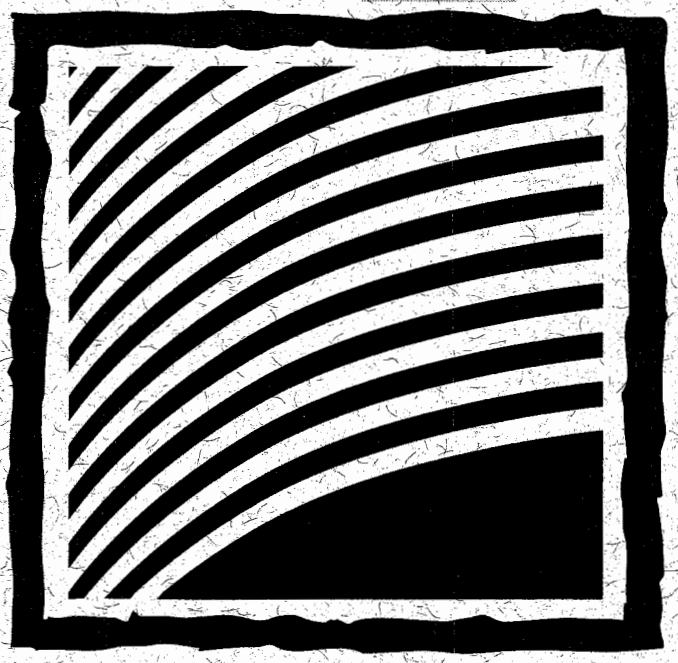
Strategic Resources Assessment

Draft Environmental Impact Statement



April 1996

Seattle City Light

SEATTLE CITY LIGHT
STRATEGIC RESOURCES ASSESSMENT

DRAFT
ENVIRONMENTAL IMPACT STATEMENT

Prepared by

Seattle City Light
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April 2, 1996

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FACT SHEET

Project Title	Seattle City Light Strategic Resources Assessment (SRA)
Description	Seattle City Light (SCL) is preparing a Strategic Resources Assessment which assesses the utility's need for additional energy resources, evaluates energy resource options and policy issues, and recommends policy direction and specific actions to allow SCL to acquire sufficient energy resources to meet anticipated customer demand for electricity. The SRA will be submitted to the City Council for consideration and possible adoption. SCL intends that this EIS will remain valid for several additional resource planning cycles, with changes in the alternatives or likely significant environmental impacts to be addressed by supplements or addenda to this EIS, as appropriate.
Project Location	This document is a non-project, or "programmatic," Environmental Impact Statement. The proposed action is not site-specific.
Proponent and Lead Agency	Seattle City Light
Proposed Date of Implementation	Possible adoption of the Strategic Resources Assessment by the Council would likely occur in the third quarter of 1996. Implementation of the policy recommendations may occur beginning in the third quarter of 1996.
Responsible Official	Gary Zarker, Superintendent Seattle City Light 700 Fifth Avenue, Suite 3100 Seattle, Washington 98104-5031
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Licenses Required

No licenses or permits are required for the City Council to adopt the Strategic Resources Assessment if it chooses to do so. Implementation of the policy recommendations and development of new energy resources could require specific permits or approvals. Permitting would be considered in any project-specific environmental review.

Authors and Principal Contributors

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Wing Cheng: Power system modeling
Contributions: description of alternatives, computer modeling of alternative portfolios and recommendations, impact ranking, air impacts, environmental externalities, transmission lines, environmental dispatch, fuel switching, interruptible load, sale/loss of existing SCL resources.

Foster Wheeler Environmental Corporation
Contributions: environmental impacts to water, earth, plants, animals, land use, employment, environmental health, and cultural/historical resources.

Howard Wick, Energy Resources Consultant
Contributions: impacts to energy resources.

Date of Issue Draft EIS April 2, 1996

Date Comments Due May 2, 1996

Time and Place of Public Hearing	Tuesday, April 23, 1996, 6:00 - 7:30 P.M. Elliott Bay Room, 15th Floor Alaska Building, 618 Second Avenue Seattle, WA
Nature and Date of Final Action	Possible adoption of the Strategic Resources Assessment by the Council could occur as early as the third quarter of 1996. Implementation of the policy recommendations may occur beginning in the third quarter of 1996.
Subsequent Environmental Review	Implementation of some of the policy recommendations in the SRA may require additional project-specific environmental review. Development of individual energy resources by SCL would require project-specific environmental review.
Location of Background Data	Seattle City Light Environment & Safety Division 700 Fifth Avenue, Suite 3360 Seattle, Washington 98104-5031
Cost	No charge

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SUMMARY

PURPOSE OF PROPOSAL

Seattle City Light (SCL) is preparing a Strategic Resources Assessment (SRA) to evaluate options and make recommendations for the acquisition of energy resources to meet future demand for electricity. SCL expects to revise the SRA periodically to account for changed circumstances and new information. This environmental impact statement (EIS) is intended to fulfill SCL's obligations for nonproject environmental review under the State Environmental Policy Act (WAC 197-11) and the City of Seattle's SEPA ordinance (SMC 25.05). At this nonproject or programmatic level, the analysis is of necessity general in nature. Additional project- and site-specific environmental review may be performed, as needed on specific proposals for development or acquisition of energy resources.

SCL intends that this EIS will remain valid for several iterations of the SRA process. Changes in the alternatives to be considered or the likely significant environmental impacts would be addressed by supplements or addenda to this EIS, as appropriate.

OVERVIEW OF ALTERNATIVES

This EIS describes and analyzes three sets of alternatives: 1) individual energy resource types, 2) long-term resource portfolios, and 3) near-term SRA recommendations.

Alternative Resource Types

The analysis of environmental impacts of individual energy resources is the foundation of subsequent analysis of alternative portfolios and SRA recommendations. Eleven alternative energy resource types have been identified as most likely to be considered for acquisition by SCL. They include: 1) conservation, 2) system efficiency measures, 3) small hydropower, 4) geothermal, 5) wind, 6) coal-fired resources, 7) combustion turbines, 8) cogeneration, 9) fuel cells, 10) fuel switching and 11) interruptible load. These resource types are described in Section 3.0 and their environmental impacts analyzed in Section 4.0. Transmission is discussed as well, since new or expanded transmission facilities may be required to deliver electricity from new generating resources.

Alternative Resource Portfolios

Seven long-term alternative resource portfolios are analyzed to highlight the environmental consequences of emphasizing particular policy goals or resource planning issues in resource acquisition decisions. Existing resource criteria established by city council policy include resource priority (with conservation having the highest priority), supply and cost certainty, cost effectiveness, environmental responsibility, and planning flexibility. The two issues considered in the development of the portfolios include concerns about the reliability and

competitiveness of BPA as an electricity supplier and concerns about keeping SCL's rates as low as possible in the face of increased competition in the electric utility industry.

With these policy criteria and issues in mind, the following resource portfolios were developed for analysis: 1) No Action portfolio (or spot market reliance), 2) Status Quo portfolio, 3) Natural Gas Emphasis portfolio, 4) Less Environmental Impact portfolio, 5) Resource Diversity portfolio, 6) Firm Energy Purchase Emphasis portfolio, and 7) Bonneville Power Administration (BPA) Independence portfolio.

The portfolios were constructed to meet the anticipated need for resources in the year 2000 and 2010, assuming SCL's high case forecast of load growth and expected declines in the capability of SCL's existing resources, primarily through the expiration of long-term power sales contracts. All of the portfolios, except the Status Quo portfolio and BPA Independence portfolio, assume that SCL has rights to purchase power from BPA at approximately the level of its 1994 entitlement (220 aMW). In addition, all of the portfolios except the No Action portfolio assume that the utility acquires the services of an 85 MW dispatchable gas-fired resources (possibly by contract) in order to increase the amount of surplus or nonfirm hydropower that can be relied on to meet customer demand. The seven portfolios are described briefly below.

No Action portfolio—Under the No Action portfolio alternative (required under SEPA), SCL would take no action to acquire new firm energy resources. Rather, it would rely exclusively on spot market purchases to meet the need for new resources.

Status Quo portfolio—In this alternative, SCL would rely on a combination of its planned levels of conservation acquisition from the 1993 Conservation Implementation Plan and increased purchases from BPA.

Natural Gas Emphasis portfolio—Under this alternative, all resource needs would be met with natural gas-fired resources, including simple- and combined-cycle combustion turbines, cogeneration and fuel cells. Given existing forecasts of resource and fuel costs, this portfolio appears most likely to result in the lowest increase in rates of any of the alternative portfolios.

Less Environmental Impact portfolio—This alternative emphasizes the reduction of environmental impacts, particularly air emissions, and would rely on a combination of planned conservation levels, wind, geothermal, cogeneration and fuel cell resources.

Resource Diversity portfolio—This alternative stresses diversity of supply and would include conservation, natural gas-fired resources (combustion turbines, cogeneration and fuel cells), and wind and geothermal resources.

Firm Energy Purchase Emphasis portfolio—This portfolio highlights the future likelihood that energy suppliers would not be able or willing to disclose the specific source of electricity provided under firm energy purchase contracts. The environmental impacts of such contract resources will be inherently uncertain.

BPA Independence portfolio—Under this alternative, SCL would reduce its entitlement to purchase power from BPA to minimal levels and substitutes a combination of conservation, natural gas-fired resources, and firm purchases.

The analysis of the alternative portfolios relies on a number of key assumptions. Consistent with the high case load growth used to anticipate the maximum likely range of environmental impacts, low-case fossil fuel prices and high-case economic and demographic growth assumptions are used. SCL is assumed to continue to own its existing generating resources such as the Boundary and Skagit hydroelectric projects and its eight percent share of the Centralia coal-fired steam plant. The capability of SCL's existing resources is assumed to be constant for all portfolios in a particular year, and the capability of SCL's hydroelectric resources assumes the National Marine Fisheries Service's 1995 Biological Opinion, which affects regional river flows and hydroelectric plant operations.

Alternative SRA Recommendations

The Draft Strategic Resources Assessment focuses on four near-term resource acquisition issues: 1) the desired level of continued conservation acquisition, 2) the desired level of reliance on BPA for power purchases, 3) the desirability of the acquisition of a gas-fired dispatchable resource or its equivalent, 4) and the consideration of environmental externalities in resource acquisition decisions. Each of these issues is first evaluated in isolation. Then four alternative sets of recommendations are analyzed. The four alternatives were created by combining a high and low level of both conservation acquisition and BPA entitlement. In addition, SCL's integrated planning model was used to determine a desirable capacity of dispatchable resource for which to contract for services for each of the four combinations of conservation and BPA.

The four alternative sets of recommendations are summarized in Table S-1.

The quantitative analysis of the four SRA recommendation alternatives focused on the year 1998. Similar assumptions were used as for the alternative portfolios, with the significant exception that the base case load forecast, rather then the high case, was assumed.

Preferred Alternative

Based on the recommendations found in the Draft Strategic Resources Assessment, SCL's current preferred alternative is closest to Alternative D described in Chapter 8 of this DEIS and consists of the following response to each of the four policy issues:

- Conservation acquisition: reduce planned acquisition level to somewhere between five and seven aMW per year by 1999 (from former planned levels of approximately 10 aMW).
- BPA purchase level: continue to purchase at least 100 aMW of BPA as long as BPA rates and contract terms are reasonable, and replace remaining BPA purchases with nonfirm hydro and increased reliance on spot market purchases.

Table S-1. Resources Assumed for Alternative SRA Recommendations, Year 1998

SRA Recommendation	SRA Issues[1/] Conservation	BPA Purchases	Dispatchable Resources[2/]
A	100% of current planned levels[3/]	100% of 1994 entitlement (220 aMW)	None
B	60% of current planned levels[4/]	100% of 1994 entitlement (220 aMW)	None
C	100% of current planned levels[3/]	50% of 1994 entitlement (110 aMW)	55 MW
D	60% of current planned levels[4/]	50% of 1994 entitlement (110 aMW)	65 MW

1/ Acquisition of energy resources through conservation, BPA purchases, and dispatchable resources are the near-term strategic resource planning issues facing SCL. Spot market purchases also are assumed to be available for each alternative to meet demand.
2/ Contract for services of a simple-cycle combustion turbine (SCCT); capacity given is the maximum assumed to be contracted for.
3/ Assumes approximately 9 aMW in 1996, declining to 7 aMW in 2000.
4/ Assumes approximately 6 aMW in 1996, declining to 4.5 aMW in 2000.

- Gas-fired dispatchable resource: depending on the outcome of BPA contract negotiations, consider a short-term contract for dispatchable energy of an undetermined amount to supplement spot market purchases.
- Environmental externalities: include externalities when making resource acquisition decisions.

SUMMARY OF IMPACTS AND MITIGATION

During scoping for this EIS, SCL identified the following environmental elements as having potentially significant adverse environmental impacts from SCL's future acquisition of energy resources to serve customer demand: 1) air quality, 2) surface and groundwater, 3) soils and geology, 4) plants and animals, 5) land use, 6) employment, 7) aesthetics and recreation, 8) environmental health (including noise), 9) cultural and historic resources, and 10) energy resources.

Alternative Resource Types

Figure S-1 provides a graphical summary of the relative environmental impacts of each of the alternative resource types. Four impact ranking categories were used to describe the relative magnitude of impacts between resource types: 1) high, 2) high-moderate, 3) moderate and 4) low.

Figure S-1. Potential Environmental Impacts of Conservation and Generation Resources and Other Means of Meeting Energy Loads

Resources	Environmental Elements									
	Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
Conservation Commercial, Residential, and Industrial Sectors						Beneficial				
System Efficiency Measures[1/]										
Small Hydropower										
Geothermal										
Wind										
Coal-Fired/Conventional Pulverized										
Coal-Fired / IGCC										
Combustion Turbines										
Cogeneration										
Fuel Cells										
Interruptible Load										

Relative impact level: High; High-moderate; Moderate; Low

1/ The impact of all system efficiency measures is considered low except for the Gorge Companion Tunnel, which is considered moderate for surface and groundwater, soils and geology, plants and animals, and aesthetics and recreation.

Summary of Potential Mitigation Measures

A discussion of potential mitigation is appropriate for alternative resource types, rather than alternative portfolios or SRA recommendations. A minor exception to this is the issue of environmental dispatch, which is discussed in Section 6.3 as possible mitigation at the portfolio level. Potential mitigation measures for alternative resource types are summarized below.

Conservation

- Safe asbestos removal
- CFC recycling
- Indoor air monitoring
- Ventilation
- Hazardous waste disposal at approved sites
- Avoid historically significant features

System efficiency measures

- Disposal of PCBs from electrical equipment at approved sites
- Best Management Practices (BMP) for erosion control
- Surveys and avoidance of threatened and endangered species and sensitive habitat (Gorge Tunnel)

Small hydropower

- Water temperature and nutrient monitoring
- Adjust flows to maintain water quality
- BMP for erosion control
- Avoid Northwest Power Planning Council protected areas
- Surveys and avoidance of threatened and endangered species and sensitive habitat
- Siting to minimize land use impact
- Recreation enhancement
- Landscaping and site design
- Noise abatement
- Surveys and avoidance of cultural and historic sites

Geothermal

- Sulfur recovery from hydrogen sulfide emissions
- Air emission controls
- Wastewater treatment
- Water recycling and reinjection
- BMP for erosion control
- Spill prevention/cleanup plan
- Surveys and avoidance of threatened and endangered species and sensitive habitat
- Siting to minimize land use, aesthetic and recreation impacts
- Slant drilling
- Landscaping and site design

- Noise abatement
- Surveys and avoidance of cultural and historic sites

Wind
- BMP for erosion control
- Surveys and avoidance of threatened and endangered species and sensitive habitat
- Avoid bird migration corridors
- Siting to minimize land use impact
- Landscaping and site design
- Limit height
- Surveys and avoidance of cultural and historic sites

Coal-fired resources (pulverized and IGCC)
- Implement Best Available Control Technology (BACT) and/or Lowest Achievable Emission Rate (LAER) techniques to control air emissions
- Wastewater treatment/cooling
- BMP for erosion control
- Ash/solid waste disposal at approved sites
- Surveys and avoidance of threatened and endangered species and sensitive habitat
- Siting to minimize land use impact
- Landscaping and site design
- Noise abatement
- Surveys and avoidance of cultural and historic sites

Combustion turbines
- Implement Best Available Control Technology (BACT) and/or Lowest Achievable Emission Rate (LAER) techniques to control air emissions
- Wastewater treatment/cooling
- Spill prevention/cleanup plan
- BMP for erosion control
- Gas pipeline siting/wildlife crossings
- Siting to minimize land use impact
- Noise abatement
- Surveys and avoidance of cultural and historic sites

Cogeneration
- Implement Best Available Control Technology (BACT) and/or Lowest Achievable Emission Rate (LAER) techniques to control air emissions
- Wastewater treatment/cooling
- Spill prevention/cleanup plan
- BMP for erosion control
- Gas pipeline siting/wildlife crossings
- Noise abatement
- Surveys and avoidance of cultural and historic sites

Fuel cells

- Implement Best Available Control Technology (BACT) and/or Lowest Achievable Emission Rate (LAER) techniques to control air emissions
- Wastewater treatment/cooling
- Gas pipeline siting
- Noise abatement
- Proper disposal of spent fuel cells

Fuel switching (expansion of gas lines)

- BMP for erosion control
- Use existing utility corridors

Interruptible load contracts

- None

New or expanded transmission

- Site generation facilities close to load centers or existing transmission rights of way to reduce the need for new transmission facilities
- BMP for erosion control
- Avoid or reduce the use of herbicides and employ nonchemical right of way maintenance methods
- Install spill containment around oil-containing electrical equipment
- Site transmission facilities to avoid or reduce visual impacts
- Surveys and avoidance of cultural and historic sites

Unavoidable Significant Adverse Environmental Impacts

There are no unavoidable significant adverse impacts associated with conservation, system efficiency measures, and interruptible load contracts.

Following is a discussion of unavoidable adverse impacts common to certain categories of generation resource types. Whether or not these unavoidable impacts are significant will vary by project and depend in part on where the facility is located and the mitigation that is applied.

All new generation facilities are likely to have the following unavoidable potential adverse environmental impacts.

- Displacement of alternative land uses
- Temporary soil disturbance
- Increased need for transmission facilities and associated impacts (except where built next to existing facilities with adequate capacity)

Fossil-fueled generation facilities, both new and existing, will have the following unavoidable potential adverse environmental impacts. (Geothermal resources share all of the potential impacts except consumption of fossil fuels.)

- Emissions of air pollutants
- Emission of carbon dioxide and possible contribution to global climate change
- Consumption of water for cooling and other purposes
- Discharge of waste heat to the environment
- Consumption of fossil fuels

For resource types such as wind and geothermal, whose siting is restricted by the availability of the primary energy source (sufficient average wind speeds and geothermal reservoirs, respectively), there is a greater possibility of the following unavoidable adverse impacts.

- Permanent loss of vegetation and wildlife habitat
- Visual, aesthetic, or recreation impacts

Alternative Resource Portfolios

Figure S-2 compares the estimated impact magnitude for each of the alternative portfolios using a similar set of categories as those used to rank the impacts of alternative energy resource types. For those environmental elements whose ranking is based in part on quantified estimates of impacts or environmental measures (air quality, surface and groundwater, soils and geology, land use, and energy resources), uncertainty exists regarding the various assumptions used in SCL's modeling of electricity generation patterns.

Alternative SRA Recommendations

The following discussion summarizes the likely environmental consequences of each of the four near-term issues being addressed in the Draft Strategic Resources Assessment. The relative environmental impacts of each of the four SRA Recommendation Alternatives is then summarized in Figure S-3. As with the analysis of the alternative portfolios, for those environmental elements whose ranking is based in part on quantified estimates of impacts or environmental measures, uncertainty exists regarding the various assumptions used in SCL's modeling of electricity generation patterns.

Conservation Acquisition

Reducing SCL's level of conservation from previously planned levels is likely to result in an increase in the electricity produced by fossil-fueled generating plants and a corresponding increase in their operational environmental impacts. These include emissions of air pollutants such as nitrogen oxides, sulfur oxides, and particulates; emissions of carbon dioxide, a greenhouse gas contributing to the potential for global climate change; water consumption and the discharge of wastewater and waste heat into the environment; and increased consumption of fossil fuels and corresponding fuel extraction and transportation impacts.

Figure S-2. Environmental Impact Magnitude of Alternative Resource Portfolios

Portfolio	Environmental Elements									
	Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
No Action (Spot Market)	High-moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Low	Low	Moderate
Status Quo	High-moderate	Moderate	Low	Moderate	Moderate	Beneficial	Moderate	Low	Low	Moderate
Natural Gas Emphasis	Moderate	Moderate	Low	Moderate	Moderate	Low	Moderate	Low	Low	Moderate
Less Environmental Impact	Low	Low	Moderate	Moderate	High-moderate	Beneficial	High-moderate	Low	Moderate	Low
Resource Diversity	Moderate	Low	Moderate	Moderate	High-moderate	Beneficial	High-moderate	Low	Moderate	Low
Firm Purchase	????1/	????1/	Low	Moderate	Moderate	Low	Moderate	Low	Low	Moderate
BPA Independence	Low	Low	Low	Moderate	Moderate	Beneficial	Moderate	Low	Low	Moderate

Relative impact level: High; High-moderate; Moderate; Low

1/ ???? indicates that impact magnitude is particularly uncertain due to uncertainty of the source of power for the firm purchase resource.

Figure S-3. Environmental Impact Magnitude of Alternative SRA Recommendations

Recommendation	Environmental Elements									
	Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
Alternative A						Beneficial				
Alternative B										
Alternative C						Beneficial				
Alternative D										

Relative impact level: High; High-moderate; Moderate; Low

Level of BPA Power Purchases

Increases or decreases in SCL's BPA purchase levels are likely to cause corresponding increases or decreases, respectively, of fossil-fueled generation serving the spot market in the Pacific Northwest or western U.S, either directly or indirectly. This effect could occur directly because BPA had to increase its spot market purchases to meet SCL's demand, or indirectly because BPA would have otherwise sold the foregone power and as a result displaced a fossil fuel resource operating on the margin. The source of spot market generation is uncertain but could be either coal- or natural gas-fired plants, depending on what resources are operating on the margin. (To the extent that increased spot market purchases occurred at a time when water would have otherwise been spilled past hydroelectric generators because water flows exceed generation capacity, then there would be no corresponding increase in the operation of fossil-fuel plants). Therefore, if SCL were to decrease its existing BPA purchase levels, the net environmental impact would depend on how the source of replacement power compared to an uncertain mix of existing fossil-fuel plants, including both coal and natural gas.

If the replacement power were provided by a firm contract for an existing natural gas-fired resource such as a combustion turbine, overall impacts would likely be lower than continued BPA purchases because of the avoidance of coal-fired generation. (However, this difference would be lessened to the extent the contracted resource would otherwise have been used to sell to the spot market.) If SCL were to construct or contract for the output of a new natural gas-fired combustion turbine, there would be additional construction-related impacts but the operational impacts, particularly air emissions, would expected to be even lower because of higher efficiencies and more stringent emission control requirements. If SCL were to rely on increased spot market purchases to replace existing levels of BPA purchases, there likely would be little or no net effect on the operation of fossil-fuel plants in the western U.S. and no associated significant environmental impacts. However, increasing its reliance on spot market purchases may increase SCL's risk that it would not have adequate power supplies in the future. The resources being relied upon to meet its load would no longer be either owned by SCL or under long-term contract.

Gas-Fired Dispatchable Resource

The main reason SCL would contract for the services of a gas-fired dispatchable resource (such as a simple-cycle combustion turbine) is as a backup resource so that SCL can make greater use of its own nonfirm hydropower production to reliably serve its own load. Under the concept of "firming nonfirm," SCL could declare a portion of its nonfirm hydropower as firm if it has another resource available to substitute for the hydropower during low water conditions.

The potential environmental impacts of contracting for the services of a dispatchable resource, likely a simple-cycle combustion turbine, are expected to be minor and result from two primary factors: (1) the shift in disposition in SCL's nonfirm hydropower, and (2) the expected operation of the dispatchable resource compared to the resource(s) that would have operated otherwise.

The shift in SCL's nonfirm hydropower is expected to result in little change in resource operations and associated environmental impacts. Rather than selling its nonfirm hydropower and displacing others' marginal fossil fuel resources, SCL would use the nonfirm to serve its own load and likely reduce its purchases from BPA and the spot market, which would be expected to result in very similar patterns of resource displacement and little net change in environmental impacts.

Regarding the operation of the dispatchable resource, there could be a net decrease in fossil-fuel generation and associated impacts under two circumstances. The first is if SCL's contract and the operation of the dispatchable resource, assumed to be a simple-cycle combustion turbine, resulted in a net decrease in coal-fired generation. This could occur if SCL relied on power from the dispatchable resource when others would have purchased coal-fired generation instead, for example, through spot market purchases. This is unlikely to occur frequently, because SCL would be relying on the dispatchable resource during periods of low water conditions when regional coal plants likely would be operated at full capacity and more expensive gas-fired plants would be the marginal resource. The other circumstance is if SCL contracted for the development of a new dispatchable resource, which would be more efficient and would have to meet more stringent pollution control requirements than existing plants.

Environmental Externalities

Environmental externalities refer to the societal costs of environmental impacts which are not borne by the producers of a product and therefore not reflected in its price. SCL has recommended a set of externality cost adders for use in resource planning (SCL, 1994c; SCL, 1996). Their inclusion in the economic evaluation of resource options allows for the consideration of a societal perspective when determining the relative cost-effectiveness of alternative resources.

The potential environmental impacts of including externalities in resource decisions arise from their effect on the outcome of the other three policy issues discussed above. In this context, their effect would be limited primarily to favoring higher levels of conservation and therefore reducing the impacts associated with construction and operation of generating resources. Conservation is assumed to have an externality cost of zero, consistent with its having the fewest impacts of any alternative resource type.

The consideration of environmental externalities is likely to have little potential effect on decisions regarding the other two issues, BPA purchase levels and contracting for a dispatchable resource, because the alternatives result in a relatively small range of potential environmental impacts and associated externality costs.

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1.0 BACKGROUND

1.1 STRATEGIC RESOURCES ASSESSMENT

Seattle City Light (SCL) is in the process of preparing its most recent Strategic Resources Assessment (SRA) to evaluate options for supplying its customers' demand for electricity. It is expected that SCL will update this plan periodically to reflect changing conditions. SCL's resource planning process evaluates electricity resources, both generation and conservation, at a generic level, rather than on a project-specific basis.

SCL's current Strategic Resources Assessment process is focusing on four specific policy issues of immediate interest to the utility and city decision-makers:

- The level of continued conservation acquisition in the face of reduced external funding;
- The level of reliance on the Bonneville Power Administration (BPA) for a portion of SCL's firm resources;
- Whether SCL should acquire a dispatchable gas-fired resource or its contractual equivalent; and
- Consideration of environmental externalities in resource acquisition decisions.

These issues are described in greater detail in Section 7.0 under the discussion of alternative recommendations.

SCL intends that this environmental impact statement (EIS) will remain valid for multiple resource planning cycles. Under this approach, environmental review of new issues or recommendations addressed in subsequent Strategic Resource Assessments will be carried out through supplements or addenda to this EIS, as appropriate.

1.2 ORGANIZATION OF EIS

This EIS is organized to reflect three levels of analysis:

- Alternative energy resource types;
- Alternative long-term resource portfolios; and
- Alternative near-term recommendations.

Each of these levels of analysis is dealt with under a pair of chapters, the first describing the alternatives to be evaluated and the second evaluating their environmental impacts.

The individual resource types include those conservation and generation technologies which are being considered by SCL in its resource planning process. Additionally, resource types that have been screened from further consideration, and are not considered in detail in this EIS, are briefly described.

The alternative resource portfolios represent combinations of resources which together meet SCL's need for resources resulting from the high case forecast of load growth (see Table 5-1) and known loss of existing resource capability, primarily from the expiration of existing long-term power contracts. The portfolios have been constructed to highlight or reflect the existing city council policy regarding resource acquisition, the fundamental tradeoffs inherent in resource planning decisions, and particularly significant issues facing the utility. The analysis of the alternative portfolios is intended to highlight the long-term impacts of a range of plausible strategies the utility could pursue over the next 15 years. The high case load forecast was used to anticipate the maximum likely magnitude of environmental impacts.

The final level of analysis focuses on the likely range of near-term recommendations that could result from the Strategic Resources Assessment currently being prepared. The alternatives have been structured to reflect plausible combinations of responses to the primary policy issues that the Strategic Resources Assessment is addressing.

1.3 SEATTLE CITY LIGHT LOADS AND RESOURCES

This section summarizes SCL's present and projected loads and the capability of its existing electricity resources. Taken together, changes in these two factors create SCL's need for additional sources of electricity. The nature of SCL's existing resources will help determine what types of new electricity resources are desirable and how they will be operated.

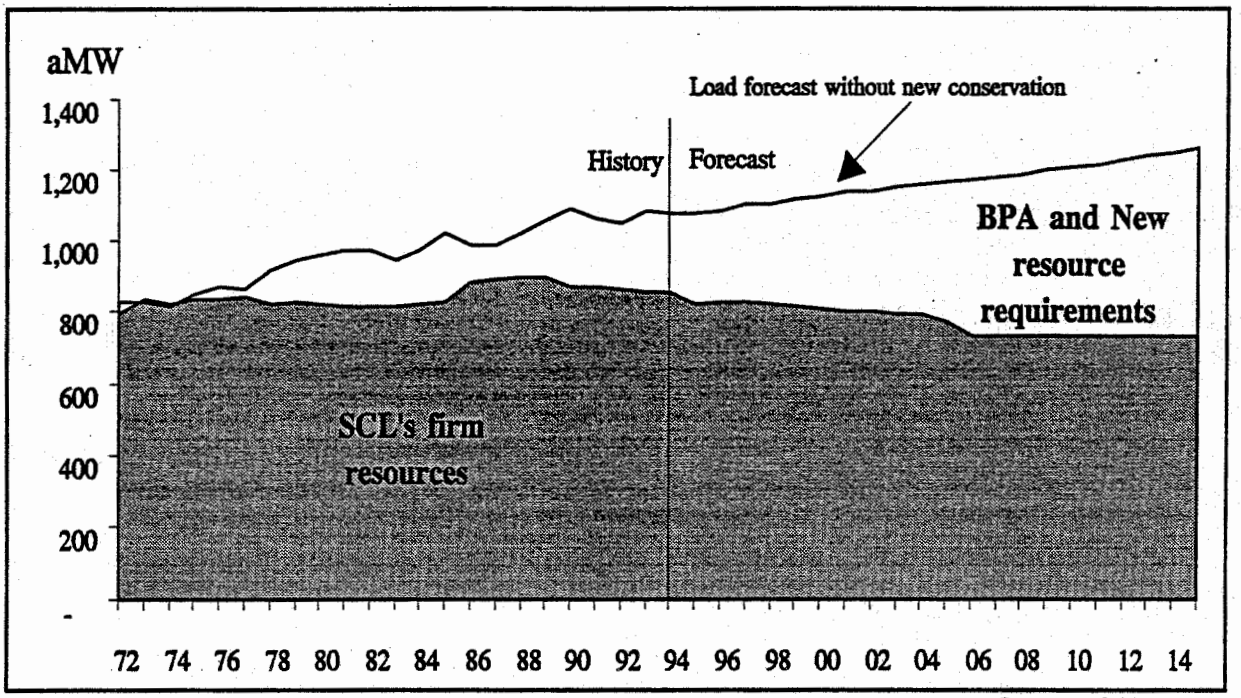
Without new conservation and under base-case assumptions of population and employment, SCL's load is expected to grow by more than 200 average megawatts (aMW) between 1995 and 2015. Meanwhile, some current contracts for resources will expire, and SCL will lose 85 additional aMW of firm resource. SCL has already lost about 40 aMW from the Boundary and Priest Rapids projects because of new flow requirements intended to assist downstream migration of salmon. If SCL also calls into question its BPA contract (but not other resources currently owned or contracted for), then SCL would need to acquire some 540 aMW of new energy by 2015 under its base case load forecast. Figure 1-1 graphically represents the forecasted change in SCL loads and decline in existing resources.

1.3.1 SCL Loads

Future growth in SCL's load depends primarily on the rate of economic and demographic growth within the service territory and the level of fossil-fuel prices. To reflect the uncertainty associated with these factors, SCL has developed base, low, and high load forecasts. The low load forecast is associated with the low case of economic and demographic growth and high fossil-fuel prices, while the high load forecast assumes the high case of economic and demographic growth and low fossil-fuel prices.

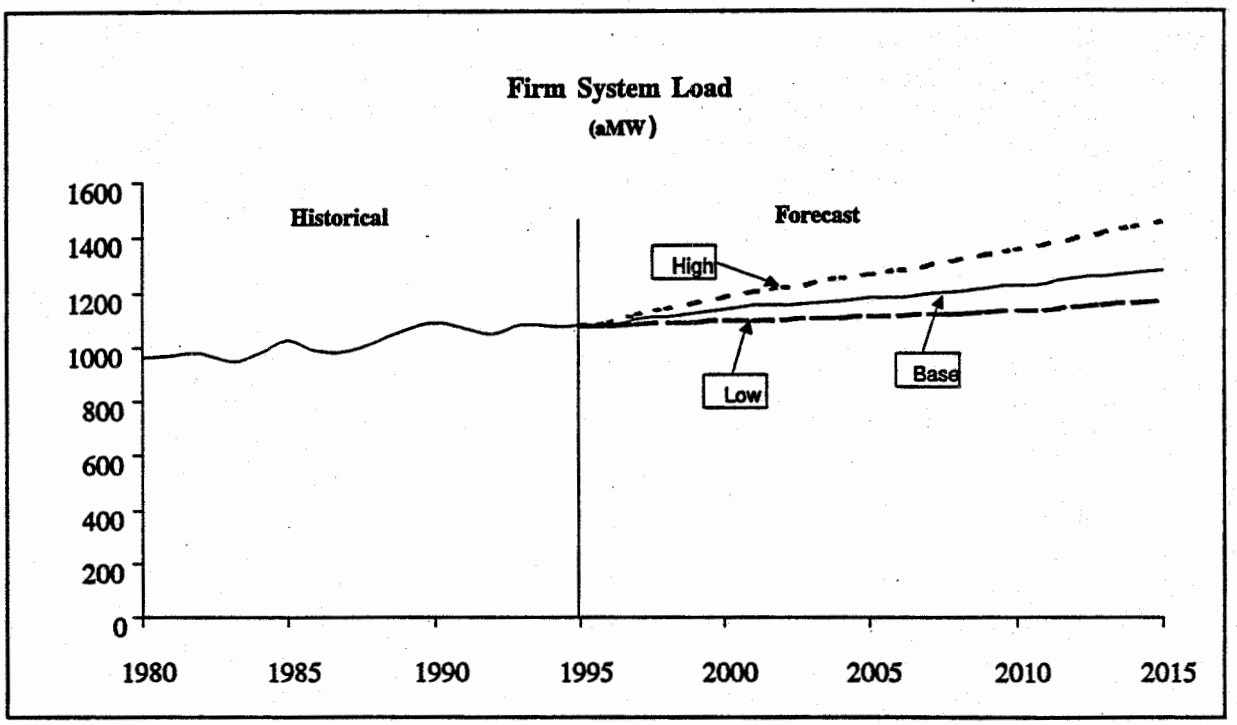
Figure 1-2 shows SCL's historical loads since 1980 and projected load growth under the base, high, and low load forecasts. The forecasts reflect no new conservation beyond 1995. New programmatic conservation would have the effect of reducing SCL's actual loads

Figure 1-1. SCL's Load/Resource Balance



Source: SCL, 1996.

Figure 1-2. SCL's Historical Load and Forecasted Load Growth



Source: SCL, 1996.

below what they would have been otherwise. The base case load growth represents an annual average rate of growth of approximately 0.8 percent, the high case 1.3 percent, and the low case 0.4 percent.

Seattle's population has grown modestly since 1980, after a previous period of population decline. Some single family homes are being replaced by apartment buildings. This trend could be magnified by the City's Comprehensive Plan and the Washington State Growth Management Act, which is intended to direct growth into selected areas and limit suburban sprawl. If the plan for urban villages results in population growth consistent with projections, then SCL anticipates load growth will be closer to the high forecast. Seattle has also experienced rapid growth of the downtown with associated growth of commercial load. Combined commercial and government load is now about half of SCL's load. This load is still winter-peaking on the whole, but much less strongly so than residential load. Commercial load has a secondary summer peak, and as larger buildings replace smaller ones, the commercial load's summer peak could become higher than the winter one.

1.3.2 SCL's Existing Electricity Resources

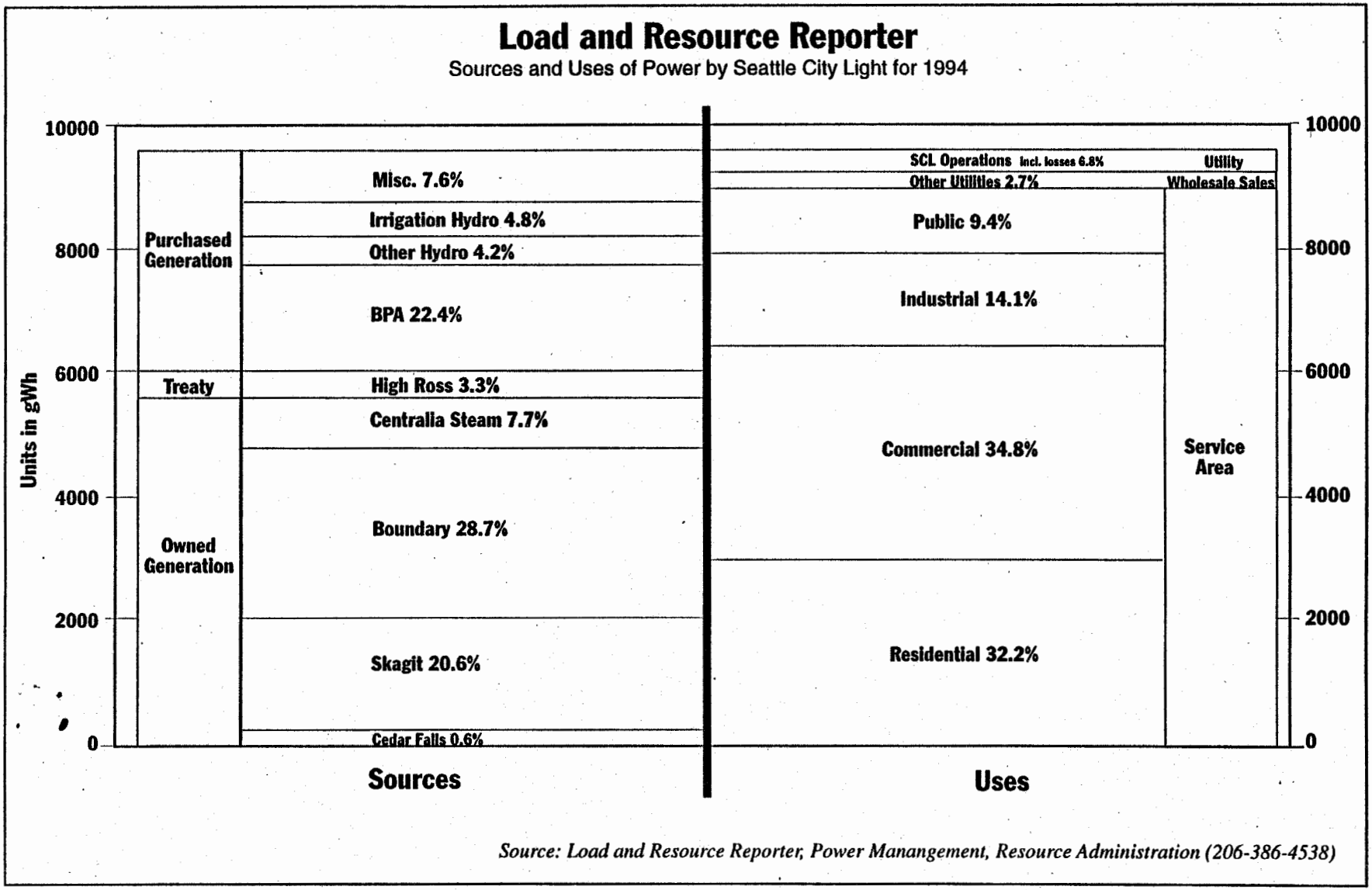
Currently, SCL meets its customers' energy needs through a combination of owned generating resources and long-term power sales contracts. During 1994, SCL-owned generating resources provided approximately 58 percent of the utility's energy needs, BPA provided approximately 22 percent, and nearly all of the remaining 20 percent was provided from long-term power sales contracts. Figure 1-3 shows the breakdown of power sources and uses by SCL in 1994. Table 1-1 is a summary of the generating resources available to SCL either through ownership or contractual arrangements. The table does not show power purchases from BPA and short-term purchases from other sources. The energy figures include both expected energy based on 50-year average of water flows and firm energy based on critical period planning under the Pacific Northwest Coordination Agreement (PNCA).

The PNCA is an agreement between federal and non-federal owners of hydropower generation on the Columbia River system. The agreement governs the seasonal release of stored water to obtain the maximum usable energy subject to other uses. The critical water period is the sequence of low water conditions during which the regional hydropower system's lowest amount of energy can be generated while drafting storage reservoirs from full to empty. Under the PNCA, the critical period is based on the lowest multi-month streamflow observed from 1928 to 1978.

Firm energy is the energy that can be generated during the critical water period; in other words, it is energy which is available with a high level of confidence, usually greater that 90 percent. Energy that can be generated only when water conditions are better than critical conditions—and sufficient to refill system reservoirs—is called nonfirm energy.

The annual energy capability of both the region's and SCL's hydroelectric system varies widely depending upon annual rainfall and snowpack accumulation. For example, the average annual output of the region's hydropower system is 15,747 megawatts. This is

Figure 1-3. Sources and Uses of Power by Seattle City Light for 1994



Source: Load and Resource Reporter, Power Manangement, Resource Administration (206-386-4538)

Table 1-1. SCL System Generating Resources, 1995[1/]

	Expected Energy (aMW)[2/]	Firm Energy (aMW)[3/]
Owned Hydroelectric	815	594
Owned Thermal Electric[4/]	81	81
Available Through Power Sales Contracts[5/]	193	175
Total	1,089	850

1/ Source: SCL Existing Resource Database, July 13, 1995.
2/ For hydroelectric projects, based on 50-year average of water flows.
3/ For hydroelectric projects, based on critical period planning for Northwest Coordination Agreement and current one-year critical period.
4/ Centralia coal-fired power plant.
5/ Excluding power from the Bonneville Power Administration.

about 3,435 megawatts, or 28 percent, greater than the critical period energy capability. (BPA, 1994) Because of the wide variability of output from hydroelectric resources, utilities such as SCL are typically unable to rely, for planning purposes, on anything but the firm component of energy produced to maintain a reliable system.

Capacity, peak power, and peaking capability are terms used interchangeably to refer to a resource's maximum power capability and ability to meet short-term peak demand. These short-term periods of system stress are caused by severe weather (which increases customer demand), and/or low stream flow conditions (which decrease SCL's hydroelectric generation capability).

The time frame can be instantaneous, one hour, ten hours, fifteen hours, or other durations. For utilities whose systems are not predominately hydro-based, capacity is concerned with the instantaneous or one-hour capability of a resource. Hydro-based systems, on the other hand, typically have relatively high levels of installed capacity to accommodate the variable nature of water flows and can therefore meet instantaneous or one hour peak demand. However, they may be unable to sustain adequate energy production over longer periods because of limitations on the amount of water stored in hydroelectric reservoirs and, consequently, the amount of electricity that can be produced.

Currently, SCL has more than sufficient capacity to meet its one-hour peak loads. SCL's system, by itself, does have difficulty meeting sustained 15-hour peak loads during winter cold spells when demand is high and river flows are low. However, this 15-hour capability is presently met from spot market purchases. SCL has previously examined capacity issues in the *Combustion Turbine Final Environment Impact Statement* (SCL, 1995a) and the *Lake*

Union Steam Plant Replacement Final Programmatic Environmental Impact Statement (SCL, 1990).

1.3.2.1 Bonneville Power Administration

Seattle City Light has traditionally been guaranteed an annual load/resource balance through its BPA contract. SCL is entitled to energy from BPA equal to the difference between its annual firm loads and its annual firm resources. In some very dry years, it is possible to have a shortfall, but normally this method of computing the BPA entitlement has given SCL surplus energy to sell, since its hydroelectric resources produce nonfirm in addition to firm energy in about 95 percent of all years. SCL currently meets just over 20 percent of its load through BPA and the rest through its own resources and firm contracts.

On an annual basis, SCL's BPA contract provides a load/resource balance, but not in every day, hour, or month. On a monthly basis, the PNCA provides for interchange among Northwest utilities, so SCL is essentially guaranteed a monthly load/resource balance as well, although the terms are such that it is often preferable to balance load through spot market purchases and sales and exchange agreements. On a daily and hourly basis, SCL meets its load through the flexibility of its own hydro resources.

BPA is now renegotiating its utility power sales contracts and is also going through considerable change in all aspects of its business. It could even be sold. In the future, SCL may not be able to (or may not choose to) continue using BPA to balance its load, depending on the cost and other terms of service.

1.3.2.2 Owned Generation

SCL owns and/or operates four large and three small hydroelectric dams with a combined firm energy production of 815 aMW. These projects supplied approximately 50 percent of SCL's power requirements in 1994. The large dams are Ross, Diablo, and Gorge Dams on the Skagit River in northwest Washington and Boundary Dam on the Pend Oreille River in northeast Washington. The three small dams include the Newhalem Dam on Newhalem Creek near the Skagit River, Cedar Falls Dam on the Cedar River, and the South Fork Tolt dam on the South Fork Tolt River. Like Cedar Falls, the new South Fork Tolt hydroelectric project involves the addition of hydroelectric generating capacity at an existing city of Seattle water supply dam. It went on line in late 1995.

SCL also has an eight percent ownership share of the 1,343 MW Centralia coal-fired generating plant, representing 111 MW of capacity and a declared firm capability of 81 aMW.

1.3.2.3 Long-Term Power Contracts and Exchanges

SCL's major long-term power sales contracts are summarized below. All of these involve the output of hydroelectric projects. In addition, SCL has entered into a number of exchange agreements with other utilities in which SCL provides energy at times when it has

more than needed to serve firm loads and the exchanging utility returns the energy when it is more valuable to SCL.

Under the High Ross Treaty, SCL agreed not to raise the height of Ross Dam in return for equivalent energy and capacity benefits from British Columbia. The 80-year contract, which took effect in 1986, provides SCL 35 aMW of energy annually and capacity equal to the difference between the High Ross maximum of 532 MW and actual production of the existing Ross Dam.

Through the Columbia Storage Power Exchange (CSPE), SCL contracts for 12.5 percent of the Canadian entitlement, Canada's share of the downstream power benefits from the development of Canadian water storage projects under the 1964 Columbia River Treaty. CSPE currently provides approximately 33 aMW of energy. This amount will decline through 2004 when the contract will expire. Prospects for renegotiation of the CSPE contract are uncertain at this time.

SCL has contracts with two eastern Washington public utility districts (PUDs) for the output of hydroelectric projects they own and operate. Both contracts expire in 2005. SCL's contract with Grant County PUD is for an eight percent share of the output of the Priest Rapids hydroelectric project on the Columbia River. SCL's share is 72 MW of capacity and approximately 45 aMW of expected and 40 aMW of firm energy. SCL's contract with Pend Oreille PUD is for a portion of the output of the Box Canyon Dam, located upstream from SCL's Boundary project on the Pend Oreille River. This contract provided 12 aMW of energy in 1995 and is expected to decline until it expires.

Under a 50-year contract with four Idaho irrigation districts, SCL purchases all of the output of the Lucky Peak power project, located on the Boise River in Idaho. This contract provides 38 aMW of expected and 28 aMW of firm energy through its expiration in 2038.

Under a contract with the Grand Coulee Project Hydroelectric Authority, SCL purchases the output from the hydroelectric generating resources of three Columbia Basin irrigation districts. The contract, which lasts 40 years beginning in 1982, provides SCL with 25.5 aMW of expected and firm energy.

2.0 AFFECTED ENVIRONMENT

SCL is a major customer of BPA and BPA in turn is a large supplier to SCL. Therefore, the primary affected area for both utilities encompasses the same region, collectively known as the Pacific Northwest. It includes Idaho, Oregon, and Washington; Montana west of the Continental Divide; and small portions of Wyoming, Utah, Nevada, and northern California (Figure 2-1). This chapter describes the existing Pacific Northwest environment that may be affected by the Seattle City Light Strategic Resources Assessment. Much of the following discussion is based on BPA's Resource Programs Plan (BPA, 1993).

Electric power interrelationships exist among the Pacific Northwest; the Canadian province of British Columbia; the state of California; the Inland Southwest (Nevada, Arizona, Utah, and New Mexico); and areas in eastern Montana, north-central Nevada, and southwestern Wyoming. However, resource development which SCL would rely on to meet its future electricity supply needs is most likely to occur in the Pacific Northwest. Resource development in California, the Southwest, and British Columbia relied upon by SCL would be so limited and site-specific that a review of the affected environment in those areas would not be useful at this level of review.

2.1 AIR QUALITY

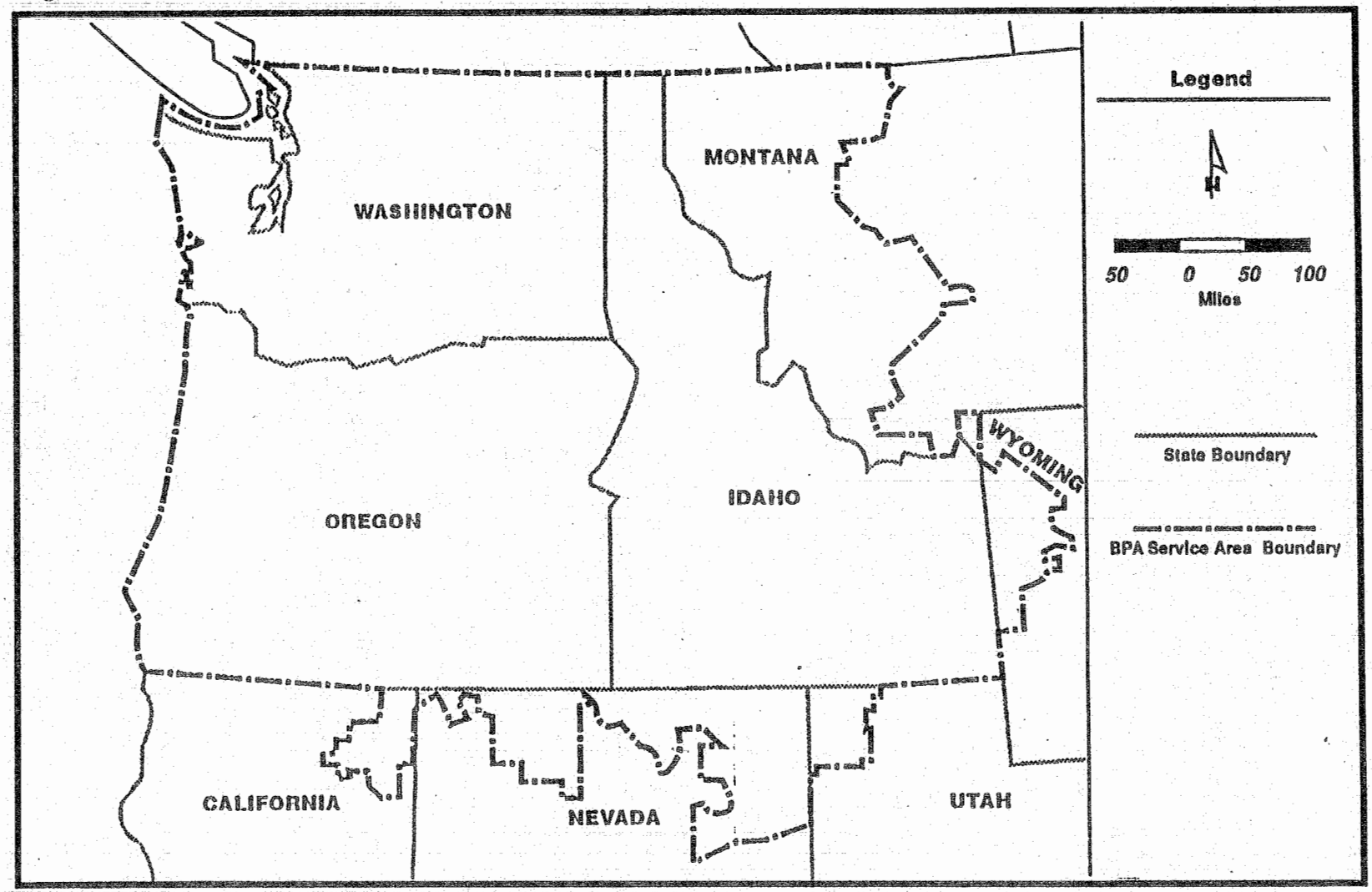
Air pollutants of concern are those produced by extracting, processing, and transporting fuel; and burning coal, oil, gas, or other fuels to produce electric power. Principal pollutants produced are the federally designated "criteria pollutants": sulfur dioxide (SO_2), nitrogen oxides (NO_x), particulates, hydrocarbons, ozone, carbon monoxide (CO), and lead. Of these, particulates, CO, SO_2, and NO_x are common emissions from electric generation plants relying on combustion. Carbon dioxide (CO_2), a major byproduct of burning fossil fuels and other carbonaceous materials, is not a regulated pollutant but may contribute to global climate change. In addition to these common pollutants, electric generation plants also may emit heavy metals, radionuclides, and hazardous compounds.

Air quality is a concern primarily in certain defined air basins where ambient concentrations of criteria pollutants exceed the federal Ambient Air Quality Standards (AAQS) and around certain generating plants in the affected region (BPA, 1993). Areas where background concentrations are greater than the AAQS are referred to as non-attainment areas.

2.2 SURFACE AND GROUNDWATER

The two major Northwest rivers, the Columbia and the Snake, are very different now in comparison to when the region was first settled by non-Native Americans. Over the last 50 years, both rivers have been dammed to produce hydroelectric power, control flooding, provide irrigation and recreation, and improve navigation. The hydroelectric projects are operated to accommodate fish, wildlife, recreation, flood control, irrigation, and other nonpower needs as well as to produce power (BPA, 1993).

Figure 2-1. BPA Service Area



(Source: BPA, 1993)

In general, the Pacific Northwest enjoys excellent water quality, but stringent protection is required. Nuclear, coal, oil, and some gas-fired generating plants use water for cooling. Water is taken from rivers, aquifers, coastal waters, or reservoirs, and is recycled within the plant or returned to its source. The Yellowstone River in Montana, the Green River in Wyoming, the Skookumchuck River in Washington, and the Columbia River in Washington and Oregon, supply water to cool existing thermal plants that serve the Pacific Northwest (BPA, 1993).

2.3 SOILS AND GEOLOGY

The affected environment centers on the Columbia-Snake river system. The Columbia River Basin contains more than 258,000 square miles of drainage including most of Washington, Oregon, and Idaho; Montana west of the Rocky Mountains; small areas of Wyoming, Utah, and Nevada; and southeastern British Columbia. The Pacific Northwest spans three physiographic areas: Northern Rocky Mountain, Columbia Plateau, and Pacific Mountain systems. Major features include the Columbia and Snake rivers, the Puget Sound and Willamette Valley plains, and the Coast, Cascade, and Rocky Mountain ranges. These features define the climate, vegetation, transportation, and development patterns of the region. The Pacific Northwest includes widely different climatic regions. Elevations range from sea level on the coast to 14,410 feet at Mount Rainier in Washington (BPA, 1993).

2.4 PLANTS AND ANIMALS

2.4.1 Plants

The northwest United States is among the more geographically diverse regions of North America. This region includes wet coastal and dry interior mountain ranges, coastline, interior valleys, basins, and high desert plateaus. Moisture, temperature, and substrate vary greatly (BPA, 1993). Vegetation has evolved to thrive in the numerous types of habitats, and consequently, is quite diverse in the Pacific Northwest.

2.4.2 Wildlife

A diversity of wildlife species inhabit the wide range of Pacific Northwest environments. These species vary in size and distribution and include larger animals such as bear, elk, and deer, and smaller animals such as butterflies, snails, and birds. All are important to the environment, but some are of special concern because of their economic or recreational value. Other species are sensitive because their populations are dwindling and they may be listed for protection by a state or the federal government.

2.4.3 Anadromous Fish

The Pacific Northwest supports a large number of anadromous fish (species that migrate downriver to the ocean to mature, then return upstream to spawn). The principal anadromous fish runs in the Pacific Northwest are chinook, coho, pink, chum, and sockeye salmon; and steelhead trout. These species are an important resource to the Pacific

Northwest, both for their economic value to the sport and commercial fisheries, and for cultural and religious value to the region's Native American tribes and others (BPA, 1993).

The development of hydroelectric projects on the Pacific Northwest rivers and tributaries reshaped the natural flow of these waterways. Altered water flows and higher temperatures in surface water of reservoirs slow juvenile fish migration, expose juvenile salmon and steelhead to predation and disease, and impair their ability to adapt to salt water when they reach the ocean. In addition, migration mortality occurs when fish attempt to pass dams (BPA, 1993).

In 1991, Snake River sockeye salmon were listed as endangered under the federal Endangered Species Act, and in 1992 Snake River spring/summer chinook and fall chinook salmon were listed as threatened. Additional Columbia River salmon stocks, as well as those of other northwest river systems, have experienced significant declines and are currently under review for listing.

2.4.4 Resident Fish

Resident fish are freshwater fish that live and migrate within the rivers, streams, and lakes of the Pacific Northwest. A few species that were originally anadromous, but are now landlocked, are included in this group. Many hydroelectric reservoirs support substantial resident fish populations. These species could be affected by changes in hydropower operations. The streams below dams also contain important populations of resident game fish (BPA, 1993).

A number of Northwest resident fish species have been listed as threatened or endangered under the Endangered Species Act, including Kootenai River white sturgeon in Idaho, while others are currently under review for listing.

2.4.5 Protected Areas

Large habitat losses have occurred in the Columbia River Basin due to the construction of hydroelectric dams on Northwest rivers. In addition, past mitigation has not fully compensated for the effects of the hydropower or other development (BPA, 1993). To ameliorate this situation, the Northwest Power Act directs the Northwest Power Planning Council to develop a "program to protect, mitigate, and enhance fish and wildlife including related spawning grounds and habitat on the Columbia River and its tributaries" [U.S.C. Section 839b(h)(l)(A)].

In 1987, the Council adopted the goal of doubling the salmon and steelhead runs within the Columbia River Basin. As part of the strategy to meet this goal and protect valuable fish habitat from damage caused by hydropower development (thus preserving an environment for wild and naturally spawning fish), the Council approved Protected Area amendments to the Fish and Wildlife Program and Power Plan (in August 1988). These amendments establish Protected Areas, which represent the region's most valuable fish and wildlife habitat. New hydropower should not be allowed in Protected Areas, but should be focused

in other river reaches. The amendments also allow hydroelectric project developers to request an exemption from compliance with the regulations for projects with "exceptional fish and wildlife benefits" (BPA, 1993).

2.5 LAND USE

Forest, rangeland, and agricultural lands are the predominant land uses in the Pacific Northwest. About two-thirds of the land is publicly owned. Managers of public lands include: the federal government, including the U.S. Forest Service, Bureau of Land Management, Department of Energy, and Department of Defense; state and local governments; and Native American tribes. The rest of the land is privately owned (BPA, 1993).

Population in the Pacific Northwest centers around the Seattle metropolitan area, greater Portland, and smaller urban areas in Washington, Oregon, and Idaho. The population of Washington grew from an estimated 4.13 million in 1983 to about 4.87 million in 1990, an average annual growth rate of 1.7 percent. The population of Oregon grew from 2.63 million in 1980 to an estimated 2.85 million in 1990, an average annual growth rate of 0.8 percent. The population of Idaho grew from 945,000 to about 1 million over the same period, an average annual growth rate of 0.7 percent. The population of western Montana grew from 294,500 in 1980 to about 303,000 in 1990, an average annual increase of 0.3 percent (BPA, 1993).

2.6 EMPLOYMENT

Over the past decade, the economy of the Pacific Northwest has diversified from agricultural and natural resource based industries to include growing trade and service sectors. Natural resource-based industries accounted for 30.9 percent of manufacturing in 1980; by 1990, their share had fallen to 27.2 percent. High technology industries (aerospace, electronics, and scientific instruments) increased over the same period from 33.7 to 38.6 percent of total manufacturing. Overall, the manufacturing share of the regional economy fell from 19.4 percent to 17.3 percent over the last decade (BPA, 1993).

The lumber and plywood products industry is still important to the region, with 3.1 percent of the total regional employment. This sector, however, has declined from a decade ago when it accounted for 4.4 percent of total employment. Food processing also has fallen from 2.5 percent in 1980 to 2.1 percent in 1990. Transportation equipment, primarily Boeing, has remained at nearly 4 percent of total employment, and the electronics industry has held steady at approximately 3 percent of total employment. Energy-intensive aluminum production is economically important to the region, but employment in this sector is relatively small at less than 0.7 percent of total employment in 1990 (BPA, 1993).

While manufacturing employment fell over the decade, the non-manufacturing share of total employment rose from 80.6 to 82.7 percent. Increases in wholesale and retail trade and the services sector of the economy account for most of this gain. The region's growing trade with California and the Far East also has broadened the economic base. An estimated 25

percent of U.S. exports to Asia and 30 percent of all exported goods are handled through Pacific Northwest ports (BPA, 1993).

2.7 AESTHETICS AND RECREATION

The diverse landscape and abundance of natural settings and scenic vistas in the Pacific Northwest provide a wide range of aesthetic and recreational opportunities. The rivers, lakes, and adjacent land areas offer many water-based recreational activities such as fishing, waterskiing, rafting, boating, windsurfing, and swimming. Land-based activities such as picnicking, camping, and hiking do not require water access, but many users prefer sites that are enhanced by scenic lakes and rivers.

A variety of government agencies, private organizations, and individuals have developed hundreds of recreational sites that offer a full range of water and land-based activities. Scenic drives also are popular less-formal recreational activities. Roads and highways parallel to rivers, lakes, and ocean shores provide access to majestic vistas and natural scenes. Many of these recreation activities occur year-round; however, the peak period of use occurs during the summer months. These recreational resources are important components of the Pacific Northwest's regional economy and lifestyle.

In addition to the diverse recreational areas and magnificent scenic vistas, the Pacific Northwest contains significant pristine wilderness areas. Designated areas are located at Mount Rainier, Mount Hood, Mount Baker, Strawberry Cap, Hells Canyon, and sites on the Olympic Peninsula and in the Cascade Mountains. These wilderness areas are sensitive to any development, including development associated with the production and transmission of electrical power. These areas are particularly sensitive to airborne pollutants that may originate from fossil-fuel burning power plants. For instance, the aesthetic visibility in some wilderness areas (e.g., Mount Rainier) can be adversely affected by airborne oxides of nitrogen. Also, the deposition in alpine lakes of nitrates and sulfates from rainfall can have adverse effects on fisheries.

2.8 ENVIRONMENTAL HEALTH

2.8.1 Noise

Noise is defined as unwanted sound that interferes with normal human activities in the environment. Noise is measured in decibels (dB), a logarithmic ratio between pressure caused by a given sound and the standard sound pressure. The human ear is not equally sensitive to all frequencies in the sound spectrum. Thus, it is standard to represent sound levels using the A-weighted scale (dBA), which corresponds to the range and characteristics most consistent with humans perception of sound. Sound levels at an average residence typically range from 45 to 55 dBA. Sounds associated with nearby freeway and highway traffic are louder, ranging from 65 to 80 dBA. Construction noise typically averages about 110 dBA, while noise from an airplane taking off equals 120 dBA (Lipscomb and Taylor, 1978). The noise level from a typical fossil fuel power plant with noise abatement in place would be about 50 dBA, measured 800 feet from the plant.

2.8.2 Electric and Magnetic Fields

2.8.2.1 Background

Electric and magnetic fields (EMF) are present wherever there is electric power, including transmission lines, generating facilities, substations, building wiring and appliances. These fields are created by electric charges. Electric fields result from the strength of the charge and vary with the amount of voltage. Magnetic fields result from the motion of the charge and vary with the amount of current. Taken together, electric and magnetic fields are sometimes called electromagnetic fields, although the fields have different physical traits, and in the power frequency range including 60 Hertz (Hz) electric power, they have separate units of measure.

Sixty Hz magnetic fields are commonly measured in units of Gauss or milligauss (mG). Unlike electric fields, magnetic fields travel unperturbed through most solid objects and are very difficult to shield. Both electric and magnetic fields fall off rapidly with distance from their source.

Fields may be steady (direct current or DC) or they may change their strength and direction regularly in time (alternating current or AC). The electric power delivery system is predominantly AC in the United States, although there are some sources of DC fields that interface with the SCL power delivery system including batteries, electric trolley substations, and equipment that converts AC power to DC for the operation of industrial motors using direct current. Future development of the electric car technology may lead to additional sources of DC fields in the power system.

DC electric and magnetic fields exist in nature as well as around all types of electrical devices. For example, the earth's magnetic field is created by charges flowing deep inside the molten core of the earth. There is a natural electric field across the cells in our bodies, and the messages that flow in our nervous systems involve electrochemical signals. These naturally occurring fields are from direct current (DC).

2.8.2.2 Potential Health Effects

Research continues on the question of whether or not power frequency EMF can be harmful to health. There is no evidence of a cause and effect connection between EMF exposure and negative health effects. There are results from laboratory studies and epidemiology that suggest further research is warranted.

Over the last ten years, a growing number of epidemiological studies suggest that people who live or work near electric powerlines or equipment may have an increased risk of cancer. Inconsistencies among the studies cast doubt on the meaning of the results. Some studies show no elevated risks. Most of the residential study findings are not based on direct measures of actual exposure. Generally speaking, the relative risks reported in the epidemiological studies are low.

2.8.2.3 SCL EMF Policy

While there are not state or national standards or regulations pertaining to powerline electric or magnetic fields applicable in Washington State, Seattle City Light has developed a corporate policy to guide decisions where concern about EMF is a factor (see Figure 2-2). The policy makes clear the utility's commitment to looking for low-cost measures to reduce EMF when constructing new or upgrading existing facilities including powerlines, substations, and generation facilities.

SCL is supporting engineering research to advance the state of the art in managing electric and magnetic fields, and is contributing to national and utility wide research programs to reach conclusions about potential health risks. SCL is committed to public involvement in determining where electrical facilities should be located, and prepares project specific EISs concerning major new construction covered under SEPA.

2.8.3 Corona

In addition to EMFs, transmission lines produce corona. Corona, the breakdown of oxygen in air near conductors, occurs when the electric field on the conductor is greatly intensified by irregularities such as metal projections, scratch marks, and dead insects that have become stuck to the line. Corona is most noticeable in 500-KV and higher voltage AC-lines during rainy weather, although lower voltage lines produce corona as well. Corona may result in audible noise, radio and television reception interference, and the production of minute amounts of ozone. Power line designs and installation practices have been developed that greatly reduce audible noise levels and corona effects. Studies have shown that the amount of ozone produced is generally not detectable above average background levels (BPA, 1993).

2.9 CULTURAL AND HISTORICAL RESOURCES

Cultural resources are the non-renewable evidence of human occupation or activity. This evidence may be reflected in a district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature. Cultural resources are important in human history and are defined at the national, state, or local level. Cultural resources that could be affected by the construction and/or operation of electric generation plants are located throughout the study area (BPA, 1993).

Figure 2-2. SCL EMF Policy

Seattle City Light Policy Statement
Electric and Magnetic Fields and Human Health

Seattle City Light is committed to providing safe, reliable, and environmentally sound electric service for its customers and a safe work environment for its employees. Seattle City Light (SCL) follows the Washington State Standards for Electrical Construction Code and Electrical Workers Safety Rules (WAC Chapter 296-44 and 45) and other applicable regulations governing installations of electrical facilities. In addition, SCL is committed to public involvement in determining where electrical facilities should be located.

SCL is supporting and monitoring research to identify the biological effects of electric and magnetic fields (EMF) and to determine if any such effects have an adverse impact on human health. Research on EMF covers a wide range of subjects, including effects on reproduction, the nervous system, immune response, and behavior. Epidemiological studies of the incidence of human health problems have investigated the relationship between exposure to EMF and health. These studies indicate possible health effects cannot be ruled out and have led to a broad consensus that more research into this complex subject is needed.

Whether low frequency EMF can cause biological change that results in adverse health effects is a matter of great scientific uncertainty. The fact that some studies suggest a possible link between electric and/or magnetic fields and health requires assertive steps by government agencies, with the cooperation and support of the electric utility industry, to find answers to questions about health effects and to respond accordingly.

The following policy objectives describe SCL's current approach and commitments related to EMF. SCL will:

- Monitor EMF health and engineering research, regulations, legal actions, and communications to further develop and maintain the Utility's preparedness for responding to the needs of decision-makers and the public concerning EMF;
- Communicate with its employees and the public to enhance understanding of the scientific basis for concern, limits to existing information, and range of choices available to the Utility and individuals for responding to possible risk from EMF exposure;
- Work with other utilities, utility organizations, and federal and state government agencies to support and increase funding for scientific research on EMF effects;
- Broadly assess SCL system EMF levels to enhance knowledge of our system for use in power system planning; and
- Prepare for implementing possible field and/or exposure reduction measures that may be required in the future, by quantifying the cost and effectiveness of various measures, and addressing equity considerations.

These objectives will be accomplished by maintaining an internal, interdisciplinary work group with responsibility for: reviewing scientific literature and attending pertinent conferences and seminars; responding to requests for information on EMF by the public and employees and conveying information as dictated by scientific milestones, utility proposals, and other important events; working with other utility and government organizations to advance and support scientific, engineering, and policy research; measuring EMF levels within the SCL system; researching possible EMF reduction techniques that may be appropriate to the SCL system such as changes in design or operating practices; and suggesting low cost measures to reduce EMF that may be accomplished in connection with new facilities or modifications to existing facilities.

2.10 ENERGY RESOURCES

Fossil fuel resources are consumed in the generation of electricity by coal-fired power plants, combustion turbines, many cogeneration facilities and fuel cells. Approximately 20 percent of electricity in the Northwest region is generated by fossil fuels. The non-renewable fuel resources used by power plants include natural gas, coal and diesel fuel. The use of these non-renewable fuel resources to produce electricity contributes to depletion of known fuel reserves. In contrast, conservation measures and increased use of renewable resources (hydropower, windpower, and geothermal energy) would have less potential adverse impacts to fossil fuel resources.

The proven reserves of natural gas in the United States are estimated at 160 trillion cubic feet and those in North American are estimated at 335 trillion cubic feet. Estimates of ultimately recoverable gas resources in North America range from 1,500 to 2,300 trillion cubic feet. Current North American consumption is about 21 trillion cubic feet per year (NPPC, 1993). In North America, the Gulf Coast of Texas and Louisiana, with 60 percent of US production, is the dominant gas producing region. In addition, Canada has vast reserves of natural gas.

Natural gas accounts for about 10 percent of the Pacific Northwest's energy consumption, with about 50 percent used by the industrial sector and 20 to 25 percent each by the residential and commercial sectors. Two gas transmission companies serve the region. Northwest Pipeline Corporation has a natural gas pipeline from the Canadian border near Sumas, Washington, south on the west side of the Cascade Mountains, and then east and south following the Columbia River through southern Idaho, and then south to the San Juan gas fields in New Mexico. The utility supplies gas to both distribution utilities and industrial customers in the region. In contrast, the Pacific Gas Transmission Company pipeline receives delivery of Canadian natural gas at the Idaho border and traverses eastern Washington and Oregon to the California border. The pipeline supplies natural gas to customers in southern Oregon, but primarily delivers to its major customer, Pacific Gas & Electric Company, at the California border. The two pipelines cross, interconnect, and make commodity gas exchanges at the Stanfield meter station near Umatilla, Oregon.

The availability of natural gas in the Pacific Northwest was evaluated in 1993 by the Northwest Power Planning Council (NPPC, 1993). The study concluded that there is a very large gas reserve base in western Canada, available to the Pacific Northwest at reasonable prices. This reserve, together with the known reserves in the western United States, are anticipated to meet supply natural gas demand for existing and planned gas-fired generation facilities in the Northwest. Generally, gas-fired power plants are sited close to natural gas pipelines. However, electric transmission lines may need to be constructed to interconnect the power plant and the existing electric transmission grid.

Coal provides 3 to 4 percent of the Pacific Northwest's fuel supply. About 86 percent of the region's consumption of coal is used to generate electricity; another 12 percent is used in the industrial sector. Abundant supplies of low-sulfur coal are available in the western United States and Canada. A 1988 study by BPA (BPA, 1988b) examined sources of coal

for new Northwest coal-fired power plants. Identified sources include the Powder River Basin fields in eastern Wyoming and Montana, the East Kootenay region of British Columbia, the Green River Basin of southwestern Wyoming, the Uinta Basin of northeastern Utah, and northwestern Colorado. Other potential coal resources are the Vancouver Island Quinsam mines, and mines in Alberta, Canada.

The existing 1,343 megawatt Centralia plant in southwestern Washington is operated by PacifiCorp and fueled primarily by nearby coal deposits extracted from an open pit mine. Additional fuel is shipped by rail from the Powder River basin and other external sources. Portland General Electric operates a 530-megawatt coal-fired plant near Boardman, Oregon. Coal for this plant is shipped by rail from Wyoming. Due to large volumes of coal required by a coal-fired power plant, rail or water bulk transportation must be available if the plants are remotely sited from coal mines. Often coal-fired plants are located in proximity to mines to minimize transportation costs. Electricity from various coal-fired plants located in Montana and Wyoming reaches the Pacific Northwest via transmission links that connect those plants to the regional transmission grid.

Fuel oil in the Northwest region is exclusively used as backup fuel for natural gas-fired generating plants, with the exception of on 35 MW oil-fired plant. In case of natural gas curtailment, a sufficient supply of oil is normally stored in tanks at the plant site, with refilling as necessary by tank trucks. Crude oil pipelines run alongside major highways in the region. Northwest supplies are delivered via the Trans-Mountain Pipeline from Canadian oil fields and the Olympic Pipeline Company transmission system, which transports oil to the region from Montana, Wyoming, and Utah. These resources are anticipated to be sufficient to supply fuel oil to existing and planned generation facilities in the Northwest region.

In conclusion, natural gas and coal are available to the Northwest region at reasonable prices and the existing reserves in the western United States and Canada would be sufficient to meet the forecast demand in the region. Fuel oil, for backup generation, is also widely available and is easily transported via trucks to power generating facilities in the northwest region.

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3.0 DESCRIPTION OF ALTERNATIVE ENERGY RESOURCES

3.1 INTRODUCTION

This chapter describes individual energy resource types that could satisfy part of SCL's future need for electricity. All of the resource types described are generic resources rather than site-specific projects. The first part of the chapter describes those resources that the utility would most likely consider. The potential environmental impacts of these resources are analyzed in the following chapter. The second part of this chapter briefly describes those resource types that are not considered in detail in this EIS and highlights the main reasons they would not likely be acquired by the utility.

The following resource types are described below and their environmental impacts are evaluated in the following chapter:

- Conservation (residential, commercial and industrial);
- System efficiency measures;
- Small hydropower;
- Geothermal;
- Wind;
- Coal-fired resources (pulverized coal, IGCC);
- Combustion turbines;
- Cogeneration;
- Fuel cells;
- Fuel switching; and
- Interruptible load.

The following resource types are briefly described below but are not considered further in this EIS.

- Nuclear;
- Internal combustion engine generation;
- Municipal solid waste;
- Landfill gas;
- Solar;
- Biomass;
- Hydrogen generation;
- Magnetohydrodynamics;
- Pumped storage;
- Battery storage;
- Compressed air energy storage; and
- Superconducting magnetic energy storage.

The evaluation of potential environmental impacts discussed in this EIS does not distinguish between energy resources to be acquired that SCL might own and those SCL would

purchase through firm-energy contracts. Instead, the EIS identifies the impacts of the energy resources independent of ownership.

3.2 ENERGY RESOURCES EVALUATED IN DETAIL

For each resource type considered in detail, the following section provides a description of its energy conversion technology, the type(s) of fuel used or its primary energy source, siting considerations, operational characteristics (baseload, peaking, etc.), development potential, and other relevant factors as appropriate.

3.2.1 Conservation Resources

Conservation includes a wide range of methods to reduce energy usage by residential, commercial, and industrial customers. Individual conservation measures are typically packaged into programs based on target customer groups, delivery methods, and funding sources. This EIS does not address specific conservation programs, but instead describes the general types of conservation measures that could be used in the variety of programs implemented by SCL.

3.2.1.1 Residential

Residential conservation includes a wide variety of approaches to promote increased efficiency of electrical use in both new and existing residences. The residential sector includes single-family homes, multiplexes (two- to four-unit dwellings), multifamily apartment buildings, condominiums, and mobile homes (SCL, 1994b). Residential conservation measures can be divided into the following general categories:

- Building envelope (the focus of weatherization measures);
- Lighting;
- Water heating;
- Space heating; and
- Other appliances.

When retrofitting existing homes, a variety of weatherization measures can be installed, including wall, floor, and ceiling insulation; caulking; weather-stripping; replacement windows; and storm windows. Additional measures that can be applied to existing residences include the installation of more efficient lighting, more efficient electric water heaters, electric water heater insulation, heating duct insulation, automatic clock thermostats, more efficient appliances such as refrigerators, and water-saving devices that reduce electricity use for water heating.

Conservation programs for new homes provide incentives and/or assistance for building owners and developers to meet or exceed current energy codes and standards. They involve construction techniques that upgrade the building shell to reduce air infiltration and heat loss, including many of the weatherization materials described above. They can also include installation of energy-efficient lighting and appliances (BPA, 1993).

3.2.1.2 Commercial

Like residential conservation, commercial sector conservation measures can be applied to both new and existing buildings. Conservation in existing commercial buildings can involve the upgrade of a single system or more substantial renovations or retrofits where new mechanical, electrical, or structural features are installed. In new commercial buildings, conservation measures incorporated in building design increase energy efficiency beyond existing codes and requirements. A variety of end use categories are included in commercial conservation measures including: lighting; heating, ventilation, and air conditioning (HVAC); refrigeration; building envelope; domestic hot water; and motors.

Lighting measures involve the installation of more efficient lamps and ballasts, the use of fixtures that deliver more useful light where it is required, the design and installation of more efficient lighting systems and controls, and increased use of daylighting to substitute natural daylight for electric lighting.

HVAC measures are aimed at increasing the efficiency of energy use in heating and cooling systems and the efficiency of air movement in buildings. They include installation of higher efficiency equipment, replacement with alternative systems with lower electricity use, equipment insulation, and the design and installation of system monitors and controls. Refrigeration measures involve replacement or installation of efficient pumps, compressors, and chillers; exhaust heat recovery; variable speed drives; and the design and installation of control systems.

Building envelope measures include installing insulation, weather-stripping, caulking, and energy-efficient doors and windows. Measures related to domestic hot water provide better insulation of equipment, alternative heating systems, and controls. Finally, motor measures include the use of appropriately sized motors, use of variable speed drives, and improved motor controls (BPA, 1993).

3.2.1.3 Industrial

Energy conservation in the industrial sector is aimed at increasing the efficiency of energy use in industrial processes and systems. Energy-consuming end uses within industrial facilities include motors, pumps, heating, cooling, fluid handling, ventilation, lighting, controls, and space and material heating.

The Resource Program EIS, (BPA, 1993) identified 20 major energy conservation measures as most useful in the industrial sector. Those potentially applicable to SCL's service area are described below. They are generally system upgrades or replacements within existing facilities.

High Efficiency Motors—Install high efficiency electric motors.

Adjustable/Variable Speed Drives—Install drives to control motor speed to the appropriate load. Tailoring speed to work output eliminates the need for intermediate regulating devices and increases system efficiency.

Energy Efficient Motor Rewinds—Repair and/or rebuild failed motors.

Heat Recovery Equipment—Install equipment to transfer heat to or from a liquid or gas and to or from an existing or proposed process which will offset electric or other fuels use.

Thermal Storage—Install equipment to store energy in the form of hot or cold fluids or mass to provide heating or cooling capacity for later use in a process.

Insulation—Install insulation to reduce heat transfer in a process.

Process Heat Equipment—Install equipment or make efficiency improvements to process heating or heat distribution systems.

Compressed Air Systems—Install efficiency improvements such as humidity controls, compressor change-outs, improved sequencing controls, piping upgrades, reduction of air leaks, and unloaders on existing or proposed compressed air systems.

Lighting—Replace or upgrade existing or proposed lighting systems to reduce electrical energy use and maintain or improve light levels and quality.

Energy Management Systems—Reduce the energy consumption of systems by optimizing control of fluid flows, material handling, and controlled variables such as temperatures, pressures, scheduling, and sequencing.

Material Handling—Upgrade the efficiency of material handling systems by replacing pneumatic conveyors with mechanical systems, installing high efficiency motors, installing adjustable speed drives, or other measures.

Cooling Tower Conversion—Install modifications to cooling towers to improve efficiency.

Pumps and Fans—Replace, rebuild, or modify fans, compressors, blowers, pumps, impellers, or fluid conveyance systems with energy saving units.

Dehumidifiers—Replace an existing or proposed electric dehumidification system with a more energy efficient one.

Furnace Upgrades—Replace existing furnaces with more energy efficient furnaces.

Water Recycle Processes—Upgrade existing water recycle or reclaim processes to conserve electrical energy.

Refrigeration Systems—Replace existing or proposed mechanical refrigeration processes or their components with systems or components of higher energy efficiency.

3.2.2 System Efficiency Measures

System efficiency improvements upgrade the utility's electric system to yield a net gain in energy and/or capacity. They can be targeted to the generation, transmission, or distribution levels of the electrical system. Some increase the efficiency of electricity supply and delivery, while others reduce customer demand on a system-wide basis. The following system efficiency measures are likely to be pursued by SCL.

3.2.2.1 Service Voltage Reduction

Closer regulation of the upper limit of allowable voltage range provided to customers would reduce the consumption of electricity, primarily for lighting. The allowable range is now 116 to 124 volts. This program would reduce the upper bound to 120 volts. Closer regulation is accomplished by installing voltage regulators or replacing existing transformers with load tap changing transformers at 12 major substations.

3.2.2.2 Gorge Companion Tunnel

Gorge powerhouse is a hydroelectric plant that is supplied with water from Gorge Reservoir through a single tunnel. Installing a second companion tunnel would decrease flow velocities and reduce the frictional losses that occur between the water and the tunnel wall, thereby increasing the effective hydraulic head. This would result in greater power production for the same amount of water. The second tunnel would branch off at the existing tunnel below the existing reservoir intake; a new intake would not be required.

3.2.2.3 Optimization of Feeder Loads

Energy loss on SCL's distribution system is estimated to be about 3 percent of the electric load. The amount of loss is a function of distribution equipment and feeder circuit routing. By leveling the amount of current flowing through the three phases of distribution feeders, electric system losses would be reduced.

3.2.2.4 Individual Hydro-Generator Control Units

Hydraulic turbines are designed to operate most efficiently at specific water force, or "hydraulic head," and flow levels. These water characteristics vary significantly during a single operating year. Currently, all generator units in SCL powerhouses operate under group rather than individual controls. When plant output varies, all units vary in unison and at the same rate. For example, instead of running two units at high efficiency levels or a third at lower efficiency levels, the control system runs all three units at lower efficiency levels. By determining the operating characteristics of individual turbine generators and modifying generator control systems, SCL would be able to produce more energy with an equivalent amount of water from its owned hydroelectric plants.

3.2.2.5 Reservoir Optimization

Using computer technology, operation of the Skagit River reservoirs could be optimized (within existing licensing constraints) to increase hydraulic head and flow and reduce spill. This project would be a companion to the individual hydro-generator unit control program.

3.2.2.6 Turbine Runner Replacements

As turbine runners, the blade and hub assembly are replaced to maintain system reliability, new computer-designed turbine runners could be installed to increase efficiency. Efficiency could be increased by the following: (1) replacing worn runners; (2) designing runners that are more efficient than original equipment; and (3) designing runners with the highest point on the efficiency curve where the turbine unit would be operated most of the time.

3.2.2.7 Generator Rewinds

As part of periodic maintenance to ensure system reliability, the coils of hydroelectric generators are periodically rewound. Increased generator efficiency could be gained by improving the rewinding technique and making core modifications.

3.2.2.8 4-kV to 26-kV Distribution System Conversion

SCL is in the process of increasing the voltage level in its distribution system from 4,000 to 26,000 volts. Doing so will reduce distribution system amperage levels, which in turn will reduce losses on the distribution system (SCL, 1990).

3.2.3 Small Hydropower

Hydroelectricity, the dominant energy resource in the Pacific Northwest and SCL's system, converts the potential energy of falling water into electricity. Water at a higher elevation is collected and delivered through a pipe to a turbine at a lower elevation. The force of the water turns the turbine, which drives an electric generator. The amount of available energy is proportional to the "head" or vertical distance between the water level and the turbine, and the flow rate. Hydroelectric projects can store water behind large dams to create head or, in "run-of-river" projects, they divert a portion of a river's flow at one point and return it at a lower level after diverting the water through a turbine. Run-of-river projects cannot regulate the water flow to a significant extent and must generate power as streamflows allow. Additionally, hydroelectric projects may also be installed on existing impoundments, canals, and/or conduits intended primarily for some non-power purpose such as flood control, irrigation, or municipal water supply (BPA, 1993).

Hydroelectric resources considered in SCL's resource planning are limited to smaller run-of-river projects with capacities on the order of 10 MW. Such projects have little flexibility to follow electrical loads (varying generation output as electrical load varies). Preference is given to projects whose streamflow patterns coincide with peak seasonal loads, which for SCL occur in the winter (SCL, 1995b).

As discussed in Section 1.3.2, SCL's Existing Electricity Resources, the annual energy output from hydroelectric projects, can vary widely depending upon rainfall and snowpack accumulated in the region each year. Because of the output variability, for planning purposes, utilities rely only on firm hydroelectric power to ensure a reliable system. However, various amounts of nonfirm hydroelectric energy are available most years that can be used to displace more costly generation, such as thermal plants, or sold in the regional energy market (see Section 1.3.2 for a discussion of firm and nonfirm energy).

The Northwest Conservation and Electric Power Plan (NPPC, 1991) estimated a regional potential for new hydropower to be 1,060 MW of capacity based on approximately 590 possible projects. This corresponds to 410 aMW of firm energy. Most of this potential energy resource would be generated by smaller run-of-river projects and incremental additions to existing projects. The Northwest Power Planning Council excluded potential projects located in existing stream-protection designated areas based on existing federal stream-protection designations (wilderness, national parks, and inclusion in the National Wild and Scenic Rivers System) and its own Protected Areas Program.

3.2.4 Geothermal

Geothermal power converts the earth's heat energy into electricity. An ideal location for geothermal energy production has an adequate heat source within a reasonable drilling depth, either due to deep circulation of ground water or intrusion of molten magma into the earth's crust. Wells are drilled to tap the pressurized heated fluids, which are brought to the earth's surface where they convert to steam. In turn, the steam is fed into a turbine to produce electricity. Once energy has been extracted from the steam and hot liquids, they are cooled and typically reinjected into the geothermal reservoir (SCL, 1994a).

The temperature and pressure of the geothermal resource are the primary factors used to determine the method to convert the geothermal fluid energy to electric energy. The three dominant methods are dry steam, flash, and binary cycle. (A fourth, hot dry rock, which accounts for potentially the largest form of the resource, is not discussed here because it is still developmental.)

In dry steam systems, high-pressure steam at temperatures above 350 degrees F is drawn up through wells and directed through a turbine. Hot dry steam sites are extremely rare. The Geysers Known Geothermal Resource Area in California is the largest developed system of this type in the world and the only such resource known in the United States. This area was developed by Pacific Gas & Electric Company starting in the 1960s and its production has now begun to decline (SCL, 1994a). Because it is highly unlikely SCL would become involved in any dry steam geothermal resource, it is not considered further in this EIS.

Both flash and binary cycle systems use liquid-dominated geothermal resources. Flash systems require pressurized liquid brine at temperatures generally greater than 350 degrees F. The hot liquid is pumped to the surface and depressurized to "flash" separate into steam and hot liquid. The steam is used to drive a turbine and is then condensed to be reinjected into the subsurface geothermal reservoir along with the unused hot liquid from the flashing

process. For higher temperature resources, a "dual-flash" system can be used in which the brine is flashed twice in succession to capture additional energy for electricity production. The lower-pressure steam from the second phase is directed into either the low-pressure stage of a compound turbine or a separate low-pressure turbine (BPA, 1993).

Binary cycle plants are used for low-temperature geothermal fluids, generally below 300 degrees F and as low as 177 degrees F (BPA, 1993). The fluids typically must be pumped to the surface where they are used to heat a secondary working fluid with a low boiling point relative to water, such as ammonia or isobutane. The geothermal and working fluids are isolated in closed-loop systems. The working fluid boils to a gas and passes through a turbine. It is then cooled and recirculated to be heated again. As with the other methods, the hot fluid from the geothermal resource is injected back into the reservoir (SCL, 1994a).

The three geothermal technologies discussed here are mature, and geothermal energy is used worldwide. Geothermal plants are typically sited in 20- to 50-MW units, but modular systems as small as 5 MW have been developed. Geothermal resources are generally not considered dispatchable and are operated as baseload resources. When plants go off-line the wells are usually vented to the atmosphere for the duration. Availability factors typically range from 85 to 90 percent and capacity factors 70 to 75 percent (BPA, 1993).

Regionwide development of geothermal is uncertain, as only extensive exploratory drilling can demonstrate the viability of geothermal resources (SCL, 1994a). The most likely locations for their occurrence in the Northwest are the basin and range provinces of southeastern Oregon and southern Idaho and the High Cascades, particularly southern Oregon. The Cascades represent the greatest potential for geothermal resources but they are the most uncertain (BPA, 1993). The Northwest Power Planning Council (1991) identified approximately 677 MW of promising geothermal resource areas in their 1991 Plan. SCL has adjusted and updated this estimate for its use to just over 1,200 MW. About 1,000 MW of this total is suitable for flashed-steam technology, which SCL regards as the most promising for development in the Northwest. Current projects under development include Newberry Crater in Oregon and Glass Mountain in northern California (SCL, 1995b).

3.2.5 Wind

Wind turbines convert wind to electricity by transferring the momentum of moving air to the rotation of rotor blades connected to a shaft and generator. The most common turbine design has a horizontal axis, in which two or three blades are connected to a shaft which is parallel to the ground, much like an airplane propeller. The rotors, generator, and controls are mounted on a tower. Yaw controllers on computer-controlled drive systems keep the turbine pointed in the direction of the wind (BPA, 1993). Wind turbine technology has seen dramatic improvement over the last 20 years, resulting in increased reliability, greater efficiencies, and lower cost. This trend is expected to continue. Current wind turbine sizes range from 50 to 500 kW (SCL, 1994a).

In order to produce electricity, wind turbines employ two primary strategies. Constant-speed turbines maintain a constant rotational speed in synchronization with the utility grid by continually varying the pitch angle of the rotor blades in response to changes in wind speed. Recent advances in power electronics have made possible development of variable-speed turbine designs. Their rotational speed and power output varies with the strength of the wind. The power frequency is converted to 60 Hz before it is integrated with the transmission grid. Such designs reduce torsional stress on the turbine towers, increase operating efficiency and electricity output, and improve power quality (SCL, 1994a).

Wind turbines are grouped in clusters called wind farms. Because the electricity output of a wind turbine varies by the square of the wind speed, it is important to locate wind farms in areas where annual average wind speeds are sufficient to maximize annual electricity production given other siting considerations. Individual turbines also should be sited to maximize the use of available winds. Average annual wind speeds of at least 12 mph are required for wind power development, but 14 mph are preferred (SCL, 1995b). Winds are generally stronger and more sustained farther above the ground. Considerable data is required on the distribution and pattern of wind speeds to effectively site individual turbines. Local topographic features and turbulence and wake from nearby turbines also must be considered (BPA, 1993).

Production of wind energy depends on both the frequency and strength of winds. Although it is not possible to accurately predict winds on an hourly basis, they do show seasonal and, to a more limited extent, daily patterns. For example, winds in the Columbia River Gorge tend to be strongest in the spring and summer, while average wind speeds on the Rocky Mountain Front and on the Oregon coast peak in the winter when storms are most frequent (BPA, 1993).

When the wind is not blowing hard enough, electricity generation stops. The intermittent nature of wind means that wind energy is not a dispatchable resource and cannot be counted on to meet peak loads. Rather, wind energy is taken as it is available. While availability factors of current vintage wind plants are relatively high, around 90 percent, typical capacity factors range from 25 to 30 percent (BPA, 1993). Coordinating multiple wind sites with diverse wind patterns may increase the dependability of the resource for planning purposes. Wind resources may be integrated with dispatchable resources to a degree to firm up their production or with resources that have the ability to shape or store energy such as hydroelectric plants (SCL, 1995b). Depending on the location of the wind resource, additional transmission lines may be required. The relatively low capacity factor typical of wind resources can require greater transmission capacity in relation to annual energy output, compared to alternative resource types (NPPC, 1991).

The Northwest Power Planning Council (1991) estimated a technical potential of 4,500 aMW for promising sites in the Pacific Northwest and an economic potential of 660 aMW. In its Resource Programs EIS (1993), BPA stated that approximately 1,500 aMW of wind resources are potentially developable in the Northwest. However, approximately 1,000 aMW of this total would be located on the Blackfoot Indian Reservation in Montana, which would require the construction of prohibitively expensive transmission lines to connect this

resource to SCL load centers. SCL currently estimates regional potential at about 1,600 MW, equivalent to 425 aMW. The utility expects wind generation to grow considerably over the next 10 years as a result of improvements in wind turbine technology, use of taller towers, and tighter spacing of turbines (SCL, 1995b). Three Northwest sites are currently under development for a planned total of 145 MW.

3.2.6 Coal-Fired Resources

Coal is the most abundant fossil fuel. Coal generation provided 57 percent of U.S. electricity in 1993, although only five percent of the electricity in the Pacific Northwest (SCL, 1995b). Two types of coal resources are considered in this EIS: conventional pulverized coal and integrated gasification combined cycle (IGCC).

Because of coal's abundance, fuel availability is not a constraint on the supply of new coal-fired resources (SCL, 1995b). Coal deposits are found in ore seams, which come in many varieties and grades with varying concentrations of ash and sulfur. Except for the area near Centralia, Washington, there is little coal mined within the Northwest region (NPPC, 1991). Thus, coal from mines outside the region must be transported long distances. Coal fields proximate to the Northwest include the East Kootenay coal field in British Columbia, the Powder River coal field in eastern Montana and Wyoming, and the Uinta coal field in Utah and Colorado. All have low sulfur content of less than one percent (BPA, 1993). The heat content, or energy per unit weight, of coal from these locations varies considerably from 12,000 to approximately 8,000 Btu/lb. Powder River coal, the most likely source of coal for new Northwest coal resource development, typically has a heat content of around 8,200 Btu/lb (SCL, 1995b).

3.2.6.1 Pulverized Coal

Pulverized coal technology is well established and a prominent source of electricity worldwide (BPA, 1993). In a conventional steam-cycle coal plant, coal is washed, crushed, and blown into a large boiler where it is burned. The heat from the coal combustion changes water under high pressure to high-temperature steam. The steam is used to operate a turbine, which drives an electrical generator. A cooling system transfers waste heat from the steam turbine to the atmosphere, and the condensed steam is pumped back to the boiler. The combustion gases pass to the flue-gas desulfurization unit(s), electrostatic precipitators, and baghouse filter before being discharged from the stack. Ash is removed from the bottom of the boiler for disposal, usually on site (SCL, 1994a).

Conventional coal plants have well-tested, reliable designs. They are generally designed as large, centralized units sized from 250 MW up to 700 MW (SCL, 1995b). Smaller plant sizes have shorter lead times and higher reliability, but are more costly to build and operate per unit of capacity (NPPC, 1991).

A pulverized coal plant is typically sited on a large area—600 to 700 acres are required for a 500 MW unit—that has fuel-storage capability, fuel-handling equipment, and ash- and sludge-disposal facilities. Additional requirements include access to water for boiler

makeup, coal washing, cooling tower operation, ash quenching, and flue-gas desulfurization; rail or water transportation; and major transmission facilities (SCL, 1995b).

Conventional coal plants are capital intensive but operation costs are low given current coal price projections. Steam cycle coal plants are baseload generators and are not dispatchable. The thermal inertia of getting boilers, turbines, and condensers up to operating temperature inhibits quick response to variations in load (BPA, 1993). It takes from 24 to 36 hours to bring a unit to full load from a cold start, but only eight hours when starting from 30 percent output. Coal-fired units are typically available for 11 months and down for maintenance one month per year. Some seasonal shaping can be done through scheduling annual maintenance during time of low demand. A capacity factor of over 85 percent is typical, depending in part on displacement by nonfirm hydropower.

The Bonneville Power Administration (1993) and the Northwest Power Planning Council (1991) have estimated the availability of coal-fired generation plants (both conventional pulverized coal and advanced technologies including IGCC) at 4,800 aMW at five potential sites, based on a qualitative assessment of the constraints surrounding the development of coal resources.

3.2.6.2 Integrated Gasification Combined Cycle

IGCC uses gasified coal to power a combined-cycle combustion turbine (see Section 3.2.7 on combustion turbine technology). IGCC technology combines the high efficiencies of combined-cycle combustion turbines with the relatively low projected cost and abundant supply of coal. It has a high degree of modularity and improved emissions control over conventional coal technology.

Coal gasification thermally decomposes solid coal into a high-quality gas fuel called syngas (BPA, 1993). Either air or oxygen can be used to partially oxidize the coal, producing low- or medium-Btu syngas, respectively (NPPC, 1991). A subsequent acid process removes sulfur from the gas stream and converts the sulfur reactants to hydrogen sulfide, which is easily removed and can be converted to elemental sulfur for resale (BPA, 1993).

A gasification plant typically consists of: (1) a coal preparation sub-plant that prepares the coal for feeding into the gasifier; (2) when higher-Btu gas is desired, an air separation sub-plant that concentrates oxygen to be fed as oxidant to the gasifier; (3) a gasifier (something akin to a constant feed pressure-cooker) that mixes the coal and oxidant at high temperature and produces hot, raw syngas; (4) a gas cooling system; (5) a particulate removal system that removes coal ash from the raw syngas; (6) an acid gas removal system that removes sulfur compounds from the raw syngas; and (7) a sulfur recovery plant that produces high quality elemental sulfur for resale. The clean gas is then supplied to the combined-cycle combustion turbine for electricity generation (SCL, 1994a).

IGCC plants are quite efficient. Heat rates typically are near 9,000 Btu/kWh, but are projected to drop to approximately 7,500 within the next 10 years due to improved

efficiency. This represents a fuel-to-electricity efficiency of 46 percent, compared to the theoretical limit of conventional steam-cycle plants of approximately 38 percent (SCL, 1994a).

IGCC plants could be developed in stages. The combustion turbine and combined-cycle sections would be installed first. They would be fueled with natural gas until the price or availability of gas warranted the addition of a gasification plant (BPA, 1993). The site, though, would need to be of sufficient size for the complete IGCC plant.

The operating characteristics of IGCC are similar to those of combined-cycle combustion turbines, discussed in a subsequent section. IGCC's potential supply, on the other hand, is similar to that of conventional coal and is not constrained by fuel availability.

3.2.7 Combustion Turbines

Combustion turbines use jet engine technology to generate electricity (BPA, 1993). When installed alone, they are referred to as simple-cycle combustion turbines. When a steam cycle is added to produce additional electricity from the combustion turbine's waste heat, they are called combined-cycle combustion turbines (SCL, 1995b). The waste heat can also be used in cogeneration applications to produce steam for other purposes.

In the basic simple-cycle combustion turbine design, a rapidly spinning shaft and blade assembly are arranged within a close-fitting case. At one end of the simple-cycle combustion turbine, air is taken into the compressor, consisting of a series of multi-bladed fans, where it is pressurized. Next, the air flows to the combustor where it is mixed with fuel and continuously burned. High-temperature, high-pressure exhaust gas released from the combustor is funneled through a second set of multi-bladed fans to operate the gas turbine. This causes the central shaft to rotate, powering an electricity generator and the compressor (SCL, 1994a).

There are two main versions of simple-cycle combustion turbines used for electricity generation. The aero-derivative variety has been adapted from aircraft jet engine designs. The electric generation section has its own shaft and turbine which are connected to the jet engine component and powered by its exhaust gases. A single-shaft variety, referred to as an industrial-frame machine, has been developed specifically for the electric utility industry. It is typically heavier and larger than its aeroderivative cousins (SCL, 1995b).

In a combined-cycle combustion turbine, the energy of the hot exhaust gases from the simple-cycle unit operates an additional steam turbine and electric generator. A heat recovery steam generator (HRSG) takes the place of the conventional steam-cycle boiler. Simple-cycle combustion turbines can be converted later to combined-cycle combustion turbine units, provided adequate space is available to accommodate the additional equipment required (BPA, 1993). The addition of the steam cycle increases electric generation efficiency by about 40 percent (SCL, 1995b).

The primary fuel used for combustion turbine generation is natural gas. Distillate fuel oil typically is used as a backup fuel in the event natural gas supplies are disrupted. Gasified fuels, such as syngas derived from coal, may also be used in combustion turbines as described in Section 3.2.6.2 (BPA, 1993).

The supply of combustion turbines is not inherently limited, but it is constrained by the ability to site plants and the availability of fuel supply (BPA, 1993). The best sites combine access to natural gas pipelines and electrical transmission facilities at elevations near sea level, where combustion turbine combustion produces more usable power. Regional natural gas supplies appear plentiful at this time. The region is supplied by two interstate gas pipelines that transport gas from British Columbia and Alberta in Canada and the San Juan Basin and Grand Valley areas in the southwestern United States (SCL, 1995b).

The Northwest Power Planning Council (1991) estimated the possible cost-effective potential of gas turbines in the region at 4,000 MW. More recently, the Council's database of regional generation projects listed 850 MW of proposed natural gas-fired combustion turbines, not including cogeneration projects, with planned on-line dates (NPPC, 1996).

Combustion turbines allow for flexible operation. They are highly dispatchable, as a simple-cycle combustion turbine unit can be brought up to full operation from a cold start in less than 10 minutes. A combined-cycle combustion turbine can be started as quickly, except the steam cycle takes hours to start up and shut down. Combustion turbines operate at highest efficiency under full load and their efficiencies fall off significantly below 75 percent of output (SCL, 1995b). Simple-cycle combustion turbines are favored for peaking purposes, either daily or short-term due to their relatively low capital costs and high operating costs. Similarly, the higher capital costs and efficiencies of a combined-cycle combustion turbine make it more desirable when intermediate or baseload service is anticipated (BPA, 1993).

Turbine equipment is available in sizes ranging from 500 kW to 225 MW, with larger units tending to have higher efficiencies. The reliability of single units can be expected to exceed 95 percent, provided periodic maintenance is routinely scheduled (SCL, 1995b).

3.2.8 Cogeneration

Cogeneration is the use of one primary fuel source for sequential generation of thermal energy and electricity (NPPC, 1991). The thermal energy can be used for a variety of purposes, including steam production, space heat, hot water, drying, and cooling (BPA, 1993). Two types of cogeneration are possible. In topping-cycle cogeneration, the fuel is used first to generate electricity; waste heat is then captured for use in the secondary process. With bottoming-cycle cogeneration, the fuel combustion initially serves the heat load and waste heat is then used to generate electricity (SCL, 1995b).

A variety of fuels can be used in cogeneration applications, including natural gas, coal, biomass such as wood residues, and municipal solid waste. Cogeneration can rely on a

variety of technologies as well, including combustion turbines, conventional boilers, reciprocating internal combustion engines, and fuel cells (BPA, 1993).

Cogeneration facilities may be balanced to the required heat load or they may be oversized with regard to the proportion of energy used for electricity generation. Oversized facilities tend to be less efficient as less of the waste heat is put to use (SCL, 1995b).

The cogeneration resource considered most likely to be available to SCL and evaluated here is a topping-cycle variety. It consists of a natural gas-fired combustion turbine with a HRSG. The hot exhaust from the gas turbine passes through the HRSG and creates steam to serve process heat load and to power a steam turbine for supplemental electricity production (SCL, 1995b).

Gas-turbine cogenerators are subject to all of the siting constraints that apply to combustion turbines and they require a viable heat load nearby. Because of this, cogeneration resources may be more likely to be closer to population centers than stand-alone generation projects.

The Northwest Power Planning Council (1991) estimated that up to 2,200 MW of potentially developable gas-fired cogeneration existed in the Northwest under their base case assumptions. More recently, the Council's database of regional generation projects listed 508 MW of natural gas-fired cogeneration projects with planned on-line dates (NPPC, 1996).

Because cogeneration projects must give first priority to meeting the resident heat load, they are considered baseload-type resources and are not generally dispatchable. Two options for meeting seasonal peak heating loads may also favorably shape electricity production to meet increased seasonal demand. These options are: (1) sizing the gas turbine to produce enough waste heat to meet the winter peak, or (2) sizing it for the base heat load and installing and operating an auxiliary burner (SCL, 1995b).

3.2.9 Fuel Cells

Fuel cells directly convert chemical energy in fuel to electricity. This is accomplished by an electrochemical reaction similar to that in batteries. Electricity passes between a cathode and an anode. Hydrogen gas is oxidized at the anode and oxygen gas is reduced at the cathode. Between them, electrically charged ions pass through an electrolyte. In a battery, chemical energy is stored within the cells; in a fuel cell, chemical energy in the form of hydrogen-rich gaseous fuel is continuously supplied to sustain the electricity-producing reaction (SCL, 1994a).

Fuel cells could operate on a variety of fuels which are able to supply the hydrogen upon which the electrochemical reaction depends. Candidates include natural gas, petroleum distillate, landfill gas, gasified coal, and hydrogen gas (SCL, 1994a). Natural gas is the most likely fuel to be used and is assumed for this analysis.

There are three types of fuel cells under development, each named for the type of electrolyte used. Phosphoric acid fuel cells represent the earliest generation of fuel cell development. Commercial units are expected to be available by 1996. Molten carbonate fuel cells represent the second generation and currently appear to be the most promising for utility-scale applications, with commercial units expected to be available in 1998. Solid oxide fuel cells are still in the preliminary design phase and are not expected to be commercially available until the early- to mid-2000s (SCL, 1994a). This analysis is based on the characteristics of a molten-carbonate fuel cell.

Fuel cell plants consist of several systems integrated to make a complete plant: fuel processing, fuel cell stacks, power conditioning, and other miscellaneous systems (BPA, 1993). The fuel processing system is used to convert natural gas or petroleum distillate into a fuel rich in hydrogen to supply the cathode. For molten-carbonate fuel cells, this fuel reforming occurs internally due to the higher operating temperatures and so a separate reforming system is not required (SCL, 1994a). Depending on the particular fuel used, a separate fuel cleaning system may be required. The fuel cell stack system generates DC electricity, while the power conditioning system converts DC to AC current and modulates the fuel cell's power factor. The remaining systems include controls, water and heat management, cooling, and heat recovery (BPA, 1993).

Fuel cells have very high efficiencies, close to 60 percent at full load and still greater than 50 percent when output is reduced to 25 percent of full load. Because chemical energy is converted directly to electricity, fuel cells are not subject to the efficiency losses of technologies that rely on fuel combustion such as steam and combustion turbines (SCL, 1994a). Phosphoric acid fuel cells operate at 400 degrees F. Molten-carbonate and solid oxide fuel cells have considerably higher operating temperatures (1,200 degrees F and 1,600 degrees F, respectively. Given these higher temperatures, combined-cycle and cogeneration arrangements may be feasible for fuel cells (BPA, 1993).

Factors that affect siting include fuel-supply infrastructure, transmission system availability, and land availability. Because of the potential installation of fuel cells at relatively high densities (25 MW per acre) and low emission levels, fuel cells could be ideal resources to site close to load centers. This approach would reduce transmission requirements and also may provide additional distribution system benefits (SCL, 1995b).

Fuel cells have excellent load following abilities. When warm, they are dispatchable and can adjust output quickly and over a wide range of output. As indicated above, fuel cells maintain relatively high generation efficiencies at lower output levels. If adequate fuel supply is available, they may be run as a baseload resource as well. Availability factors of commercial fuel cell units are expected to exceed 90 percent (BPA, 1993).

Assuming fuel cell technology advances as expected, the supply of fuel cell units is not inherently limited. Factors such as fuel supply and siting are likely to be the primary constraints on fuel cell development.

3.2.10 Fuel Switching

Fuel switching occurs when customers change from electricity to another fuel, usually natural gas, for an energy end use (BPA, 1993). Switching to gas would reduce peak loads and overall electricity demand (SCL, 1992). SCL estimates the technical potential for single family residential fuel switching in its service territory at approximately 60 aMW (personal communication, Villamor Gamponia, Acting Manager, Load Forecasting Unit, Seattle City Light, September 13, 1995).

Given current prices and rate structures for natural gas and electricity, customers already have significant economic incentive to switch. However, utilities can promote fuel switching through incentive or loan programs in order to help meet their loads. Because peak loads are reduced, fuel switching also helps to reduce demands on distribution systems in areas where there are electric system capacity constraints. An additional argument often advanced for fuel switching is that the direct use of natural gas is more efficient than using natural gas to generate electricity to serve the same customer end uses (SCL, 1995b).

If SCL were to promote fuel switching, it would likely focus on fuel switching for single family resident space and water heating. Such a program could take the form of incentives, or loans to customers for capital, installation, and hookup costs, as well as joint marketing activities with the local natural gas supplier, Washington Natural Gas. The program could also assist the gas utility to expand the gas distribution system to homes currently lacking access to gas.

For existing homes with electric forced-air heating systems, converting to natural gas requires pipeline connection to a nearby gas main, replacing the furnace, and proper venting of waste gases. Converting from electric baseboard heat is more involved and expensive because duct work must be installed to distribute the heat throughout the house. For houses converting from electric space heating, simultaneous conversion of the water heater may also be desirable. The costs of connecting to the distribution gas line generally do not make it desirable to convert only the water heater. For houses that already use gas for space heating but have electric water heating, conversion to a gas water heater is a relatively straightforward option (BPA, 1993).

3.2.11 Interruptible Load

An interruptible load resource refers generally to a contractual arrangement with one or more of SCL's larger commercial and/or industrial customers that requires the customer to curtail electrical usage when requested by the utility. Alternatively, the arrangement could allow the utility to interrupt the customer's service temporarily on an as-needed basis. In order to encourage customers to enter into such arrangements, SCL would offer financial incentives in the form of financial payments, alternative rate structures, or reduced rates. This resource could be considered dispatchable depending on the contractual provisions, and could be used to forego resource acquisition or short-term power purchases to meet peak loads (SCL, 1990).

3.3 ENERGY RESOURCES NOT CONSIDERED FURTHER

To meet future electric loads, SCL briefly considered a number of additional energy resources. For various reasons, however, SCL determined these alternative energy resources would not likely be acquired by the utility. The following sections describe nine energy resources and the reasons SCL dismissed them from detailed evaluation. Beyond this discussion, these alternative energy resources are not considered further in this EIS.

3.3.1 Nuclear

Nuclear power uses the heat energy produced by the controlled splitting, or fission, of radioactive elements such as uranium to convert water to steam. The steam is then used to turn a turbine and generate electricity (BPA, 1993). SCL is not considering new nuclear resources and it is highly unlikely that any new nuclear plants would be constructed in the near future. Obstacles to nuclear development include public concerns over the long-term disposal of nuclear waste, the potential for accidents, the large incremental capacity of new plants, and the high capital cost to develop such plants.

3.3.2 Internal Combustion Engine Generation

Internal combustion engines can be connected to the shaft of a generator to produce electricity. Fuel options include diesel oil, natural gas, and landfill gas. The acquisition of this resource option is not considered likely because it is not economically competitive with combustion turbine technology and has higher environmental impacts.

3.3.3 Municipal Solid Waste

Electricity can be generated by burning municipal solid waste to power a conventional steam-electric power plant. Mass-burn plants use direct firing of unprocessed municipal solid waste, while refuse-derived fuel technologies separate and process the combustible portion of municipal solid waste (NPPC, 1991). The cost of this resource is relatively high and implementation would not be consistent with existing City of Seattle policy regarding solid waste management.

3.3.4 Landfill Gas

As solid waste in a landfill decomposes, it produces a gas composed of high concentrations of combustible gases such as methane. This gas mixture can be burned to produce electricity using several generation technologies, the most common of which is an internal combustion engine. Generally, landfill gas projects are relatively small in size and are not economically competitive with alternative energy resources.

3.3.5 Solar

Solar generation technologies harness the energy of the sun to generate electricity. Commercial utility applications include two main types, photovoltaics and solar-thermal

plants. Photovoltaics are solid-state electronic devices that produce electricity directly from incident radiation. Solar-thermal plants, on the other hand, concentrate solar energy to heat a working fluid to produce steam to drive a steam-turbine generator (NPPC, 1991). Solar generation technologies are not considered further by SCL because of relatively high costs compared to other resource alternatives and low solar insolation in the Northwest. They could be potentially cost-effective in areas with high solar insolation and/or in remote locations where the cost of transmission lines would be prohibitive.

3.3.6 Biomass

Biomass fuels include a variety of types of organic matter that is available on a renewable basis. Examples include forest residues, wood product residues, agricultural field residues, and forest crops grown for fuel. Once processed—which may include conversion to liquid or gaseous forms—these fuels can be used in a variety of generation technologies, including conventional steam boilers, combustion turbines, internal combustion engines, and fuel cells (NPPC, 1991). Biomass resources are costly compared to other resource alternatives.

3.3.7 Hydrogen Generation

Hydrogen gas is a highly combustible fuel which can be readily produced by decomposing water by electrolysis. Electricity generated by hydropower—or another intermittent source such as wind or solar—could be used to produce hydrogen, which could then be stored and/or transported for later use in a combustion turbine, fuel cell, or internal combustion engine to generate electricity during peak periods. This resource is not considered further because it remains an experimental technology.

3.3.8 Magnetohydrodynamics

Magnetohydrodynamics is a process for converting the heat energy of fuel combustion directly into electricity. It employs a high-temperature, high-velocity stream of ionized gas which acts as an electrically conductive plasma. As the plasma passes through the magnetic field created by two superconducting magnets, an electrical potential is created and electricity is produced. This experimental technology promises greater efficiency than generation resources which rely on mechanical processes (BPA, 1993). This resource is not considered further because it remains an experimental technology.

3.3.9 Storage Technologies

Storage technologies are used to store electric energy for later use or to convert electric energy to another form for later conversion back to electricity. All storage technologies consume more energy than they return to the system, because of inherent losses. Storage technologies are not currently cost-effective for use in SCL's system.

3.3.9.1 Pumped Storage

Pumped storage facilities are associated with hydroelectric plants. During periods of high demand, the water in the reservoir is released downstream to generate the hydroelectric power. During periods of low energy demand (generally at night), water downstream of the hydroelectric plant is pumped back upstream to the reservoir. In this way, the water is reused. This technology is currently used by many peak-constrained utilities with appropriate reservoir storage capability. Such utilities have difficulty providing energy to all customers during periods of extreme peak demand.

3.3.9.2 Battery Storage

Batteries can be used to store electricity for later use. The batteries convert the electrical energy into chemical energy. Current technologies rely on lead-acid batteries and are limited to small-scale applications. Reversal of the chemical reaction in the battery produces electrical energy.

3.3.9.3 Compressed Air Energy Storage

Compressed air energy storage uses salt-domes or rock caverns to store energy in the form of compressed air. The compressed air is released through a turbine when electricity is needed. Suitable locations and geologic formations for this technology are relatively scarce.

3.3.9.4 Superconducting Magnetic Energy Storage

Superconducting magnetic energy stores electric energy as direct current circulating in a superconducting coil. The technology, however, is only experimental at this time.

3.4 TRANSMISSION

The development of new generation energy resources may require construction of new or upgraded transmission facilities to transmit the electricity to the SCL service territory or to deliver it to the existing regional transmission grid. Until specific information on the size, location and operating characteristics of proposed new resources is available, associated transmission requirements cannot be known. In general, resources farther from load centers would require more transmission facility construction than would resources close to load centers. Similarly, resources farther from existing transmission lines and corridors would require more construction of new transmission lines and development of new transmission corridors.

Transmission line construction activities could include building new transmission lines, upgrading existing lines, upgrading existing substations, and constructing new substations. New lines could be located on existing transmission corridors or on new corridors (BPA, 1993).

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4.0 ENVIRONMENTAL IMPACTS OF AND MITIGATION FOR ALTERNATIVE ENERGY RESOURCES

The purpose of this chapter is to identify potential adverse environmental impacts and mitigation measures associated with new alternative energy resource types which SCL may rely on to meet future demand for electricity. Adverse environmental impacts could result from the installation of conservation and system efficiency measures and the construction and operation of generating plants. Such impacts would occur whether SCL owned and operated a particular project or committed to long-term energy purchases which allowed a particular project to be developed. Adverse impacts may also be indirect, such as those resulting from the extraction and transportation of fuels used to generate electricity.

At this level of review, alternative energy resources and their impacts can be addressed only generically. A more detailed analysis of impacts and mitigation would be site- and project-specific and would be performed as part of subsequent project-specific environmental review under SEPA.

In order to compare the relative impacts of alternative resource types, each resource type has been assigned one of four impact-ranking categories for each environmental element. The categories are: low, moderate, high-moderate, and high. Assignment of a particular ranking is a function of both the relative weighting of impacts for different environmental elements and the relative magnitude of the impacts between alternative resource types within the same environmental element. The assignment of impact categories assumes the mitigation and/or avoidance of significant environmental impacts for which mitigation and avoidance is feasible. Figure 4-1 summarizes and compares the relative environmental impacts of the alternative energy resources. Fuel switching is not included on this figure as it is not directly comparable to the other resource types. Fuel switching is unique among the other means of meeting load in that it involves substituting one fuel or energy source for another in meeting an existing end use.

4.1 CONSERVATION RESOURCES

Although conservation measures have a number of potential adverse environmental impacts, all are either insignificant or readily mitigated. Conservation has the lowest environmental impacts of any alternative energy resource (Figure 4-2).

4.1.1 Air Quality

Energy conservation improvements in commercial buildings typically reduce the exchange between indoor and outdoor air. This decrease in air circulation may lead to an accumulation of pollutants that have either entered the building from outside or have been produced indoors. Pollutants affecting indoor air quality include cigarette smoke, radon, formaldehyde, asbestos fibers, disease microorganisms, and gases released from construction materials, carpeting, and furniture.

Figure 4-1. Potential Environmental Impacts of Conservation and Generation Resources and Other Means of Meeting Energy Loads

Resources	Environmental Elements									
	Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
Conservation Commercial, Residential, and Industrial Sectors						Beneficial				
System Efficiency Measures[1/]										
Small Hydropower										
Geothermal										
Wind										
Coal-Fired/Conventional Pulverized										
Coal-Fired / IGCC										
Combustion Turbines										
Cogeneration										
Fuel Cells										
Interruptible Load										

Relative impact level: High; High-moderate; Moderate; Low

1/ The impact of all system efficiency measures is considered low except for the Gorge Companion Tunnel, which is considered moderate for surface and groundwater, soils and geology, plants and animals, and aesthetics and recreation.

Figure 4-2. Potential Environmental Impacts—Conservation (Commercial, Residential, and Industrial Sectors)

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
					Beneficial				
MITIGATION									
• Safe asbestos removal • CFC recycling • Indoor air monitoring • Ventilation	• Haz. waste disposal at approved sites						• Indoor air monitoring • Indoor air ventilation & filtration	• Avoid historically significant features	

Relative impact level: High High-Moderate Moderate Low

Unsafe concentrations of radon have been detected in the lower floors of commercial buildings in many parts of the United States. Formaldehyde, which can have adverse health effects, is released from urea formaldehyde foam insulation (UFFI) as it ages. UFFI is no longer used to insulate buildings, but indoor air quality may be degraded in older buildings that are insulated with this substance. Microscopic, airborne asbestos fibers are carcinogenic and may affect the respiratory system. If present in existing insulation, ceiling tiles, floor tiles, or other construction materials, asbestos can be released to the atmosphere during building insulation or reconstruction activities.

Chlorofluorocarbons (CFCs) used in refrigeration and air conditioning systems could be released to the atmosphere if these systems are upgraded. CFCs are broken down in the upper atmosphere by ultraviolet radiation to produce, among other compounds, atoms of chlorine or bromine. The latter chemically destroys ozone in a layer of the upper atmosphere. The ozone layer forms a filter that shields the earth from harmful ultraviolet radiation, so destruction of ozone results in increased ultraviolet radiation from the sun. Thus, atmospheric releases of CFCs that ultimately find their way into the stratosphere may result in increases in ultraviolet radiation.

Residential energy conservation improvements typically involve increasing the insulating capability of walls and structures, and reducing the exchange between indoor and outdoor air. This decreased air circulation would result in effects on indoor air quality that are similar to those found in the commercial sector. In addition to these effects, air in residences may be degraded by cooking odors, vaporized cooking oils, and increased moisture in bathrooms and kitchens. Decreasing indoor/outdoor air exchange would increase indoor relative humidity and pests such as dust mites. Incidences of allergies and asthma are expected to increase. These effects would decrease the personal enjoyment of the home environment. Increased moisture would encourage the growth of mold and

mildew and accelerate wood decay and aging of interior paints. These effects can be minimized by venting indoor air to the outside while cooking or taking showers.

Mitigation for effects on indoor air quality in residential and commercial buildings include providing adequate ventilation, monitoring for radon in the lower floors of buildings, practicing safe asbestos removal techniques, recovering and recycling CFCs, and filtering indoor air.

Energy conservation measures in the industrial sector could affect indoor air quality in enclosed buildings. Indoor air quality effects would be similar to those discussed for the commercial sector. Like the commercial sector, industrial plants could have problems with radon, cigarette smoke, formaldehyde, asbestos fibers, microorganisms, and gases released from construction materials, as well as additional sources of indoor air pollution released during normal plant operations. Release of chlorofluorocarbons (CFCs) during the upgrading of refrigeration and air conditioning systems would contribute to degradation of the ozone layer. Mitigation for effects on indoor air quality include providing adequate ventilation, monitoring for radon and pollutants associated with plant activities, practicing safe asbestos removal techniques, recovering and recycling CFCs, and filtering indoor air.

4.1.2 Surface and Groundwater

For the residential, commercial, and industrial sectors, water quality can be degraded if wastes from energy conservation measures are improperly disposed. Wastes include discarded light bulbs, fluorescent light ballasts, asbestos, or machinery. Many types of light bulbs contain lead and/or mercury, which can affect human health and degrade the natural environment. In the past, polychlorinated biphenyls (PCBs) have been used in fluorescent light ballasts. PCBs are suspected carcinogenic compounds and federally regulated toxic substances. They can bioaccumulate and pollute soil and sediment. Some machinery may also contain PCBs and other toxic compounds. Mitigation includes disposal in lined hazardous waste sites.

4.1.3 Soils and Geology

The implementation of conservation programs would not result in adverse impacts in the residential, commercial, and industrial sectors.

4.1.4 Plants and Animals

There are no direct adverse effects on plants and animals in the residential sector; however, some plants and animals, especially amphibians, could be injured or killed by increased ultraviolet radiation resulting from releases of CFCs by commercial and industrial conservation efforts. Polluted water that has been improperly disposed by the commercial and industrial sectors could also adversely affect plant and animal populations.

4.1.5 Land Use

There are no direct or indirect adverse effects from residential, commercial, or industrial sector conservation efforts.

4.1.6 Employment

There are no direct adverse employment effects from residential, commercial, or industrial sectors. As a result of increased conservation, there may be a slight increase in the number of employment opportunities in the conservation technologies and service industry. These employment opportunities would likely be concentrated in or near the utility service territory, thereby increasing local economic benefits compared to other resource types. Conservation programs result in employment opportunities of from around 20 to 80 employee-years per MW of energy, depending on the sector and nature of the program. These employment opportunities occur in the year of program implementation, and no subsequent ongoing employment is attributed to programmatic conservation. (BPA, 1993) For the purposes of subsequent analysis in this EIS, a value of 30 employee-years per MW is used.

4.1.7 Aesthetics and Recreation

There are no direct or indirect adverse effects from conservation in the residential, commercial, or industrial sectors.

4.1.8 Environmental Health

Commercial conservation measures that may affect public health include improvements in building insulation, lighting, heating, cooling, refrigeration, and water heating systems. Various energy conservation activities may pose health and safety risks if not properly installed. Effects of excessive concentrations of indoor air pollutants may include cancer, Legionnaire's disease, headaches, eye/nose/throat irritation, dizziness, nausea, sensitivity to odors, difficulty in concentrating, skin irritation, and odor and taste complaints (BPA, 1993). Energy-efficient lights can increase glare or cause a flicker effect, resulting in eye strain, but should have no long-lasting effects on human health (BPA, 1993). Elevated ultraviolet radiation from the sun due to CFCs released to the atmosphere could result in increased incidences of eye cataracts and skin cancer. PCBs found in old fluorescent light ballasts are suspected carcinogens and federally regulated toxic substances. Typical mitigation includes indoor air monitoring, adequate ventilation, and following proper installation and maintenance procedures. Noise levels would be reduced with conservation investments in insulation.

Although similar to the commercial sector, many industrial plants have additional sources of indoor air pollution not found in the commercial sector, which could require monitoring and greater rates of air exchange to be safe.

The effects of conservation measures to residences are similar; however, noise levels would be reduced with the application of conservation technology.

4.1.9 Cultural and Historical Resources

There are no adverse effects to cultural and historical resources from conservation in the residential and industrial sectors. With commercial buildings, however, the conservation resource could alter the exterior or interior appearance of historical buildings. In turn, altered appearances of historical buildings could decrease their perceived or actual cultural significance. Changes in lighting also could change the ambience or aesthetic appeal of a building. Mitigation includes avoiding historically significant features.

4.1.10 Energy Resources

No direct adverse effects to energy resources would result from conservation efforts (Table 4-1). Manufacture of necessary conservation equipment will indirectly require expenditure of energy.

4.2 SYSTEM EFFICIENCY MEASURES

The environmental impact of all system efficiency measures is considered low, with the exception of the proposed Gorge Companion Tunnel project. This project has moderate impacts to several environmental elements (Figure 4-3). As described in Section 3.0, this project would involve boring a second tunnel from Gorge Reservoir to Gorge Powerhouse in order to reduce frictional losses between the water and tunnel walls.

4.2.1 Air Quality

There are no adverse environmental impacts to air quality from system efficiency measures.

4.2.2 Surface and Groundwater

Water quality may be affected if transformers or other electrical equipment replaced during system upgrades are not disposed of properly. Older transformers and oil-containing equipment may contain polychlorinated biphenyls (PCBs), a suspected carcinogen and federally regulated toxic substance. Such equipment should be tested to determine their PCB content and disposed of properly.

Excavation and construction of the Gorge Companion Tunnel and the disposal of excavated soil and rock debris could have short-term impacts on surface water quality, particularly increased turbidity or siltation. The preparation of erosion control plans prior to construction, the use of best management practices such as hay bales and siltation fences, and the restoration of sites following construction would mitigate short-term impacts to water quality. With the mitigation of significant adverse environmental impacts, the impact to surface water is expected to be moderate (for Gorge Tunnel only).

Table 4-1. Fuel Usage by Alternative Energy Resource

Resource	Heat Rate Btu/KWh	Fuel Value Btu/unit Fuel	Fuel Rate Unit Fuel/MWh	Fuel Use Unit Fuel/aMW[1/]	Units
Conservation	N/A	N/A	N/A	N/A	N/A
System Efficiency Measures	N/A	N/A	N/A	N/A	N/A
Small Hydropower	N/A	N/A	N/A	N/A	N/A
Geothermal	N/A	N/A	N/A	N/A	N/A
Wind	N/A	N/A	N/A	N/A	N/A
Coal-Pulverized	10,541	7,500	1,405 lbs coal	6,156	Tons per year/aMW
Coal-IGCC	10,268	8,200	1,252 lbs coal	5,485	Tons per year/aMW
CCCT	7,520	1,030 139,400	6,936 cubic ft natural gas 2.7 gal backup fuel oil	60,759 24	Thousand cubic ft natural gas/aMW Thousand gal backup fuel/aMW
SCCT	11,210	1,030 139,400	10,339 cubic ft natural gas 4.0 gal backup fuel oil	90,572 35	Thousand cubic ft natural gas/aMW Thousand gal backup fuel/aMW
Cogeneration	7,020	1,030	6,816 cubic ft natural gas	59,704	Thousand cubic ft natural gas/aMW
Fuel Cells	6,000	1,030	5,825 cubic ft natural gas	51,029	Thousand cubic ft natural gas/aMW
Fuel Switching[2/]	7,520	1,030	6,936 cubic ft natural gas	60,759	Thousand cubic ft natural gas/aMW
Interruptible Load	N/A	N/A	N/A	N/A	N/A

1/ In this EIS, "aMW" is equivalent to MW-year or annual average megawatt. Conversion from "unit fuel/MWh" to "unit fuel/aMW" is made by multiplying the former by 8,760 MWh/aMW.

2/ Fuel usage for fuel switching resource assumed to be the same as the CCCT generation it would replace. Actual fuel usage would be somewhat reduced if efficiency of overall energy conversion proves better for fuel switching.

Figure 4-3. Potential Environmental Impacts—System Efficiency Measures[1/]

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
	• PCB disposal at approved sites • Erosion control (Gorge Tunnel)	• Erosion control (Gorge Tunnel)	• T&E species & sensitive habitat surveys & avoidance			• Timing of construc-tion activities (Gorge Tunnel)			

Relative impact level: ■ High ▨ High-moderate ▒ Moderate □ Low

1/ The impact of all system efficiency measures is considered low except for the Gorge Companion Tunnel, which is considered moderate for surface and groundwater, soils and geology, plants and animals, and aesthetics and recreation.

4.2.3 Soils and Geology

There would be no direct effects from system efficiency measures with the exception of construction-related soil movement requiring stabilization measures. Excavation and construction of the Gorge Companion Tunnel and the disposal of excavated soil and rock debris could have short-term impacts on soils, including erosion. The preparation of erosion control plans prior to construction, the use of best management practices such as minimizing construction activities during wet winter months and covering excavated spoils with plastic, and the restoration of sites following construction would mitigate short-term impacts to soils. With the mitigation of significant adverse environmental impacts, the impact to surface soils is expected to be moderate (for Gorge Tunnel only).

4.2.4 Plants and Animals

Replacing transmission lines would disturb vegetation in the transmission line right-of-way. However, these effects would be minimal because they would be similar to routine vegetation management.

Excavation and construction of the Gorge Companion Tunnel could include removal of aquatic vegetation, which provides habitat for aquatic invertebrates, fish, and waterfowl. Raptors such as ospreys or bald eagles can be affected by decreases in prey populations resulting from habitat loss. Excavated soil and rock debris can cover existing habitat for terrestrial wildlife and plants. They can also erode and increase siltation in nearby streams, thereby diminishing and degrading habitat for resident or anadromous fish. Typical mitigation includes conducting biological surveys for affected threatened and endangered species such as raptors, revegetating disturbed habitats with native vegetation, providing forage and cover for wildlife, disposing of excavated rock and soil away from sensitive

habitats, and using sediment control measures. With mitigation or avoidance of significant adverse environmental impacts, the effect on plants and animals is expected to be moderate (for Gorge Tunnel only).

4.2.5 Land Use

Typically, system efficiency improvements and voltage reduction do not affect land use. However, improvements that require new construction, such as substations, adding parallel feeders and support towers, or installing additional tunnels to hydroelectric facilities, may have moderate adverse impacts.

4.2.6 Employment

No direct or indirect adverse effects to employment would result from implementation of system efficiency measures. Improvements requiring new construction may create temporary and minor increases in construction employment.

4.2.7 Aesthetics and Recreation

No direct or indirect significant adverse impacts are expected for system efficiency measures other than the Gorge Companion Tunnel. Improvements requiring new construction may temporarily disturb local recreational activities.

Excavation and construction of the Gorge Companion Tunnel and the disposal of excavated soil and rock debris could have impacts on recreation and aesthetics given the location of the project within the Ross Lake National Recreation Area. Short-term impacts to aesthetics and recreation could be mitigated by the use of compressed construction schedules during non-peak recreational use of the construction site vicinity. With the mitigation or avoidance of significant adverse environmental impacts, the impact to recreation and aesthetics is expected to be moderate (for Gorge Tunnel only).

4.2.8 Environmental Health

No direct adverse impact to environmental health would result from system efficiency measures. Improvements that require new construction would result in a temporary increase in noise levels.

4.2.9 Cultural and Historical Resources

No potential adverse impact on cultural and historical resources would result from system efficiency measures, except for the Gorge Companion Tunnel project. Construction activities and disposal of excavated materials for the Gorge Tunnel may potentially disturb

cultural resources. Mitigation includes surveys of cultural sites and avoiding any that are discovered. Assuming mitigation and avoidance of cultural sites, potential impacts would be low.

4.2.10 Energy Resources

Overall, no adverse effects on energy resources would result from the implementation of system efficiency measures. Rather, system efficiency measures would generally increase generation of energy from existing facilities and reduce existing energy losses. Conversion of the distribution system to 26 kV and optimizing feeder loads would reduce line losses, while voltage regulation would reduce energy consumption. The remaining measures would all increase the operating efficiency of hydroelectric plants owned by SCL, thereby increasing hydroelectricity production from a given amount of water. As hydropower does not consume energy resources, the implementation of these measures would result in low to moderate decreases in overall consumption of energy resources to generate electricity.

4.3 SMALL HYDROPOWER

The potential environmental impacts of small hydropower are summarized in Figure 4-4 and discussed in greater detail below.

Figure 4-4. Potential Environmental Impacts—Small Hydropower

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
	• Water temp. & nutrient monitoring • Increase flows as needed	• Erosion control	• T&E species & sensitive habitat surveys & avoidance • Avoid anadromous fish impacts • Wetland creation • Intake screens	• Siting to minimize impact • Recreation enhance-ment		• Siting & landscap-ing/design • Recreation enhance-ment	• Noise abatement	• Cultural & historic site surveys & avoidance	

Relative impact level: High; High-moderate; Moderate; Low

4.3.1 Air Quality

Air quality impacts would be limited to temporary construction-related effects such as fugitive dust emissions.

4.3.2 Surface and Groundwater

Hydropower projects can affect water quality. Reduced flow in diverted streams or storage in reservoirs may result in temperature changes and in some cases may lead to increases in nutrient levels and reduced dissolved oxygen concentrations. Operation mitigation includes monitoring water temperature and nutrient levels, and establishing bypass reach flows that maintain water quality. Measures to mitigate construction impacts include the preparation of erosion control plans prior to construction, the use of best management practices such as hay bales and siltation fences, planning construction activities during dry months, and the restoration of sites following construction. With mitigation or avoidance of significant adverse environmental impacts, impacts would be moderate.

4.3.3 Soils and Geology

Construction of dams and diversions may increase short-term soil erosion. Scouring may increase downstream of dams. Also, dams may prevent natural scouring that would normally clear sand and gravel bars. Measures to mitigate construction impacts include the preparation of erosion control plans prior to construction, the use of best management practices such as hay bales and siltation fences, planning construction activities during dry months, and the restoration of sites following construction. With mitigation or avoidance of significant adverse environmental impact, potential impacts would be moderate.

4.3.4 Plants and Animals

There is a potential for existing plant and animal habitats to be significantly decreased by hydropower projects. Sensitive and unique habitats, such as riparian habitats and wetlands, can be altered or eliminated, depending on the nature and extent of the hydropower project. Habitat for many fish species can also be altered or eliminated. Moreover, anadromous and resident fish passage to spawning areas may be blocked, or fish can be delayed, weakened, or killed. Fish spawning areas may be negatively affected by changes in flow regimes. The prevention of scouring flows, which clear sandbars and gravel bars in larger rivers, results in the loss of habitat for birds that require open sand or gravel islands for nesting. In addition, increased scouring below dams removes gravels needed for spawning. Canals and conduits associated with run-of-river projects can disrupt wildlife migration patterns, and wildlife can also be drowned if trapped in fast-flowing canal water.

Typical mitigation includes: creating wetlands and riparian vegetation; compensating for habitat loss through acquisition or enhancement of equivalent lands/habitats; turbine intake screens or hatcheries; establishing minimum flows to maintain aquatic life in bypassed stream reaches and downstream areas; limiting ramping to avoid stranding of fish; enhancing gravel spawning beds below dams by reducing scouring in these areas;

constructing crossing points along canals and conduits to allow wildlife to use existing migration corridors; building ramps to allow wildlife to escape canals; and surveying for critical habitats and threatened and endangered species.

The small hydropower resources that would be considered by SCL are assumed to be located outside of the Northwest Power Planning Council's Protected Areas and to be above barriers to anadromous fish passage. As such, significant impacts associated with fish passage are avoided. Assuming mitigation or avoidance of additional potential significant impacts, the impact to fish and wildlife would be moderate.

4.3.5 Land Use

Adverse environmental effects from small hydropower projects can result from the conversion of land required for the reservoir and facilities. With run-of-river projects, land is also required for the canal or pipeline used to divert water to the forebay and for the conduit leading to the powerhouse. The land is often converted from forested, farmed, or grazed land. The number of acres required for these facilities varies with site characteristics and facility design requirements. Impacts are considered moderate because of the small size of these generation facilities.

4.3.6 Employment

No direct or indirect adverse effects to employment would occur. BPA has estimated that the construction of new hydropower resources would create 9.3 employee-years of temporary employment opportunities per MW of capacity and 0.3 employees per MW of ongoing operational employment opportunities (BPA, 1993). A relatively small number of temporary employment opportunities would be created during the construction period. Often, small hydroelectric facilities, especially run-of-river plants, do not require on-site employees to operate the plant. Rather, employees visit the site periodically to inspect, maintain, repair, and monitor the plant equipment. Impacts are considered low.

4.3.7 Aesthetics and Recreation

Small hydropower projects are visible and diminish the aesthetic value of natural settings. Recreational uses of rivers, including rafting and fishing, can be directly affected. Mitigation would include: (1) minimizing interference with recreation sites, (2) enhancing recreational opportunities in the project vicinity, (3) building and painting powerhouses and other structures to blend in with the natural surroundings, and (4) siting project facilities in areas that are not visible from populated areas or highways. Impacts are considered moderate.

4.3.8 Environmental Health

Construction activities related to small hydropower projects can result in increased ambient noise levels. Noise levels produced by construction-related activities vary depending on the

specific equipment being operated at the time. The degree of audibility depends not only on the level of noise produced by the equipment, but also on the ambient noise levels at the receptor location. The presence of traffic and terrain features such as trees and buildings can provide significant attenuation in the vicinity. Operation of hydropower plants can also result in increased ambient noise levels from turbine whine, water crashing through the spillways, and other power generation equipment. Noise levels can be mitigated by locating plants away from sensitive areas, restricting construction activities to daytime hours, and installing noise control devices on certain equipment. Construction of small hydroelectric projects also could enhance flood control, and thereby increase the margin of public safety. Impacts are considered low.

4.3.9 Cultural and Historical Resources

Because land is disturbed during construction, destruction of archaeological resources and culturally significant sites is possible with the development of small hydropower plants. Mitigation would include surveying for archaeological sites and developing a plan of action, should cultural or historical resources be uncovered. Impacts are considered low.

4.3.10 Energy Resources

No direct adverse energy resources effects would result from the construction or operation of small hydropower plants . Where suitable sites exist, hydropower is effectively a renewable resource. Manufacture of necessary hydropower equipment will indirectly require expenditure of energy.

4.4 GEOTHERMAL

Figure 4-5 summarizes the potential environmental impacts of the geothermal resource, along with appropriate mitigation measures.

4.4.1 Air Quality

Gas emissions associated with the operation of geothermal energy conversion affect air quality. Of greatest concern is the production of hydrogen sulfide (H_2S) by dry and flash steam systems (closed-loop binary systems do not emit H_2S). In small concentrations, H_2S has an unpleasant odor similar to rotten eggs; in large concentrations, it cannot be detected and it affects the nervous system; at high concentrations, it becomes lethal (NPPC, 1991; BPA, 1993). During plant operations, non-condensible H_2S emissions can be reduced by 90 to 99 percent using various mitigation processes, including separation of the gas into elemental sulfur and hydrogen, and reinjection into original reservoirs. CO_2 emissions also are produced by geothermal plants and may contribute to global warming (SCL, 1989). However, CO_2 emissions per kilowatt-hour for a geothermal plant are small compared to those for a coal plant (BPA, 1993). There is no cost-effective way to eliminate CO_2

Figure 4-5. Potential Environmental Impacts—Geothermal

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
• Sulfur recovery	• Waste-water treatment • Water recycling/ reinjection	• Erosion control • Spill prevention/ cleanup plan	• T&E species & sensitive habitat surveys & avoidance • Waste-water treatment	• Siting to minimize impact • Slant drilling		• Siting & land-scaping/ design	• Gas treatment • Personnel training • Spill prevention/ cleanup plan • Noise abatement	• Cultural & historic site surveys & avoidance	

Relative impact level: High High-moderate Moderate Low

emissions (BPA, 1993). Construction of the facility would result in temporary construction-related impacts, mostly related to fugitive dust emissions. Impacts are considered moderate.

4.4.2 Surface and Groundwater

Geothermal operations can affect water quantity resulting from extraction of subsurface hot liquids or steam. BPA attributes 44.8 acre-feet of water per aMW to be required for geothermal generation (BPA, 1993). However, the groundwater that would be withdrawn is unlikely to be suitable for other uses such as irrigation and drinking water. Condensed steam can be used to provide necessary cooling water.

Geothermal operations also can affect water quality, primarily from chemical contaminants. Geothermal fluids rising to the surface from supply wells and returning through injection wells may contaminate local water tables with brine and trace toxic elements such as boron, mercury, lead, ammonia, and arsenic. However, waste fluids and steam can be reinjected into reservoirs and reused in flash steam and binary plants, or can be mitigated through waste-water treatment. Thermal discharge would not be to surface waters, but rather to the atmosphere from cooling towers or back to the geothermal reservoir through reinjection of water and steam. With mitigation of significant adverse impacts, impacts would be moderate.

4.4.3 Soils and Geology

Hazardous wastes from drilling, concentrated scaling from brine residue, and sulfur solids from gas reduction processes could adversely affect the soil environment through contamination. Impacts can be mitigated by following proper safety, accident prevention,

and waste disposal practices. In addition, reinjection of brine to recharge geothermal reservoir fluids may induce seismic activity; however, mitigation is not well understood for this technique. Removal of geothermal fluids can cause land to sink, although reinjection of fluids generally compensates for this effect, and may impact geothermal features such as hot springs and geysers. Construction of geothermal facilities also can affect soils and geology. Approximately 0.27 acre per MW of land area can be potentially disturbed during construction (BPA, 1993). With mitigation of significant adverse impacts, impacts would be moderate.

4.4.4 Plants and Animals

Emission of harmful and potentially lethal H_2S gas concentrations, particularly those that accumulate in low pockets, may adversely affect wildlife and vegetation. Potential contamination of waters and soils could harm plants and wildlife. Mitigation measures for gas and fluid pollution are discussed above. Drilling, construction, and plant operation may also disturb or displace wildlife. Injection and extraction of water in geothermal sites may change the hydrology of hot springs and destroy the habitat for unique plants and animals specially adapted to this environment. Depending on the location of the geothermal resource, some impacts may not be able to be mitigated or avoided. Impacts are high-moderate.

4.4.5 Land Use

Geothermal operations require 500 to 3,000 acres for exploration, drilling, construction, and plant facilities. Actual energy production, however, requires only about 0.27 acre per MW (BPA, 1993). Drilling damages land but effects can be minimized by angle drilling where multiple wells open to the surface in one location. Geothermal resources may be located some distance from existing transmission lines, requiring new transmission corridors. Mitigation includes siting facilities in conformance with applicable local ordinances and state or federal regulations. Overall land use impacts are considered high-moderate.

4.4.6 Employment

No direct or indirect employment adverse effects would result from geothermal development. Temporary construction employment opportunities of 4.1 employee-years per MW would be created (BPA, 1993). Permanent employment of plant operations personnel, approximately 0.3 employees per MW, may enhance local employment opportunities (BPA, 1993). Impacts are considered low.

4.4.7 Aesthetics and Recreation

In the Pacific Northwest, many potential geothermal sites are located in pristine regions of high aesthetic and recreational value (NPPC, 1991). Significant conflicts with aesthetics and recreation could arise in these areas because geothermal plants would reduce local aesthetic and recreational quality through loss of natural landscape, construction of visually displeasing structures, emission of steam, creation of fog, and impacts to geothermal

features such as hot springs and geysers. Landscaping could mitigate some adverse effects. Locating plants away from sensitive areas would reduce aesthetic and recreation impacts. Impacts are considered high-moderate.

4.4.8 Environmental Health

The H_2S emissions at geothermal drill sites could be lethal if workers are not properly clothed and equipped, trained, and required to observe prescribed safety procedures. H_2S emissions from geothermal plants may affect the comfort and health of people who are sensitive to air pollution, particularly those who suffer from asthma and emphysema. Clouds of condensing steam from cooling towers produce fog which can cause a visibility hazard, particularly on roads. Mitigation measures for the air quality effects are presented above.

Construction and operation of geothermal plants produce potentially annoying noise up to one mile away, primarily from well drilling and steam venting during operation (NPPC, 1991). Noise levels could be mitigated by muffling steam wells, constructing berms, restricting operation to daylight hours, and locating plants away from sensitive areas. Overall, impacts are considered moderate.

4.4.9 Cultural and Historical Resources

Large areas of soil disturbance associated with geothermal plant construction may affect cultural or historical sites. Potential effects could be limited or avoided by conducting site surveys and preparing contingency plans, should cultural or historical resources be discovered during construction. Impacts are considered moderate.

4.4.10 Energy Resources

No direct adverse effects to energy resources would result from the construction and operation of geothermal generation facilities. Where suitable sites exist, geothermal is effectively a renewable resource. Manufacture of necessary geothermal equipment would indirectly require expenditure of energy.

4.5 WIND

Figure 4-6 shows the potential environmental impacts of wind, along with associated mitigation measures.

4.5.1 Air Quality

Air quality impacts from wind generation would be limited to temporary construction-related effects, such as fugitive dust emissions. Sprinkling the project site and washing the construction vehicle tires prior to leaving the site would reduce such emissions. Impacts are considered low.

Figure 4-6. Potential Environmental Impacts—Wind

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
		• Erosion control	• T&E species & sensitive habitat surveys & avoidance • Install lights • Avoid migration corridors	• Siting to minimize impact		• Siting & land-scaping/ design	• Limit height	• Cultural & historic site surveys & avoidance	

Relative impact level: ■ High ▨ High-moderate ▭ Moderate □ Low

4.5.2 Surface and Groundwater

Wind farms do not directly affect water quality, except for temporary increases in turbidity from possible erosion and run-off during construction. Any adverse effects can be mitigated by constructing facilities during the dry season and using best management practices such as hay bales and siltation fences to minimize water quality impacts. Due to the lack of extensive excavation to erect wind generation structures, impacts are considered low.

4.5.3 Soils and Geology

Impacts to soil would occur primarily during construction and can be minimized through erosion control. At windy sites, however, retaining topsoil during construction and operation may require special measures. Assuming mitigation of adverse impacts, potential impacts would be low.

4.5.4 Plants and Animals

Collisions between birds and wind turbine blades are a concern. Studies indicate that bird mortality associated with wind farms appears to be limited primarily to nocturnal migrants, particularly songbirds and raptors (Avery et al., 1980; McCrary et al., 1983; BPA, 1987). Installing small lights on wind turbine blades may minimize collisions with nocturnal birds. Additional mitigation would include locating wind farms away from areas used by endangered species, migratory paths, and areas densely populated by birds. Interconnection between remote wind farms and the main transmission grid could require construction of power lines. Use of designs for conductor spacing (Olendorff et al., 1981), relocation of bird nests on top of power line poles, and height limitations on utility structures would mitigate potential impacts to birds. Rodents may also be discouraged from inhabiting wind farm sites due to ground vibrations from the turbines (BPA, 1987).

Effects on other wildlife and vegetation during construction or operation of wind farms, due to noise disturbance, are site dependent. Assuming avoidance of significant adverse impacts through careful siting and facility design, impacts are considered moderate.

4.5.5 Land Use

Wind farms require large tracts of land, approximately 6 acres per MW capacity (BPA, 1993). Only a portion of the total occupied acreage, is disturbed for construction of turbines, roads, transmission lines, substations, and buildings (NPPC, 1991; BPA, 1993). Other land uses, such as livestock grazing or non-intensive farming, can coexist with wind farms. However, wind farms may be located far from existing electrical load centers due to site area requirements, which may require construction of long transmission lines. Overall impacts to land use are considered moderate.

4.5.6 Employment

No significant direct or indirect adverse effects to employment are expected from the development and operation of wind farms. Temporary construction employment opportunities of approximately 1.9 employee-years per MW would be created. Employment opportunities for operations staff, about 0.4 employees per aMW, would be created for the life of the project (BPA, 1993). Impacts are considered low.

4.5.7 Aesthetics and Recreation

Wind generation towers would reduce the aesthetic visual quality of the wind farm site and vicinity, particularly in scenic areas. To maximize use of the wind source, wind farms often are located in exposed and visually obtrusive areas. Visual impacts can be reduced by designing an aesthetic layout for the turbines and locating wind turbine towers and associated transmission lines away from visually sensitive areas. With mitigation or avoidance of significant adverse impacts through careful siting and facility design, overall impacts are considered moderate.

4.5.8 Environmental Health

Wind farms would not affect public health and safety if they are properly operated. However, hazards to aircraft from the wind towers should be considered. Limiting the height of the wind towers to comply with Federal Aviation Administration regulations would reduce this possibility. The operation of wind turbine blades can create considerable noise, including periodic thumps. Noise levels depend on turbulence, atmospheric boundary layers, wind direction, terrain, blade shape, and turbine design (NPPC, 1991). Potential noise disturbance can be mitigated by the following: 1) complying with state noise regulations; 2) locating wind towers away from sensitive areas; 3) orienting blades into the predominant wind direction; and 4) periodically monitoring noise. In the Pacific Northwest, noise disturbance to humans would be low due to the remoteness of suitable wind source sites. Overall impacts are considered moderate.

4.5.9 Cultural and Historical Resources

Cultural or historical sites could be disturbed during the construction of wind farms. Significant impacts can be mitigated by conducting a site survey before construction and siting wind farms away from sensitive areas. Assuming avoidance of significant adverse impacts by careful siting, impacts are considered moderate.

4.5.10 Energy Resources

No direct adverse effects to energy resources would result from the construction and operation of wind farms. Where suitable sites exist, windpower is effectively a renewable resource. Manufacture of necessary windpower equipment will indirectly require expenditure of energy.

4.6 COAL-FIRED RESOURCES

Potential environmental impacts of coal-fired resources (pulverized coal and IGCC coal plant) are shown in Figure 4-7 and 4-8, respectively.

4.6.1 Air Quality

Pulverized Coal

Coal combustion results in emissions of NO_x, SO_2, CO, CO_2, particulate matter (from the stacks and coal-handling operations), and some hazardous air pollutants. Air quality impacts from coal plants are related to the quality of fuel used and the degree of emissions control. Uncontrolled coal-burning emissions may result in large ambient concentrations of air pollutants, which may adversely affect human health, wildlife, and vegetation; reduce visual quality; and contribute to global warming (SCL, 1989) and acid rain (Trisko, 1989). Emissions must be controlled, possibly by using low-sulfur coals, wet lime flue-gas scrubbing, combustion modification techniques, scrubbers, electrostatic precipitators, baghouses, selective catalytic reduction (SCR), and Best Available Control Technology/ lowest achievable emission rate (BACT/LAER) techniques.

Like other fossil fuels, the chief air emission from coal combustion is carbon dioxide (CO_2), which although not a ground-level pollutant is a greenhouse gas implicated in global warming and climate change. Coal has the highest CO_2 emissions of any fossil fuel, from 205 to 220 pounds CO_2 per MMBtu of energy content, compared to approximately 165 and 115 pounds per MMBtu for fuel oil and natural gas respectively. There is no cost-effective method to eliminate or capture CO_2 emissions at the source, although CO_2 is removed from the atmosphere by plants and stored in the form of biomass.

Even assuming compliance with existing regulatory requirements, the air quality impacts of pulverized coal are considered high in relation to other alternative energy resources.

Integrated Gasification Combined Cycle

There are several technologies that offer higher heat rates and reduce emissions. IGCC systems decompose solid coal into a high-quality gas fuel that can burn in a combustion

Figure 4-7. Potential Environmental Impacts—Coal-Fired/Conventional Pulverized Coal

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
• BACT/ LAER • SNR • SCR	• Waste-water treatment/ cooling • Ash disposal at approved sites	• Spill prevention/ cleanup plan • Ash disposal at approved sites • Erosion control	• T&E species & sensitive habitat surveys & avoidance	• Siting to minimize impact		• Siting & land-scaping/ design	• BACT/ LAER • Noise abatement	• Cultural & historic site surveys & avoidance	

Relative impact level: High High-moderate Moderate Low

Figure 4-8. Potential Environmental Impacts—Coal-Fired/IGCC

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
• BACT/ LAER • SCR • SNR	• Waste-water treatment/ cooling • Solid waste disposal at approved sites	• Solid waste disposal at approved sites • Erosion control	• T&E species & sensitive habitat surveys & avoidance	• Siting to minimize impact		• Siting & land-scaping/ design	• BACT/ LAER • Noise abatement	• Cultural & historic site surveys & avoidance	

Relative impact level: High High-moderate Moderate Low

turbine. IGCC "gas-cleaning" techniques significantly reduce air emissions (Fulkerson et al., 1990). This result is achieved by removing nitrogen and sulfur compounds and particulate matter from the fuel gas. Fugitive emissions from coal-handling systems would be similar to conventional coal. Emissions of NO_x and SO_2 are dramatically reduced compared to conventional coal-fired plants (BPA, 1993). Because of the higher efficiency of combustion turbine generation compared to steam-boilers, IGCC plants typically have CO_2 emissions on the order of ten to twenty percent lower than conventional coal-fired power plants (SCL, 1995b).

New IGCC plants would be subject to local, state, and federal air quality regulations, including emission limits, BACT demonstration, compliance with the AAQS, and compliance with the Prevention of Significant Deterioration (PSD) program. New construction would have air emissions controls.

IGCC air emissions are typically more stringently controlled than those of conventional pulverized coal due to greater efficiency and the removal of pollutants during the gasification process prior to combustion. Assuming compliance with existing regulatory requirements, the air quality impacts of IGCC are considered high-moderate compared to alternative electricity resources.

4.6.2 Surface and Groundwater

Pulverized Coal

Water consumption by coal-burning facilities could have potentially adverse affects on surface and groundwater quantity. Annual water consumption for a typical coal-burning facility has been estimated at 10.69 acre-feet per aMW and thermal discharge at 42,200 MMBtu per aMW (BPA, 1993).

Potential effects of coal-burning operations on water quality may result from cooling tower blowdown, ash handling during combustion, and wastewaters. These processes may adversely affect surface and groundwater with chemical contaminants. Estimated discharge of wastewater is 1.87 acre-feet per aMW (Fluor Daniel, 1991). Adverse effects can be mitigated by using waste-water treatment, fully closed-cycle condenser cooling systems, and lined ash disposal. However, fully closed-cycle systems compromise the efficiency of plant operation. Assuming mitigation of significant environmental impacts, impacts would be high-moderate compared to alternative energy resources.

Integrated Gasification Combined Cycle

Annual water consumption for a typical IGCC facility has been estimated at 16.26 acre-feet per aMW. Estimated thermal discharge is 42,200 MMBtu per aMW (BPA, 1993) and estimated discharge of wastewater is 1.51 acre-feet per aMW (Fluor Daniel, 1991).

IGCC operations may also potentially affect water quality due to waste handling during coal gasification, combustion and wastewater removal. Uncontrolled, these processes may contaminate surface water and groundwater with dissolved heavy metals, mineral salts, and toxic compounds. Such effects can be mitigated by using wastewater treatment and lined

solid waste disposal. Assuming compliance with environmental regulations and mitigation of significant impacts, impacts would be high-moderate compared to alternative energy resources.

4.6.3 Soils and Geology

Pulverized Coal

Coal mines permanently alter landscapes and potentially contribute to soil erosion, which could adversely affect soil productivity, watersheds, and ultimately vegetation and wildlife. Potential land area that may be disturbed by construction of typical coal-burning facilities is estimated at 1.33 acre per MW. Annually, 0.25 acre per aMW would be consumed for mining of coal (BPA, 1993). Production of solid waste, primarily ash, may also adversely affect the soil environment through contamination. The type of contamination depends on the chemical composition of the coal fuel and disposal methods. These solid wastes are generally disposed of in ponds or landfills, where leaching could occur. Proper pond lining can prevent leaching. Assuming compliance with existing regulations and mitigation of significant adverse impacts, impacts would be high-moderate compared to alternative energy resources.

Integrated Gasification Combined Cycle

Potential effects of coal plant operations on land and soil are similar to pulverized coal and are associated primarily with coal mining and solid waste disposal. Plant construction would disturb 0.75 acres per MW (BPA, 1993). Proper waste disposal methods would mitigate some effects. Impacts would be high-moderate compared to alternative energy resources, assuming mitigation of significant adverse impacts.

4.6.4 Plants and Animals

Pulverized Coal

Plants and animals may be adversely affected by coal-burning processes because suitable habitat is reduced by mining and site construction; air, water, and soil pollution; and condenser cooling techniques. The third process may affect fish populations by reducing natural waterflows and by impingement on intake screens. Mitigation includes treatment of air and water emissions and disposal of solid waste in lined landfills. Impacts would be considered high-moderate compared to alternative energy resources.

Integrated Gasification Combined Cycle

Plants and animals may be adversely affected by coal-burning processes due to habitat reduction; mining and site construction; and pollution of air, water, and soil. Mitigation is similar to that for pulverized coal. Impacts are considered high-moderate compared to alternative energy resources.

4.6.5 Land Use

Pulverized Coal

Coal mining results in permanent alteration of land use, resulting in about 0.25 acre per aMW altered per year of mining (BPA, 1993). An additional 1.33 acres per MW would be required to construct power generation facilities and coal ash disposal requires special landfills. Availability of suitable coal-fired plant sites is very limited due to specialized site requirements (NPPC, 1991). Impacts to land use are considered high.

Integrated Gasification Combined Cycle

As with pulverized coal, mining would result in permanent alteration to land use at a similar rate as pulverized coal (0.21 acre per aMW per mining year). Construction of plants would require about 0.75 acre per MW. In addition, coal ash disposal requires special landfills. Land use impacts are considered high.

4.6.6 Employment

Pulverized Coal

The construction and operation of pulverized coal plants would not result in direct or indirect adverse effects on employment. Temporary construction opportunities for about 4.7 employee-years per MW would become available for workers (BPA, 1993). These coal plants would create permanent employment opportunities for about 1.2 employees per MW capacity including mining, processing, transporting, and plant operations. Special training is necessary for some jobs. Impacts are considered low.

Integrated Gasification Combined Cycle

IGCC generation plants also would not cause significant direct or indirect adverse effects during construction and operation. Construction of the mining and generation facility would provide about 5.7 employee-years per MW of temporary employment. Mining, processing, transporting, and plant operations would provide opportunities for about 1.5 employees per MW of permanent employment (BPA, 1993). Impacts are considered low.

4.6.7 Aesthetics and Recreation

Pulverized Coal

The construction and operation of coal mines and pulverized coal burning plants reduces local aesthetic quality, including loss of natural landscape. Steam associated with plant operation would also diminish aesthetic qualities. Operation of fully closed-cycle condenser cooling systems would reduce visible emissions. Landscaping could mitigate some adverse effects; however, impacts are considered high-moderate.

Integrated Gasification Combined Cycle

As with pulverized coal, construction and operation of coal mines and IGCC plants would reduce local aesthetic quality through loss of natural landscape and emissions of steam. Although landscaping would mitigate some adverse effects, impacts would be considered high-moderate.

4.6.8 Environmental Health

Pulverized Coal

Reduced air quality may affect the health of people who are sensitive to air pollution, particularly those who suffer from asthma and emphysema.

At coal-fired plants, machinery and heavy equipment used in fuel preparation and off-site disposal can generate high noise levels. Noise levels could be reduced or limited by installing mufflers, constructing berms, restricting night-time operations, and isolating noise activities away from sensitive receptors. Impacts are considered moderate.

Integrated Gasification Combined Cycle

Reduced air quality may affect the health of people who are sensitive to air pollution, particularly those who suffer from asthma and emphysema.

Operation of IGCC coal plants generally includes fuel preparation using machinery and heavy equipment to move fuel and solid waste to trucks for off-site disposal, which create noise. Noise levels could be reduced or limited by installing mufflers, constructing berms, and implementing daylight operation restrictions. Impacts are considered moderate.

4.6.9 Cultural and Historical Resources

Pulverized Coal

Cultural or historical resources may be affected by large areas of soil disturbance from coal mining and plant construction. In addition, coal-burning emissions contribute to acid rain, which corrodes the metallic and masonry components of buildings and other historic monuments. Mitigation includes emission controls such as scrubbers which reduce contribution to acid rain. Impacts are considered moderate.

Integrated Gasification Combined Cycle

Cultural or historical sites may be affected by large areas of soil being disturbed and historical structures being corroded by acid rain. Mitigation includes emission controls such as scrubbers which reduce contribution to acid rain. Impacts are considered moderate.

4.6.10 Energy Resources

Coal-fired electrical generation would directly affect the supply of coal to the region. While coal is non-renewable, it is the most abundant fossil fuel. Coal availability is not a

constraint, because additional coal resources are available in Canada and neighboring states. The net impact on existing regional coal resources would be moderate.

4.7 COMBUSTION TURBINES

Figure 4-9 summarizes the potential environmental impacts of combustion turbines, along with associated mitigation measures.

Figure 4-9. Potential Environmental Impacts—Combustion Turbines

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
• BACT/ LAER • SCR	• Spill prevention/ cleanup plan • Waste-water cooling/ treatment	• Erosion control	• Pipeline siting/ wildlife crossings • Spill prevention/ cleanup plan	• Siting to minimize impact			• BACT/ LAER • SCR • Noise abatement	• Cultural & historic site surveys & avoidance	

Relative impact level: High; High-moderate; Moderate; Low

4.7.1 Air Quality

Combustion turbines fired with natural gas emit primarily NO_x, CO, and CO_2 If fuel oil is burned as a backup fuel when natural gas is not available, SO_2 and particulates are also emitted. Other emissions include hazardous air pollutants such as formaldehyde, methane from blowdown and leaking valves and flanges, and fugitive dust from roads. Natural gas fueled plants produce the lowest CO_2 emissions per unit of output of any form of fossil fuel (SCL, 1989). Unabated NO_x emissions are elevated in natural gas powered turbines, and could contribute to the formation of acid rain and smog. Typical mitigation for air quality effects includes the use of low-NO_x burners and selected catalytic reduction (SCR) technologies.

New combustion turbines would be subject to local, state, and federal air quality regulations, including emissions limits, BACT demonstration, and compliance with the AAQS and requirements of the PSD program. A new facility would increase the emissions of criteria and hazardous air pollutants (unless emission offsets were required) and greenhouse gases. Construction of new combustion turbines would result in temporary air quality impacts, primarily from emissions of fugitive dust.

Combined-cycle combustion turbines have somewhat lower air emissions than simple-cycle combustion turbines per unit of energy generated. This is due in part to the greater

efficiency of combined-cycle plants. In addition, combined-cycle combustion turbines more typically run as baseloaded plants with higher capacity factors, while simple-cycle combustion turbines are used more intermittently to provide peak service. As a result, combined-cycle combustion turbines usually have more stringent emission requirements. Overall, both simple-cycle combustion turbines and combined-cycle turbines have moderate impacts.

4.7.2 Surface and Groundwater

Surface and groundwater would be used for cooling purposes in combined-cycle combustion turbines. Simple-cycle combustion turbines do not require cooling water. A typical combined-cycle combustion turbine generation facility requires approximately 3.4 acre-feet of water per aMW (BPA, 1993). Thermal discharge for combustion turbines is estimated at 28,800 MMBtu per aMW. The estimated discharge of wastewater is 1.67 acre-feet/aMW (Fluor Daniel, 1991). Simple-cycle combustion turbines consume 0.148 acre-feet/aMW, discharge an equivalent volume of wastewater, and emit no thermal discharge to surface or groundwater (Fluor Daniel, 1991). Heated water discharged from combustion turbine cooling towers contains trace amounts of metals or chemicals used in controlling corrosion, scaling, and algal growth (SCL, 1990), and could affect living organisms. Mitigation includes wastewater treatment. Assuming mitigation of significant environmental impacts, impacts would be moderate due to the consumption of water resources.

4.7.3 Soils and Geology

Impact to soil would occur primarily during construction and can be minimized with erosion control plans. The estimated land area involved in construction of combustion turbine facilities, as well as gas extraction facilities and pipelines, is 0.15 acres per MW (BPA, 1993). Assuming mitigation of significant environmental impacts, impacts would be low.

4.7.4 Plants and Animals

The construction and operation of combustion turbines, both simple-cycle and combined-cycle would have limited effects on plants and animals. Construction of new facilities could temporarily disturb wildlife in the vicinity and permanently displace existing plant and animal habitat. If new gas pipelines are required, their construction and operation could adversely affect plants and animals by disturbing and displacing habitat and, if located above ground, disrupting wildlife migration patterns. The transportation and storage of backup fuel oil presents a risk of spill which could adversely impact plants and animals in the vicinity.

Possible mitigation includes careful siting of generation plants and pipelines to avoid environmentally sensitive areas, critical habitat or threatened and endangered species; placing pipelines underground or elevating above-ground pipelines at wildlife migration routes; and developing a Spill Prevention, Control and Countermeasure Plan to minimize damage resulting from the accidental release of fuel oil. Assuming avoidance or mitigation of significant adverse environmental impacts, impacts are of low magnitude.

4.7.5 Land Use

Construction of typical combustion turbine facilities requires converting about 0.15 acre per MW capacity of existing land use to industrial use. Extraction of gas would temporarily affect 0.03 acre per aMW and annually convert about 0.025 acre per aMW to gas production (BPA, 1993). Buried oil and gas supply pipelines and overhead electric transmission lines that may be required could modify land use. Maintenance practices, such as tree and brush removal, may interfere with some land uses. Siting combustion turbine plants in areas zoned for such uses, adjacent to compatible neighboring land use, and near existing electric transmission lines and fuel pipelines would reduce potential impacts. Overall impacts to land use are considered low.

4.7.6 Employment

The construction and operation of combustion turbines would have no significant direct or indirect adverse effects on employment. Temporary construction employment opportunities for about 1.88 employee-years per MW would be available, including exploration and transportation. Permanent employment of about 0.1 employees per MW for operating personnel would be available to individuals with adequate training (BPA, 1993). Impacts are considered low.

4.7.7 Aesthetics and Recreation

Most combustion turbine plants are likely to be sited at some distance from residential neighborhoods, or in areas where there is already some industrial development or new industrial operations planned. However, the height and extent of a plant's buildings and cooling towers (for combined-cycle plants), along with the emission stack(s), may be a visual intrusion into the landscape. Also, construction of needed gas supply lines and overhead transmission lines may temporarily or permanently disrupt recreational activities along pipeline routes. Mitigation includes landscaping at the plant site, painting the structures with neutral colors, replanting the pipeline transmission rights-of-way quickly, and selecting pipeline routes that avoid or minimize impacts to recreation areas. Assuming avoidance or mitigation of significant adverse impacts, impacts would be low.

4.7.8 Environmental Health

Construction-related activities can result in increased noise levels primarily from the use of heavy equipment. Noise levels can be mitigated by restricting construction projects to daytime hours. In Washington, construction activities are excluded from the Department of Ecology's noise ordinances (WAC 173-60-040).

Combustion turbine operation can produce high noise levels primarily from equipment noise and gas venting through the stacks. Typical mitigation activities include properly insulating buildings that house turbines and generators, using noise control devices in the stacks, and restricting night-time operation if near sensitive land uses. In addition, separate enclosures can be installed for major noise sources like combustion turbines, pumps, and generators. Locating stations away from sensitive areas also helps mitigate high noise levels.

Exposure of on-site personnel to hazardous material releases or explosions can be mitigated by adequate ventilation and following proper material-handling procedures. Overall, impacts are considered moderate.

4.7.9 Cultural and Historical Resources

Cultural or historical sites could be disturbed during construction of combustion turbines. Effects can be limited by conducting a site survey before construction and preparing an action plan to consult with appropriate parties. Impacts are considered low.

4.7.10 Energy Resources

The primary fuel for combustion turbines is natural gas, a non-renewable fossil fuel. While natural gas supplies to the region appear plentiful at this time, availability and price may change in the future. The net impact on regional gas supplies would be moderate.

4.8 COGENERATION

The potential environmental impacts of cogeneration are summarized in Figure 4-10.

Figure 4-10. Potential Environmental Impacts—Cogeneration

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
• BACT/ LAER • SCR	• Waste-water cooling • Spill prevention/ cleanup plan	• Erosion control	• Pipeline siting/ wildlife crossings • Spill preven-tion/ cleanup plan	• Siting to minimize impacts			• BACT/ LAER • Noise abatement	• Cultural & historic site surveys & avoidance	

Relative impact level: High; High-moderate; Moderate; Low

4.8.1 Air Quality

For this evaluation, it has been assumed that cogeneration plants are fired with natural gas. The emissions of concern would be NO_x, CO, and CO_2. Emissions of SO_2 and particulate matter from natural gas fired combustion turbines would occur if fuel oil is used as a backup fuel. Other emissions would include hazardous air pollutants such as formaldehyde, methane from blowdown and leaking valves and flanges, and fugitive dust from roads.

New cogeneration facilities would be subject to local, state, and federal air quality regulations including emissions limits, BACT demonstration, and compliance with the AAQS and requirements of the PSD program. A new facility would result in increased emissions of criteria and hazardous air pollutants (unless emission offsets were required) and greenhouse gases. However, these emissions would be controlled. The combustion turbine and steam generator would be operated in conjunction with an existing industrial facility; therefore, total emissions may actually decrease if the host can shut down unnecessary and/or antiquated emissions sources. Construction of new cogeneration turbines would result in temporary air quality impacts, primarily from fugitive dust emissions. Overall, cogeneration resources have moderate air quality impacts compared to alternative energy resources.

4.8.2 Surface and Groundwater

Gas-fired combined-cycle combustion turbine cogeneration facilities would have similar potential effects on surface and groundwater quantity and quality as combustion turbines (see Section 4.7.2). Surface or groundwater use occurs for cooling purposes. Water disposal may cause thermal pollution if appropriate mixing and cooling does not occur. Assuming mitigation of significant impacts, impacts would be moderate due to the consumption of water resources.

4.8.3 Soils and Geology

Impacts to soils and geology from gas-fired cogeneration facilities would be the same as those described for combustion turbines (see Section 4.7.3). Impacts would be low, and limited to soil disturbed during facility construction.

4.8.4 Plants and Animals

The construction and operation of cogeneration plants would have a limited effect on wildlife and vegetation, because facilities are typically co-located near or adjacent to already existing industrial uses. The plants, however, are fueled by natural gas. As described in Section 4.7.4, the construction and operation of natural gas pipelines would affect vegetation and wildlife. Impacts and mitigation would be similar to those of combustion turbines. Assuming mitigation of significant adverse impacts to plants and animals is implemented, impacts would be low.

4.8.5 Land Use

Gas-fired cogeneration projects usually consist of a combustion turbine plant with an auxiliary boiler to supply excess steam to an industrial "host" in the vicinity for use in a variety of industrial processes. Typical cogeneration sites require conversion of about 0.15 acre of existing land use into industrial use per MW capacity. Extraction of gas would temporarily affect 0.03 acre per MW and annually convert about 0.025 acre per aMW to gas production (BPA, 1993). The construction of gas supply pipelines and overhead electric transmission lines that may be required for the plant could restrict land use. Maintenance practices such as tree and brush removal may interfere with some land uses. Siting combustion turbine projects in areas with compatible zoning and land use and near existing

electrical transmission lines and fuel sources would reduce potential impacts. Overall land use impacts are considered low.

4.8.6 Employment

No significant direct or indirect adverse effects to employment would result from the construction and operation of a cogeneration plant. Temporary construction employment opportunities for about 1.88 employee-years per MW capacity would be available, including exploration and transportation (BPA, 1993). Permanent employment opportunities of about 0.1 employees per MW for operating personnel would be available to individuals with appropriate training. Impacts are considered low.

4.8.7 Aesthetics and Recreation

As with combustion turbines, most cogeneration projects would be located at some distance from residential neighborhoods, or in areas where there is already some industrial development existing or planned. However, the height and extent of a plant's buildings and cooling towers, along with the emission stack(s), present a visual intrusion into the landscape. Also, construction of needed oil and/or gas supply pipelines and overhead transmission lines may temporarily or permanently disrupt recreational activities along utility corridors. Mitigation includes landscaping the plant site, painting the structures with neutral colors, replanting the pipeline/transmission rights-of-way quickly, and choosing alternative routes that avoid or minimize potential impacts to recreation areas. As with combustion turbines, impacts are considered low assuming avoidance or mitigation of significant adverse impacts.

4.8.8 Environmental Health

Increased noise levels related to cogeneration projects are caused by construction activities and the operation of turbines, generators, and other equipment. Mitigation includes insulating turbine and generator buildings and restricting night-time operation, as well as locating power plants away from residential and recreational areas.

Exposure of on-site personnel to hazardous material releases or explosions can be mitigated by adequate ventilation and following proper material-handling procedures. Overall, impacts are considered moderate.

4.8.9 Cultural and Historical Resources

Cultural or historical sites may be affected by large areas of soil being disturbed during construction. Low impacts can be mitigated by conducting a site survey before construction and preparing an action plan, should cultural or historic resources be uncovered during construction.

4.8.10 Energy Resources

While other fuels and equipment configurations can be used, cogeneration plants in the Northwest are typically natural gas-fired combustion turbines with heat recovery steam generators (HRSG). Gas-fired cogeneration would directly affect the natural gas resources

available to the region in much the same manner as gas-fired combustion turbines (SCL, 1995b).

Natural gas usage per aMW of electricity generation is higher for cogeneration than combustion turbine because the waste heat from the turbines is used to serve secondary heat loads rather than generate additional power. The net impact on regional natural gas supplies would be about the same as the combustion turbine provided that the cogeneration is balanced efficiently and the waste heat used for secondary heat loads offsets use of other electric power or natural gas resources. The net impact on regional gas supplies would be moderate.

4.9 FUEL CELLS

Figure 4-11 summarizes the potential environmental impacts of fuel cells, along with associated mitigation measures.

Figure 4-11. Potential Environmental Impacts—Fuel Cells

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
• BACT/ LAER	• Wastewater cooling/ treatment • Reuse/ proper disposal of spent fuel cells		• Pipeline siting/ wildlife crossings				• BACT/ LAER • Noise abatement		

Relative impact level: High; High-moderate; Moderate; Low

4.9.1 Air Quality

Effects on air quality depend on the source of fuel used to produce hydrogen gas for operating the fuel cells. Assuming natural gas is used, emissions of NO_x and CO would be considerably less than combustion turbine emissions. CO_2 emissions would be lower than any other generation technology fueled by natural gas because electricity is produced more efficiently by fuel cells than through combustion processes. Typical mitigation for effects on air quality would include use of BACT or LAER. Impacts are considered moderate.

4.9.2 Surface and Groundwater

Annual water requirements for a typical fuel cell are estimated at 0.97 acres-feet per aMW. Warm water discharged from fuel cells and their cooling systems could degrade water quality by introducing chemical contaminants. When a molten carbonate fuel cell is not in operation, its electrolyte exists in a solid, inert form. It is not yet known whether spent fuel cells will be able to be refurbished for reuse. Spent fuel cells are not expected to release toxic or hazardous constituents; however, the reuse of spent fuel cells or their proper disposal in solid waste or hazardous waste landfills will mitigate potential impacts to surface water or groundwater. Additional mitigation includes treatment of wastewater. Impacts are considered moderate.

4.9.3 Soils and Geology

No direct adverse effect to soils would result from the installation of self-contained fuel cell units.

4.9.4 Plants and Animals

Transportation of natural gas may require construction of pipelines, which would affect wildlife. Typical mitigation includes locating pipelines and other transportation routes in areas that are less environmentally sensitive, routinely maintaining the pipeline and associated equipment, and conducting personnel training programs. In addition, elevated pipelines also can be constructed to allow wildlife to use existing migration corridors. Assuming mitigation of significant adverse environmental impacts, impacts would be low.

4.9.5 Land Use

The use of fuel cells would not result in significant direct or indirect adverse effects. A typical 50 MW fuel cell plant would require only about three acres. Because fuel cells would be manufactured off site and commercial models are expected to be 2 MW in size, siting could occur at existing electrical substations and/or adjacent to existing natural gas pipelines to minimize land use effects, which are considered low.

4.9.6 Employment

The installation and operation of fuel cells would not result in significant direct or indirect adverse effects. Temporary employment for workers would be available during the construction period. Permanent employment for local operations personnel would be limited because of the specialized training required. No on-site personnel would be required to operate the fuel cells, which would likely be controlled electronically from utility power control offices.

4.9.7 Aesthetics and Recreation

No significant direct or indirect adverse effects are expected from the installation and operation of fuel cells.

4.9.8 Environmental Health

No direct adverse effect would be expected. Fuel cell plant operation could result in increased noise levels, which could be mitigated through the use of noise control equipment. Public health would not be affected if plants are properly maintained and operated. Assuming mitigation of significant impacts, their magnitude is considered low.

4.9.9 Cultural and Historical Resources

The installation of fuel cells could affect cultural and historical resources, especially if the site is distant from existing natural gas transmission pipelines. Should either cultural or historical resources be uncovered, conducting a route survey prior to construction and preparing an action plan would mitigate potential impacts. Impacts are considered low.

4.9.10 Energy Resources

Natural gas is likely to be the primary fuel for fuel cells, though other fuels could be used. Gas-fueled fuel cells would directly affect the natural gas resources available to the region in much the same manner as gas-fired combustion turbines, except that natural gas usage would be lower to the extent that the generation efficiency of fuel cells is higher. Assuming expected advances in fuel cell technology, fuel cell resource development is limited only by fuel supply and proximity to a major gas pipeline. The net impact on regional natural gas supplies would be lower than the combustion turbine to the extent that power generation efficiency is higher. Impact on regional gas supplies would be moderate.

4.10 FUEL SWITCHING

The potential environmental impacts of fuel switching and mitigation measures are summarized in Figure 4-12.

Figure 4-12. Potential Environmental Impacts—Fuel Switching

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									
						• Use existing utility corridors			

Relative impact level: ■ High ▨ High-moderate ▒ Moderate □ Low

4.10.1 Air Quality

Fuel switching, like conservation, reduces the total demand for electricity, which would reduce air emissions from utility generation plants. The concept behind fuel switching is to encourage electric customers to use natural gas directly, rather than electricity, for end uses such as heating. Typically, residential customers would convert furnaces, water heaters, dryers, and kitchen appliances to natural gas. In this way, natural gas is burned by the end-user, rather than fueling power plants to generate electricity for heating. Overall air emissions could increase or decrease depending on the type of electricity generation that was reduced or avoided and the emissions of the various natural gas-fired end uses. Impacts are considered low. In general, direct use of natural gas is more efficient than using natural gas to generate electricity to serve the same end use. However, combustion emissions for end uses such as furnaces and water heaters are not as strictly controlled as those from electricity generation plants. Furthermore, the lower combustion temperatures typical of non-industrial natural gas burners would generate a different mix of air pollutants, including greater trace organic compound emissions (USEPA, 1995).

4.10.2 Surface and Groundwater

Fuel switching would not require the construction of new generation plants or peaking plants, and, therefore, would have no significant effect on water quality. Possible construction of new gas lines would require mitigation measures to protection water quality if routes crossed drainages. Impacts would be low.

4.10.3 Soils and Geology

Fuel switching would not require the construction of new baseload or peaking plants, avoiding their associated effects on soils and geology. Potential new gas line construction could affect soils and slope stability. Potential mitigation includes preparation of erosion control plans and use of Best Management Practices to protect slopes and reduce erosion. Impacts would be low.

4.10.4 Plants and Animals

The construction of new gas lines to customers choosing to switch from electric to gas heating could affect plants and animals. However, as fuel switching is an individual customer decision, the construction of gas lines would likely be limited to expansion of the natural gas distribution system. Potential adverse impacts are considered low.

4.10.5 Land Use

Construction of new gas distribution lines that may be required would have minor effects on land use because the affected area would be confined to existing utility corridors, including public road rights of ways. Impacts are considered low.

4.10.6 Employment

Minor temporary employment opportunities would accompany any construction of gas distribution lines.

4.10.7 Aesthetics and Recreation

The construction of natural gas lines to facilitate fuel switching by customers would not affect aesthetic and recreation resources because the lines would be underground.

4.10.8 Environmental Health

There would be no direct adverse effects from fuel switching on noise levels. However, as air emissions from residential natural gas burners is uncontrolled and byproducts include hazardous air pollutants, there would be increased risk to public health and safety. Overall, impacts would be considered low.

4.10.9 Cultural and Historical Resources

No direct adverse effect would be expected.

4.10.10 Energy Resources

The primary fuel for fuel switching is assumed to be natural gas. Fuel switching would directly affect the natural gas resources available to the region in much the same manner as gas-fired combustion turbines, assuming that fuel switching offsets the need for added power generation that would be supplied by new gas-fired combustion turbines. As noted in Section 3.2.10, SCL estimates the technical potential for single-family residential fuel switching in its service territory at approximately 60 aMW.

Natural gas usage would be lower for fuel switching to the extent that direct use of natural gas is more efficient than using gas to generate electricity to serve the same customer end uses. The net impact on regional gas supplies would be low.

4.11 INTERRUPTIBLE LOAD

The potential environmental impacts of using interruptible loads are summarized in Figure 4-13.

4.11.1 Air Quality

Peak demand can be curtailed with interruptible loads. Construction of peaking projects could be avoided, fewer could be required, or existing peaking plants could be used less frequently. In any case, air emissions would be reduced.

4.11.2 Surface and Groundwater

No direct or indirect adverse effects would be expected.

4.11.3 Soils and Geology

No direct or indirect adverse effects would be expected.

Figure 4-13. Potential Environmental Impacts—Interruptible Load

Air Quality	Surface and Groundwater	Soils and Geology	Plants and Animals	Land Use	Employment	Aesthetics and Recreation	Environ. Health, Including Noise	Cultural and Historical Resources	Energy Resources
MITIGATION									

Relative impact level: High High-moderate Moderate Low

4.11.4 Plants and Animals

No direct or indirect adverse effect would be expected.

4.11.5 Land Use

No direct or indirect adverse effects would be expected.

4.11.6 Employment

Some short-term loss in employment could result if SCL enforced contract provisions to interrupt the load of customers who were then forced to temporarily suspend their operations. However, the impacts are expected to be low in magnitude given the short duration and expected infrequent occurrence of interruptions.

4.11.7 Aesthetics and Recreation

No direct or indirect adverse effects would be expected.

4.11.8 Environmental Health

Due to reduced use of peaking plants, the implementation of interruptible load programs would reduce air emissions. As a result, the risks to public health and safety would decrease.

4.11.9 Cultural and Historical Resources

No direct or indirect adverse effects.

4.11.10 Energy Resources

Implementation of interruptible load programs would have no direct adverse effects, unless customers activated installed backup electrical power or heat generation systems. Fuel for these backup systems would be natural gas or petroleum fuels.

4.12 TRANSMISSION

4.12.1 Air Quality

The construction or expansion of transmission lines may create fugitive dust and exhaust emissions from construction equipment (BPA, 1993). Beyond these minor temporary impacts, the construction and operation of new transmission lines and facilities would not have any potential significant adverse impacts on air quality.

4.12.2 Surface and Groundwater

Clearing new right-of-way, expanding existing right-of-way and constructing access roads can temporarily accelerate runoff and increase sediments in streams. Herbicides used to control vegetation and oil found in transformers and capacitors at substations could contaminate surface water or groundwater (BPA, 1993). Potential mitigation includes the use of Best Management Practices to reduce erosion, scheduling construction work during dry months, reducing or avoiding the use of herbicides and employing nonchemical right of way maintenance methods (Integrated Pest Management techniques), and installing spill containment around oil-containing electrical equipment.

4.12.3 Soils and Geology

Clearing new right-of-way, expanding existing right-of-way and constructing access roads involve temporary land clearing and the permanent loss of some vegetation, both of which could increase erosion. Potential mitigation includes the use of Best Management Practices to reduce erosion and scheduling construction work during dry months.

4.12.4 Plants and Animals

Clearing for new or expanded right-of-way and access roads can impact vegetation, including wetlands. Existing vegetation is removed and vegetation composition may change. Noxious weeds may be introduced. Vegetation is also affected by ongoing right-of-way maintenance, which may include the use of herbicides.

Clearing may displace some wildlife and alter habitat, although the creation of edge habitat may also increase species diversity locally. Short-term reduction of water quality from construction activities could harm fish.

In addition, animals may experience annoying or, if surrounding metallic objects are not properly grounded, harmful discharge shocks from the electric and magnetic fields created by transmission lines. The audible noise and light from corona effects may also disturb animals. Mitigation includes proper grounding of transmission facilities and nearby metallic objects (BPA, 1993).

4.12.5 Land Use

Land use impacts are directly related to the amount of new and existing rights-of-way affected. Building a new transmission line with a new corridor would have the greatest impact because new line segments would intrude on existing land use. Potential mitigation includes using expanded or existing right-of-way to reduce land use conflicts (BPA, 1993).

4.12.6 Employment

The construction or expansion of transmission lines would result in both temporary construction and permanent maintenance employment opportunities.

4.12.7 Aesthetics and Recreation

Transmission lines may have a long-term significant visual impact. Lines and towers may intrude on scenic views, and towers may be out-of-scale with the surrounding landscape. Marking to increase visibility to aircraft may increase visual impact. Transmission lines may also cross trails and otherwise intrude on outdoor recreational activities. Potential mitigation includes careful siting of facilities, avoiding crossings at high points, avoiding long views, placement of lines behind ridges or forested areas, diagonal approaches, and maximizing the use of natural screens such as vegetation or terrain (BPA, 1993).

4.12.8 Environmental Health

New transmission lines may result in changes in the strength of electric and magnetic fields within existing transmission corridors, while the construction of lines in new corridors will increase electric and magnetic fields. See section 2.8.2 for a discussion of potential human health effects from electric and magnetic fields.

People may experience annoying or, if surrounding metallic objects are not properly grounded, harmful discharge shocks from the electric and magnetic fields created by transmission lines. The audible noise and light from corona effects may also be annoying (BPA, 1993).

4.12.9 Cultural and Historical Resources

Upgrading existing lines, constructing a new corridor, or expanding an existing right-of-way could disturb cultural resources. Construction may disturb subsurface sites and the line may intrude visually on cultural resources. Potential mitigation includes archaeological surveys, siting to avoid visual intrusion, and screening with vegetation.

4.12.10 Energy Resources

There are no significant adverse impacts to energy resources as a result of new transmission development.

5.0 DESCRIPTION OF ALTERNATIVE RESOURCE PORTFOLIOS

5.1 ISSUES AND POLICIES

The preceding two chapters address individual energy resources used to generate electricity. It is unlikely that SCL would choose to meet its future electricity needs by relying exclusively on one resource type. This section and the following one consider alternative resource portfolios, a combination of resource types and quantities, which together are sufficient to meet the projected need for new resources. SCL's resource planning process addresses a 20-year planning horizon. The analysis of alternative portfolios focuses on the years 2000 and 2010 to represent both shorter- and longer-term trends and impacts.

The alternative portfolios are meant to represent a reasonable range of alternative resource acquisition approaches that SCL may consider in the future. The portfolios have as their foundation existing policy objectives established by the Seattle City Council and significant issues of concern likely to affect future resource acquisition. They are intended to highlight the fundamental tradeoffs inherent in resource acquisition decisions.

SCL's resource planning is guided by existing Seattle City Council policies, which have been adopted by the council over a period of years. In particular, Ordinance 26983 in 1983 established policies regarding the criteria by which alternative electricity resources are to be evaluated (SCL, 1991). These criteria have been modified slightly since 1983 and continue to capture the key tradeoffs facing SCL. They are:

- Resource priority, from highest to lowest, is: (1) conservation, (2) hydroelectric power, (3) other renewable resources, (4) cogeneration resources and resources using waste heat, (5) abundant non-renewable energy resources, and (6) resources using oil;
- Supply and cost uncertainty;
- Cost effectiveness;
- Environmental responsibility; and
- Planning flexibility.

In addition, two emerging issues are likely to significantly affect SCL's resource acquisition decisions in the foreseeable future:

- Concerns about the reliability and competitiveness of BPA as an electricity supplier; and
- Concerns about SCL's rates because of increased competition in the electric utility industry.

A host of factors contributes to uncertainty about the future role and competitiveness of BPA. In turn, this raises questions about SCL's future reliance on BPA to meet load growth and even to continue to purchase current amounts of power from BPA.

The ongoing restructuring of the electric utility industry has already introduced increased competition at the wholesale level. Key factors contributing to this trend include the opening of wholesale transmission access under the federal 1992 Energy Policy Act, advances in the efficiency and costs of new generation technologies, and declining natural gas prices. Competition at the retail level, referred to as retail wheeling, does not yet exist but remains a possibility.

In response to these considerations, the following new resource portfolios, which are described in greater detail below, have been developed for analysis:

- No Action portfolio (spot market reliance);
- Status Quo portfolio;
- Natural Gas Emphasis portfolio;
- Less Environmental Impact portfolio;
- Resource Diversity portfolio;
- Firm Energy Purchase Emphasis portfolio; and
- BPA Independence portfolio.

5.2 ASSUMPTIONS FOR ALTERNATIVE RESOURCE PORTFOLIOS

The following discussion highlights the key assumptions used in developing the alternative resource portfolios.

5.2.1 New Resource Need

All of the portfolios have been constructed to meet SCL's anticipated need for new resources. This need was determined by combining the change in load forecasted for the SCL service territory (discussed below in Section 5.2.1.1 Load Growth) and the expected change in the capability of SCL's existing resources including contracts (discussed below in Section 5.2.1.2, Capability of SCL's Existing Resources). Table 5-1 shows the estimated amount of energy required to meet anticipated load growth and to replace expected decreases in resource capability. These amounts are 115 and 380 aMW, respectively, for the years 2000 and 2010.

In examining the alternative new resource portfolios, the capability and output of SCL's existing resources is assumed to be constant for all portfolios (other than the expected capability changes listed below). However, one exception is the existing (1994) level of BPA entitlement (the amount of energy SCL is entitled to purchase from BPA under its existing Power Sales Contract).

As discussed earlier, there are concerns about the reliability and competitiveness of BPA as an electricity supplier. Because of this, the alternative portfolios, in addition to examining new resources to meet SCL's increased load and to replace lost capability, also examine the effects of changing SCL's 1994 entitlement (approximately 220 aMW). To do this, the Status Quo and BPA Independence portfolios assume different levels of BPA entitlement while the other portfolios assume that BPA entitlement will stay constant at 220 aMW.

Table 5-1. Source of Need for New Resources

	Year 2000 (aMW)	Year 2010 (aMW)
Forecasted Load Growth	110	300
Loss of Existing Resources	5	80
BPA Entitlement, 1994	220	220
Total	335	600

Sources: SCL Load Forecast Model, File "EISRUN1", July 28, 1995; SCL Existing Resource Database, July 13, 1995.

Thus, the portfolios examine a total resource level of 335 aMW (115 aMW load growth/reduced capability plus 220 aMW BPA entitlement) and 600 aMW (380 aMW load growth/reduced capability plus 220 aMW BPA entitlement), respectively, in years 2000 and 2010.

5.2.1.1 Load Growth

The change in electricity demand within SCL's service territory is uncertain. Higher levels of load growth require more electricity resources with correspondingly greater environmental impacts. SCL's high case load forecast was used for this analysis so that it would anticipate the maximum likely magnitude of environmental impacts. Under the high case load forecast, it is anticipated that SCL's load would increase 110 and 300 aMW, respectively, by the years 2000 and 2010. Differences in environmental impacts between the various portfolios would be expected to be proportionally similar under base case load growth assumptions, although the total impacts for each alternative would be less.

5.2.1.2 Capability of SCL's Existing Resources

The calculation of resource need assumes known changes in the capability of SCL's owned resources as well as changes in power delivered under existing power purchase contracts. Highlights include:

- Reductions in hydroelectric resource capability resulting from the 1995 Biological Opinion issued by the National Marine Fisheries Service;
- The addition of the South Fork Tolt hydroelectric project in 1995;
- Decline in energy purchased under the Columbia Storage Power Exchange contract until its expiration in 2004;
- The expiration of a contract for Priest Rapids output in 2006; and
- Decline in energy purchased under the Box Canyon contract with Pend Oreille County PUD until its expiration in 2006.

It is expected that the above known changes in SCL's owned and contracted resources will decrease SCL's resource capability five and 80 average megawatts, respectively, by the years 2000 and 2010.

5.2.2 Additional Assumptions

Spot market purchases are assumed to be available to displace resources acquired by SCL and to meet short-term peak loads during periods of low water and reduced capability of SCL's hydroelectric resources. Rather than being fixed by portfolio as the other resource types are, spot market purchases are allowed to vary in the modeling of the portfolios and provide load/resource balance.

The following assumptions have been made with regards to existing SCL resources capacity. All portfolios assume that SCL continues to own and operate its existing 8 percent share of the coal-fired Centralia steam plant (approximately 111 MW) and that the plant is modified in 2002 to comply with expected pollution control requirements under the Clean Air Act Amendments. Conservation savings for programs implemented through 1995 are assumed to continue through the useful life of the relevant conservation measures and are accounted for in the load forecast. Planned system efficiency measures, including the Gorge Companion Tunnel, are assumed for all portfolios and are reflected in either the load forecast as reductions in losses or as increases in resource capability.

With the exception of the No Action (spot market) portfolio, all portfolios assume that 30 aMW of power is obtained by firming nonfirm hydroelectricity through the services of an 85-MW dispatchable natural gas-fired resource beginning in the year 2000. All portfolios assume that this resource is a simple-cycle combustion turbine through the year 2010, except for the Less Environmental Impact portfolio portfolio that substitutes a fuel cell for the simple-cycle combustion turbine in 2010. Firming nonfirm energy refers to the practice of declaring a firm resource as standby to substitute for nonfirm hydroelectric energy should it be unavailable due to low water conditions. The 30 aMW of firm energy can be produced by running the 85-MW dispatchable resource only during low water years, for an average annual capacity factor of around 15 percent (SCL, 1995a).

5.3 DESCRIPTION OF ALTERNATIVE RESOURCE PORTFOLIOS

Provided below is a description of the basis for and composition of each of the alternative portfolios of new firm energy resources analyzed in the following chapter. Tables 5-2 and 5-3 summarize the portfolios by resource type and energy availability in average megawatts for the years 2000 and 2010, respectively. The resources in the portfolios could be either SCL-owned or contracted. SCL's economic evaluation of resources is indifferent to the question of whether SCL owns or contracts for a resource. This would also be the case in the analysis of the environmental impacts of a particular resource. In other words, the environmental impacts of a given resource would be similar whether SCL owns it or not.

Table 5-2. New Firm Energy Resources Assumed in Alternative Portfolios, Year 2000

	Alternative Resource Portfolio, Year 2000 (aMW)						
Resource Type	No Action[1/] (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
BPA Entitlement	220	263	220	220	220	220	10
Conservation	0	42	0	42	34	0	42
Wind	0	0	0	15	12	0	0
Geothermal	0	0	0	28	15	0	0
Cogeneration	0	0	0	0	0	0	38
CCCT[2/]	0	0	85	0	24	20	150
SCCT[3/]	0	30	30	30	30	30	30
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases	0	0	0	0	0	65	65
Total[4/]	220	335	335	335	335	335	335

1/ The No Action portfolio assumes no acquisition of new firm resources, continuance of 1994 levels of BPA entitlement, and reliance upon the spot market to meet the need for new resources.
2/ CCCT = Combined-Cycle Combustion Turbine.
3/ SCCT = Simple-Cycle Combustion Turbine.
4/ Total includes the sum of new firm resources assumed to meet anticipated demand identified in Table 5-1 plus the assumed level of BPA entitlement.

5.3.1 No Action Portfolio

A No Action portfolio alternative is legally required by SEPA. The term "no action" is interpreted here to mean that SCL takes no action to meet additional need for firm resources, including not increasing its purchase from BPA under the existing power sales contract and not acquiring any additional programmatic conservation. SCL would instead rely exclusively on spot market purchases to meet increased energy demand. This alternative would result in inherent uncertainty regarding the source of energy being purchased and its resulting environmental impacts. In addition, it is likely to have risks regarding the reliability of energy supply since SCL would have neither ownership of nor contractual commitments for its electricity supplies.

5.3.2 Status Quo Portfolio

This alternative portfolio assumes that SCL proceeds with those recommendations from the 1992 Energy Resources Strategy that remain viable—conservation acquisition at levels consistent with the current Conservation Implementation Plan and the acquisition of combustion turbine services—but otherwise does not acquire any additional resources or

Table 5-3. New Firm Energy Resources Assumed in Alternative Portfolios, Year 2010

	Alternative Resource Portfolio, Year 2010 (aMW)						
Resource Type	No Action[1/] (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
BPA Entitlement	220	475	220	220	220	220	10
Conservation	0	95	0	95	95	0	25
Wind	0	0	0	80	45	0	0
Geothermal	0	0	0	120	50	0	0
Cogeneration	0	0	80	45	30	0	125
CCCT[2/]	0	0	240	0	110	140	305
SCCT[3/]	0	30	30	0	30	30	30
Fuel Cells	0	0	30	40	20	0	40
Firm Purchases	0	0	0	0	0	210	65
Total[4/]	220	600	600	600	600	600	600

1/ The No Action portfolio assumes no acquisition of new firm resources, continuance of 1994 levels of BPA entitlement, and reliance upon the spot market to meet the need for new resources.
2/ CCCT = Combined-Cycle Combustion Turbine.
3/ SCCT = Simple-Cycle Combustion Turbine.
4/ Total includes the sum of new firm resources assumed to meet anticipated demand identified in Table 5-1 plus the assumed level of BPA entitlement.

enter into new long-term contracts. The remainder of the resource need would be met through increased purchases from BPA.

Under the terms of SCL's existing power sales contract with BPA, SCL is entitled to BPA power equal to the difference between its firm load and the firm capability of its owned and contracted resources. The likelihood of SCL being able to rely on BPA to meet its load growth is questionable in the long term, as the existing Power Sales Contract expires in 2001. Even in the short term, BPA is pushing for renegotiation of its contracts by 1996 and proposing significant changes in the contract terms. However, it is possible that under a new contract SCL would have the option, if not the right, to purchase additional power from BPA above the levels it is currently entitled to.

5.3.3 Natural Gas Emphasis Portfolio

In this portfolio, all new resource needs are met with natural gas-fired resources, including a simple-cycle combustion turbine (for firming nonfirm hydropower), combined-cycle combustion turbines, cogeneration, and, in later years, fuel cells. Given existing forecasts of gas prices and the absence of conservation, this alternative is likely to have among the lowest potential effect on near-term rates of any of the alternatives.

5.3.4 Less Environmental Impact Portfolio

This alternative was constructed to have the lowest cumulative environmental impacts of the alternative resource portfolios. It includes a level of conservation acquisition consistent with SCL's current Conservation Implementation Plan. Additional resource needs are met by a combination of non-hydro renewable resources, including wind and geothermal, as well as cogeneration and fuel cells in later years. The firming of nonfirm hydropower provided by the simple-cycle combustion turbine in the other portfolios is assumed to be met by contract for combustion turbine services in 2000 and by the acquisition of a fuel cell in 2010. This portfolio is most consistent with the City Council's existing resource priorities and best meets the criteria of environmental responsibility.

5.3.5 Resource Diversity Portfolio

This alternative portfolio consists of a diverse combination of resource types, including conservation, non-hydro renewables, natural gas-fired resources, and power purchase contracts. This alternative is likely to perform well in relation to the City Council policy criteria regarding supply and cost uncertainty.

5.3.6 Firm Energy Purchase Emphasis Portfolio

This alternative is intended to represent a future in which SCL elects to forego the construction or acquisition of resources under its control and instead substantially relies on firm energy contracts of varying durations from other utilities, power marketers, or independent power producers. This might occur, for example, in response to growing concerns about the utility's level of outstanding debt or as part of a trend towards limiting the vertical integration of generation, transmission, and distribution functions in response to concerns about utility industry restructuring and competition.

In many cases it will be possible to identify the specific resource used to meet a particular power contract, as well as its associated environmental impacts. However, it is also likely that firm power contracts will be offered as system sales in which it may not be possible to identify the specific generation resources supplying the electricity. Energy providers may be unable or unwilling to disclose the source of the power being offered because of concerns about confidentiality or competitive advantage. As a result, the environmental impacts of such system sales are likely to be uncertain and it is useful to evaluate a separate portfolio focusing on firm energy purchases in order to highlight that uncertainty for decision-makers. In addition to firm contracts for system sales, this alternative also assumes that the utility does acquire some specific resources by contract. Along with the Natural Gas Emphasis portfolio, this alternative is likely to have among the lowest potential effect on near-term rates of any of the alternatives.

5.3.7 BPA Independence Portfolio

Under this alternative, SCL chooses to forego nearly all of its existing power purchase from BPA, which in 1994 was made from an entitlement of approximately 220 aMW, and

replaces it with new resources by the year 2000. This could happen in the event BPA's rates to SCL become uncompetitive with other suppliers or there is a significant decline in the reliability of BPA as a supplier. The resources acquired to meet an additional 210 aMW of supply to replace the BPA power by the year 2000 include current planned conservation levels, firm energy contracts, and natural gas-fired resources. The portfolio assumes that this aggressive resource acquisition effort results in upward rate pressures and increasing concern about rates beyond 2000. In order to minimize future rate increases, it is assumed that after the year 2000 additional resources are acquired in the same amounts as the Natural Gas Emphasis portfolio (and implicitly that natural gas-fired generation remains relatively inexpensive).

6.0 ENVIRONMENTAL IMPACTS AND MITIGATION FOR ALTERNATIVE RESOURCE PORTFOLIOS

6.1 FRAMEWORK FOR ANALYSIS OF ENVIRONMENTAL IMPACTS OF ALTERNATIVE RESOURCE PORTFOLIOS

In the previous chapter, each alternative portfolio was described in terms of the amount of energy assumed to be available from each new resource type. In this section, the environmental impacts of each portfolio are evaluated for the years 2000 and 2010. These impacts result from: (1) the construction of new generation resources and (2) the operation of generating resources, both new and existing, to produce electricity.

6.1.1 Construction Impacts

Construction-related impacts are a function of the amount of new generating capacity (in MWs) required for each resource type. The new resource capacities for each portfolio are summarized in Tables 6-1 and 6-2 for the years 2000 and 2010, respectively. They are calculated by dividing the amount of energy assumed to be available from each resource for a particular portfolio (see Tables 5-2 and 5-3) by the resource's assumed availability factor.

This factor is a ratio of the amount of time a resource is capable of generating electricity over a given period. It accounts for maintenance, unplanned outages, and, in the case of intermittent resources such as wind and hydroelectricity, the fact that wind or water is not always available to generate electricity. The lower the availability factor, the more generating capacity is required to provide a particular amount of energy. (The availability factor assumed for each resource is indicated in the table footnotes.)

6.1.2 Operational (Generation) Impacts

The operational impacts (such as air emissions or fossil fuel consumption) of a particular portfolio are a function of the amount of energy (in MWh or aMW) expected to be generated by each new resource type, given the amount of generating capacity assumed for the portfolio, in combination with SCL's existing generating system. To comprehensively evaluate operational impacts, changes in the operation of SCL's existing generating resources must be accounted for, as well as those of non-SCL generating resources. Changes in the latter can result from SCL's purchasing nonfirm electricity (also called economy energy), selling its surplus electricity, and varying the amount it purchases from the Bonneville Power Administration.

Tables 6-3 and 6-4 summarize the expected generation by resource type for each portfolio for the years 2000 and 2010, respectively, based on results from SCL's Integrated Resource Planning Model. These generation patterns form the basis for evaluation of the resulting operational environmental impacts.

Table 6-1. Capacity of New Firm Energy Resources Acquired in Alternative Portfolios, Year 2000

	Alternative Resource Portfolio, Year 2000 (MW)						
Resource Type	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
BPA Purchase[1/]	220	263	220	220	220	220	10
Wind[2/]	0	0	0	50	40	0	0
Geothermal[3/]	0	0	0	30	16	0	0
Cogeneration[4/]	0	0	0	0	0	0	41
CCCT[5/]	0	0	95	0	27	23	170
SCCT[6/]	0	85	85	85	85	85	85
Fuel Cells[7/]	0	0	0	0	0	0	0
Firm Purchases[8/]	0	0	0	0	0	65	65

Source for availability factors: SCL, Draft Power Options, 1995, p. A-3.

1/ Availability Factor = 100%. Assumes negotiated BPA entitlement. 1994 level is approximately 220 aMW.
2/ Availability Factor = 30%.
3/ Availability Factor = 92%.
4/ Availability Factor = 92%.
5/ Availability Factor = 89%.
6/ For 30 aMW firming of nonfirm energy.
7/ Availability Factor = 97%.
8/ Availability Factor = 100%.

Table 6-2. Capacity of New Firm Energy Resources Acquired in Alternative Portfolios, Year 2010

Resource Type	Alternative Resource Portfolio, Year 2010 (MW)						
	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
BPA Purchase[1/]	220	475	220	220	220	220	10
Wind[2/]	0	0	0	267	150	0	0
Geothermal[3/]	0	0	0	130	54	0	0
Cogeneration[4/]	0	0	87	49	33	0	136
CCCT[5/]	0	0	270	0	124	157	343
SCCT[6/]	0	85	85	0	85	85	85
Fuel Cells[7/]	0	0	31	95[8/]	21	0	41
Firm Purchases[9/]	0	0	0	0	0	210	65

Source for availability factors: SCL, Draft Power Options, 1995, p. A-3.

1/ Availability Factor = 100%. Assumes negotiated BPA entitlement. 1994 level is approximately 220 aMW.
2/ Availability Factor = 30%.
3/ Availability Factor = 92%.
4/ Availability Factor = 92%.
5/ Availability Factor = 89%.
6/ For 30 aMW firming of nonfirm energy.
7/ Availability Factor = 97%.
8/ Assumes fuel cells include 85 MW for firming 30 aMW of nonfirm SCL hydroelectric energy as a substitute for SCCT, and 10 MW of fuel cell energy capacity.
9/ Availability Factor = 100%.

Table 6-3. Generation by Type of Energy Comprising Resource Alternative Portfolios, Year 2000

	Alternative Resource Portfolio, Year 2000 (aMW)						
Resource Type	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
BPA Purchase[1/]	143	185	129	126	127	126	5
Not Purchased	*(77)*	*(35)*	*(91)*	*(94)*	*(93)*	*(94)*	*(215)*
Centralia	69	67	68	68	68	68	68
Conservation	0	42	0	42	34	0	42
Wind	0	0	0	6	5	0	0
Geothermal	0	0	0	28	15	0	0
Cogeneration[2/]	0	0	0	0	0	0	38
CCCT[3/]	0	0	45	0	13	10	69
SCCT[4/]	0	17	21	21	21	20	24
Fuel Cells[5/]	0	0	0	0	0	0	0
Firm Purchases[6/]	0	0	0	0	0	65	65
Spot Market Purchases[1/]	146	85	104	90	94	91	77
Total Energy [7/]	358	396	367	381	377	380	388
Surplus Sales[1/]	101	136	108	119	115	119	123

1/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.

2/ Assumes cogeneration fueled by natural gas.

3/ CCCT = combined-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

4/ SCCT = simple-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

5/ Assumes natural gas fuel cells.

6/ Assumes firm purchases generated by SCCT fueled 95% natural gas and 5% fuel oil.

7/ Total energy plus expected output of SCL's existing hydroelectric resources and firm contracts, less surplus sales, equal SCL forecasted load which is approximately equal between portfolios. Differences reflect rate-induced conservation resources estimated by SCL's Integrated Planning Model.

Table 6-4. Generation by Type of Energy Resource Comprising Alternative Portfolios, Year 2010

	Alternative Resource Portfolio, Year 2010 (aMW)						
Resource Type	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
BPA Purchase[1/]	202	357	171	159	165	164	8
Not Purchased	*(18)*	*(-137)*	*(49)*	*(61)*	*(55)*	*(56)*	*(212)*
Centralia	76	71	72	68	71	71	74
Conservation	0	95	0	95	95	0	25
Wind	0	0	0	20	12	0	0
Geothermal	0	0	0	114	48	0	0
Cogeneration[2/]	0	0	80	45	30	0	125
CCCT[3/]	0	0	108	0	48	56	140
SCCT[4/]	0	13	19	0	20	17	22
Fuel Cells[5/]	0	0	22	65	15	0	29
Firm Purchases[6/]	0	0	0	0	0	210	65
Spot Market Purchases[1/]	271	104	132	91	114	101	110
Total Energy[7/]	549	640	604	657	618	619	598
Surplus Sales[1/]	66	130	99	154	112	118	98

1/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.

2/ Assumes cogeneration fueled by natural gas.

3/ CCCT = combined-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

4/ SCCT = simple-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

5/ Assumes natural gas fuel cells.

6/ Assumes firm purchases generated by SCCT fueled by 95% natural gas and 5% fuel oil.

7/ Total energy plus expected output of SCL's existing hydroelectric resources and firm contracts, less surplus sales, equal SCL forecasted load which is approximately equal between portfolios. Differences reflect rate-induced conservation estimated by SCL's Integrated Planning Model.

6.1.3 Analytical Assumptions

For this analysis, SCL's Integrated Planning Model used information about the capacity, capability and costs of both new and existing resources, and dispatched them to meet load at the lowest cost to SCL. Regarding SCL's existing resources, only changes in Centralia generation and BPA purchases are accounted for, as only they are likely to vary significantly between portfolios. The capability and output of SCL's existing hydroelectric resources is assumed to remain constant for any particular year.

Hydroelectric project operational constraints are dictated by the terms of each project's Federal Energy Regulatory Commission (FERC) license and associated agreements with regulatory agencies and tribes. For example, the operation of SCL's Skagit Project is governed partly by a set of flow constraints used to protect valuable downstream fish resources. These FERC license constraints define monthly limits or requirements for such things as minimum flow, peaking amplitudes, average daily flows, downramp timing and rate. The operation of SCL's hydroelectric system is not anticipated to differ significantly between portfolios. Any significant changes in its operation would be subject to extensive FERC environmental review and federal license approval.

The estimates of generation patterns used for this analysis is based on average rather than firm water conditions for SCL's hydroelectric resources. Because SCL has based its planning on the amount of hydroelectricity produced in historically dry years (referred to as "firm" power), on average SCL has surplus hydroelectricity. This surplus energy can be used to displace, or reduce the operation of, SCL's share of the Centralia plant or new resources which are displaceable. It also can be used to reduce the amount of energy purchased from BPA or it can be sold on the spot market. Spot market purchases can be used to displace SCL resources when economical or to meet demand under conditions when the assumed resource capability for a portfolio is not adequate.

The calculation of quantified impacts includes reductions in impacts due to the displacement of others' generating resources. This is assumed to occur when SCL sells its surplus generation on the spot market or as a result of reductions in SCL's purchase from BPA below 1994 entitlement levels (approximately 220 aMW). In the latter case, BPA is assumed to either reduce its purchase of power from the spot market, and thereby avoid fossil fuel generation, or to have increased surplus hydroelectricity which it would market to others and therefore ultimately displace their fossil-fuel generation. If the reductions in impacts from resource displacement are larger than the increases from additional generation, it is possible to have negative totals. (This is not uncommon given SCL's average production of surplus hydroelectricity.) Such negative totals reflect an overall reduction in the quantified impact. Comparisons can still be made between portfolios based on relative increases or decreases.

The ultimate or marginal source of electricity is uncertain for resources such as spot market purchases and increases in BPA purchases, as are the resources displaced when SCL sells its surplus energy or reduces its purchases from BPA. The resource assumptions used in the calculation of quantified impacts are provided in Tables 6-3 and 6-4.

Appendix B includes a comprehensive reference table of the capacity and generation amounts for all of the alternative portfolios. The calculation of quantified impacts is summarized in tables found in Appendix C.

6.1.4 Direct and Indirect Environmental Impacts

The environmental impacts of resource portfolios (and of alternative recommendations in Section 8.0) can be either direct or indirect. Direct impacts result from the construction or operation of those specific resources which SCL would either own or contract for, such as a combustion turbine, a wind plant, or SCL's share of the Centralia coal plant. In addition to the more typical definition of indirect environmental impacts—those resulting from the manufacture, transportation, supply or disposal of equipment, supplies, fuel or waste products—they are defined here to include those resulting from energy purchases or displacement which are not based on ownership of or a contract for the output of a particular resource. These include BPA purchases and spot market purchases, as well as resource displacement from SCL's sale of surplus energy or reductions in BPA purchases.

This alternative definition is necessary because it is assumed that while the immediate or direct source of non-SCL power (or displacement) may be a hydroelectric resource, fossil-fuel resources are nearly always the marginal resource due to the fact that regional hydroelectric capability is limited to the amount of water available in a particular year. The purchase of one additional unit of electricity will deplete the finite supply of hydroelectricity and cause a corresponding additional unit of electricity to be generated by a fossil fuel resource at some later time. The significant exception to this is when increased purchases cause the spilling of water past partially loaded hydroelectric generators to be avoided.

6.2 ANALYSIS OF IMPACTS OF RESOURCE PORTFOLIOS

In comparing the portfolios under each of the environmental elements, a four-category system has been used to rate the relative magnitude of impacts. The four categories are the same as those used in ranking the impacts of the individual resource types in Section 4.0: high, high-moderate, moderate, and low. However, in this case (and in the case of the alternative recommendations discussed in Section 8.0) the categories apply to the portfolio as a whole, not the individual resource types of which it is composed. The ranking categories have been assigned based on both the relative significance of the impacts involved and the relative magnitude of the impacts between portfolios. In addition, they are based on both quantified and qualitative estimates of impacts.

6.2.1 Air Quality

Air quality impacts refer to air pollutant emissions resulting from construction and operation of power-generating resources. Construction-related impacts, primarily fugitive dust emissions, can be controlled through good construction practices and are temporary in duration. Construction-related air quality impacts are considered low for all portfolios.

The following section evaluates air emissions by portfolio for the years 2000 and 2010. Assumed heat rates and air pollutant rates (in pounds per million Btu energy content) for portfolio resources are presented in Table 6-5. Air emissions for portfolio resources (in pounds per megawatt-hour) are shown in Table 6-6. The cumulative air emissions by portfolio for 2000 and 2010 are presented in Tables 6-7 and 6-8, respectively. The comparative impact rankings of the portfolios are presented in Figure 6-1.

Figure 6-1. Impact Magnitude—Air Quality

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude						????1/	

Relative impact level: High High-moderate Moderate Low

1/ ???? indicates that impact magnitude is particularly uncertain due to uncertainty of the source of power for the firm purchase resource.

All sources of air emissions, from both proposed and existing energy resources, are assumed to comply with all applicable air quality regulations. Because air discharge permits are based on the physical limitations of the plant, increases in the power generated by a particular facility will not result in violations of the air quality regulations. The relative ranking presented below and in Figure 6-1 is intended to provide a relative comparison of total emissions resulting from a mix of resources. The emissions for the Centralia plant reflect the requirement that the facility reduce its SO_2 and NO_x emissions by the year 2002 and this is primarily responsible for the reduction in SO_2 emissions generally seen for all but the No Action (Spot Market Reliance) and Status Quo portfolios from the year 2000 to 2010. The differences in expected Centralia generation between portfolios is relatively small and does not significantly affect the relative air emissions of the portfolios. Although CO_2 is not a regulated air pollutant, it is included in this analysis because of global warming concerns.

Air emissions are a function of both the mix of resources in each portfolio and their expected operation, given current assumptions about factors such as the cost of resource operation, fossil fuel prices, and spot market sales and purchase prices. A portfolio emphasizing conservation and renewable resources will have less emissions than one which emphasizes fuel-burning technologies. The addition of new gas-fired resources such as combustion turbines is likely to reduce overall emissions by displacing the generation of older, less efficient, and more highly polluting existing plants fired by coal and natural gas. Finally, the tradeoff between spot market purchases and BPA purchases is expected to have little overall impact on resource operation and resulting air emissions, but instead to result primarily in a shifting of energy among parties within the region and the west coast power system in response to broader market conditions and regional hydroelectric availability.

Table 6-5. Air Pollution Assumptions of Alternative Portfolio Resource Types (lb/MMBtu)

Resource Type	Heat Rate (Btu/KWh)	Air Pollutant[1/] (lb/MMBtu)					
		CO_2	NO_x	SO_2	TSP	VOCs	CO
BPA Purchase[2/]	10,000	146.59	0.306	0.295	0.015	0.003	0.043
Centralia[3/]	10,541	220	0.35	0.9	0.04	0.04	0.035
Conservation	N/A	0	0	0	0	0	0
Wind	N/A	0	0	0	0	0	0
Geothermal	20,080	8	0	0	0	0	0
Cogeneration	7,020	115	0.03	0.001	0.005	0.009	0.022
CCCT[4/]	7,520	117.45	0.031	0.011	0.005	0.009	0.022
SCCT[4/]	11,210	117.45	0.089	0.011	0.005	0.009	0.033
Fuel Cells	6,000	115	0.0016	0	0	0	0
Firm Purchase[5/]	11,210	117.45	0.089	0.011	0.005	0.009	0.033
Spot Market Purchases[2/]	10,000	146.59	0.306	0.295	0.015	0.003	0.043
Surplus Sales[2/]	10,000	-146.59	-0.306	-0.295	-0.015	-0.003	-0.043

Source: SCL, Draft Power Options, 1995.

1/ CO_2 = carbon dioxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, TSP = total suspended particulates, VOCs = volatile organic compounds, and CO = carbon monoxide.

2/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.

3/ Assumes reduction in SO_2 and NO_x levels to meet projected requirements under Clean Air Act Amendments.

4/ Assumes operation using 95% natural gas, 5% fuel oil as backup fuel.

5/ Assumes Southwest surplus capacity with emission characteristics equivalent to SCCT fueled by 95% natural gas and 5% fuel oil.

Table 6-6. Air Pollution Assumptions of Alternative Portfolio Resource Types (lb/MWh)[1/]

	Air Pollutant[2/] (lbs/MWh)					
Resource Type	CO_2	NO_x	SO_2	TSP	VOCs	CO
BPA[3/]	1465.9	3.06	2.95	0.145	0.035	0.43
Centralia[4/]	2319	3.69	9.49	0.042	0.421	0.37
Conservation						
Wind	0	0	0	0	0	0
Geothermal	160.6	0	0	0	0	0
Cogeneration	807.3	0.21	0.007	0.063	0.035	0.15
CCCT[5/]	883.2	0.233	0.082	0.067	0.037	0.17
SCCT[5/]	1316.6	0.997	0.123	0.1	0.056	0.37
Fuel Cells	690	0.009	0	0	0	0
Firm Purchase[6/]	1316.6	0.997	0.123	0.1	0.056	0.37
Spot Market Purchases[3/]	1465.9	3.06	2.95	0.145	0.035	0.43
Surplus Sales[3/]	-1465.9	-3.06	-2.95	-0.145	-0.035	-0.43

Source: SCL, Draft Power Options, 1995.

1/ Calculated using heat rate in Btu/KWh and emissions rate in lbs/MMBtu found in Table 6-5.
2/ CO_2 = carbon dioxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, TSP = total suspended particulates, VOCs = volatile organic compounds, and CO = carbon monoxide.
3/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.
4/ Assumes reduction in SO_2 and NO_x levels to meet projected requirements under Clean Air Act Amendments.
5/ Assumes operation using 95% natural gas, 5% fuel oil as backup fuel.
6/ Assumes Southwest surplus capacity with emission characteristics equivalent to SCCT fueled by 95% natural gas and 5% fuel oil.

Table 6-7. Air Emissions for Alternative Portfolios by Air Pollutant, Year 2000[1/]

	Alternative Resource Portfolio, Year 2000 (tons of pollutant)						
Air Pollutant [2/]	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
CO_2	459,073	217,168	366,529	36,966	126,558	422,486	-75,593
NO_x	1,004	296	259	-150	-33	128	-1,605
SO_2	4,964	4,122	4,091	3,714	3,825	3,727	1,975
Particulates	106	72	76	51	59	68	-3
VOCs	8	6	20	2	7	34	42
CO	53	105	-2	-87	-63	24	-160

1/ Air emissions presented in this table are cumulative for each alternative portfolio for six air pollutants. Emissions include those produced by energy resources acquired or purchased as well as the air emission offsets by SCL surplus sales and BPA entitlement resources not purchased.

2/ CO_2 = carbon dioxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, VOCs = volatile organic compounds, and CO = carbon monoxide.

Table 6-8. Air Emissions for Alternative Portfolios by Air Pollutant, Year 2010[1/]

	Alternative Resource Portfolio, Year 2010 (tons of pollutant)						
Air Pollutant[2/]	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.
CO_2	1,968,830	1,499,762	1,506,739	341,112	863,651	1,778,248	1,036,219
NO_x	3,730	2,677	1,213	-501	599	1,213	-851
SO_2	5,552	4,364	2,832	1,255	2,288	2,149	583
Particulates	258	203	157	55	114	149	72
VOCs	43	36	73	6	36	118	96
CO	475	343	250	-91	103	387	70

1/ Air emissions presented in this table are cumulative for each alternative portfolio for six air pollutants. Emissions include those produced by energy resources acquired or purchased as well as the air emission offsets by SCL surplus sales and BPA entitlement resources not purchased.

2/ CO_2 = carbon dioxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, VOCs = volatile organic compounds, and CO = carbon monoxide.

The No Action (Spot Market Reliance) portfolio generally has the highest air emissions for nearly all of the six pollutants in both 2000 and 2010. The Status Quo portfolio, because of its reliance on existing levels of conservation, has somewhat lower levels of emissions, but both portfolios are considered high-moderate in magnitude. Their higher levels of emissions are due to reliance on spot market purchases and BPA purchases, respectively, to meet load growth. Both sources are assumed to be supplied primarily by existing fossil fuel resources including coal and natural-gas fired boilers and natural gas-fired CTs.

The Natural Gas Emphasis, Resource Diversity, and Firm Purchase portfolios have intermediate levels of emissions compared to the other portfolios and are considered of moderate magnitude. Emission levels for these three are lower than the No Action and Status Quo portfolios because new, cleaner resources are developed and displace existing resources with higher emission levels. The Resource Diversity portfolio has generally lower levels than the Natural Gas Emphasis and Firm Purchase portfolios because it includes conservation and renewable resources which the others lack. The analysis of the Firm Purchase resource found in the Firm Purchase portfolio assumes simple-cycle combustion turbine emissions, but there is considerable uncertainty as to the ultimate source of such a contract resource. If it were served by some proportion of existing coal-fired resources in addition to natural-gas resources, then the portfolio's emissions would be higher. On the other hand, they would be lower if the contract resource were served by existing combined-cycle combustion turbines or newly developed gas-fired combustion turbine generation, whether simple- or combined-cycle.

The Less Environmental Impact and BPA Independence portfolios generally have lower emission levels than all of the other portfolios, and both portfolios' impacts are considered of low magnitude. The Less Environmental Impact portfolio's emissions are relatively low because it assumes the highest amounts of conservation and renewable resource development. In 2000, the BPA Independence portfolio assumes both high levels of conservation and a large amount of new resource development to replace existing BPA purchases, which in turn reduces emissions from more polluting existing fossil-fuel resources. In combination, these two factors result in the lowest emissions for all but VOCs in the year 2000. Although no new conservation is assumed for this portfolio beyond 2000, the continued development of new gas-fired generation and a firm purchase contract (again assumed to be gas-fired CTs) maintain relatively low levels of emissions through the year 2010, compared to the other portfolios.

6.2.2 Surface and Groundwater

Construction-related impacts to surface and groundwater quality could occur from the development of any of the generation resources considered in the portfolios. These potential impacts involve degradation of surface water quality from soil erosion and runoff that may occur during construction in proximity to surface drainage systems (e.g., streams). These impacts can be readily mitigated. Although there are potentially greater impacts associated with those portfolios for which new generation resources are developed, construction-related impacts are considered low for all portfolios.

Operations-related impacts could occur to both surface and groundwater quantity and quality, mainly associated with coal-fired plants, gas-fired combined cycle combustion turbine and gas-fired steam plants. These impacts would primarily involve: (1) the depletion of surface and groundwater resulting from the cooling and other water requirements of these plants, and (2) degradation of water quality in the receiving streams from the discharge of process wastewater from these facilities. Indirect impacts to surface and groundwater could occur from coal mining and natural gas extraction activities due to leaching from fly ash and other combustion wastes disposed of in the ground.

Potential impacts among the alternative resource portfolios would differ because of variations in the mix of potentially polluting energy resources. Accurate assessment of potential impacts would require site-specific surface and groundwater data for resources included in each portfolio. However, assuming that environmentally sensitive siting criteria are used and applicable water quality standards are adhered to, impacts to surface and groundwater would generally be considered low or moderate, depending on the mix of resources and their expected operation. The impact magnitude of the portfolios is summarized in Figure 6-2.

Figure 6-2. Impact Magnitude—Surface and Groundwater

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude						????1/	

Relative impact level: High High-moderate Moderate Low

1/ ???? indicates that impact magnitude is particularly uncertain due to uncertainty of the source of power for the firm purchase resource.

Operations-related impacts were quantified using impact multipliers for acre-feet of water consumed per aMW (BPA, 1993), acre-feet of wastewater produced per aMW (Fluor Daniel, 1991), and million British thermal units (MMBtu) of waste heat potentially discharged to surface water (thermal discharge) per aMW (BPA, 1993). The quantified impacts are summarized in Tables 6-9 and 6-10 for the years 2000 and 2010, respectively. The characteristics of the individual resources are discussed in Section 4.0 and the detailed calculations are summarized in Appendix C.

Three portfolios are judged to have moderate rather than low impacts to surface and groundwater: the No Action (Spot Market Reliance), Status Quo, and Natural Gas Emphasis portfolios. The first two rely heavily on purchases from the spot market or BPA, respectively, and the marginal source of this power is assumed to be existing fossil fuel resources with higher water impacts, such as conventional coal plants and southwest natural gas-fired boilers. The Natural Gas Emphasis portfolio relies heavily on new combined-cycle combustion turbine generation and cogeneration facilities, which have higher levels of

Table 6-9. Surface and Groundwater Operation Impacts for Alternative Portfolios, Year 2000

Alternative Portfolio	Water Consumption (acre-feet per year)	Wastewater (acre-feet per year)	Thermal Discharge (MMBtu/year)
No Action	566	82	1,999,090
Status Quo	246	103	302,581
Natural Gas Emphasis	36	62	1,378,562
Less Environmental Impact	60	-54	-704,717
Resource Diversity	145	-21	-118,805
Firm Purchase	98	-28	-439,853
BPA Independence	-324	-73	-1,668,722

Table 6-10. Surface and Groundwater Operation Impacts for Alternative Portfolios, Year 2010

Alternative Portfolio	Water Consumption (acre-feet/year)	Wastewater (acre-feet/year)	Thermal Discharge (MMBtu/year)
No Action	1,829	422	8,646,724
Status Quo	1,359	300	6,199,688
Natural Gas Emphasis	1,345	427	7,980,172
Less Environmental Impact	275	18	591,653
Resource Diversity	751	187	3,696,827
Firm Purchase	584	150	2,477,865
BPA Independence	637	293	4,901,151

water consumption, wastewater and thermal discharge than alternative new resources acquired in the other portfolios.

The Less Environmental Impact and Resource Diversity portfolios are judged to have low impacts. The geothermal resources assumed to be acquired in these portfolios do withdraw significant quantities of hot groundwater and steam and produce wastewater from steam condensate. However, as discussed in Section 4.0, the groundwater that is withdrawn is unlikely to be suitable for other uses such as irrigation and drinking water, and wastewater is assumed to be reinjected into the geothermal reservoir, reducing the potential for impacts to surface water.

The relatively low impacts of the Firm Purchase portfolio is due in large part to the assumption that the energy for the firm purchase contracted resource would be supplied by existing simple-cycle combustion turbines. Because simple-cycle combustion turbines do not use a steam cycle to generate electricity, their water use and wastewater discharge are relatively minor and there is no potential for thermal discharge to surface waters. If the firm purchase contracted resource were supplied by other fossil-fuel resources such as conventional coal plants, natural gas-fired boilers, or combined cycle combustion turbines, the potential impacts could be considerably higher and might warrant a ranking of moderate for this portfolio, as well as BPA Independence portfolio which relies on the firm purchase resource to a lesser extent.

6.2.3 Soils and Geology

The potential impacts to soils and geology from the alternative resource portfolios are described below. Construction-related impacts to soils and geology could occur from the development of any of the resources considered in portfolios. These potential impacts include: (1) possible structural weaknesses or damage that may occur from constructing facilities on steep or unstable slopes, (2) loss of soil from water and wind erosion, and (3) reduced fertility and drainage potential from soil compaction by heavy equipment. Among the portfolios, the potential for impacts would be proportional to the amount of potential land disturbance during development of the selected resources. For example, the amount of land disturbance per MW capacity in the development of a geothermal facility would be greater than a combustion turbine facility, which in turn would be greater than a fuel cell.

Potential operations-related impacts to soils and geology would result mainly from land disturbance associated with the mining of coal and the extraction of gas for use by coal-and gas-fired generation facilities. Impacts would be similar to the potential construction impacts and would include: (1) soil loss from erosion, and (2) loss of soil fertility and drainage potential from soil compaction.

The relative magnitude of anticipated impacts to soils and geology of the alternative portfolios is summarized in Figure 6-3.

Construction- and operations-related impacts have been quantified using multipliers for land effects from construction and operations for the various resources (BPA, 1993), as

Figure 6-3. Impact Magnitude—Soils and Geology

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

discussed in Section 4.0. These quantified impacts are summarized in Tables 6-11 and 6-12 for the years 2000 and 2010, respectively. The calculation of these impacts is summarized in Appendix C. Impacts among the alternative resource portfolios differ because of their variations in the amount of land disturbance that could occur in the mix of energy resources. Accurate assessment of potential impacts would require site-specific soils and geology data and an estimate of the potential land disturbance for each resource developed in each portfolio. Generally, however, use of environmentally sensitive siting criteria and industry standards, and implementation of mitigation measures, would result in low to moderate impacts to soils and geology.

The Less Environmental Impact and Resource Diversity portfolios are judged to have moderate rather than low impacts because of the considerably larger number of acres that potentially would be disturbed or occupied by new resource construction. This is due to the fact that the portfolios include wind resources, which occupy considerably larger areas of land per MW of installed capacity than other generating resource types. In addition, wind resources generally have lower availability factors than other resources due to the intermittent nature of wind, requiring larger amounts of capacity to provide an equivalent amount of energy.

6.2.4 Plants and Animals

As indicated in Figure 6-4, all of the portfolios could potentially result in moderate-level direct or indirect adverse impacts on plants and animals due to construction and/or operation of new and existing resources. Differences in effects between portfolios are likely to occur based on the relative use of different resource types, particularly conservation resources which are expected to have the lowest impact to plants and animals of any alternative resource type. The degree of impact cannot be more accurately determined without site-specific data on occurrence of plants and animals in affected areas.

Potential direct and indirect impacts from all portfolios include possible declines in animal and plant populations due to loss or degradation of habitat from construction of new generation resources, transmission facilities, or natural gas pipelines; degradation of water quality (e.g., thermal and contaminant pollution, particularly relevant to fish); reduction of

Table 6-11. Soils and Geology Impacts of Alternative Portfolios, Year 2000

Alternative Portfolio	Cumulative Construction-Related Impacts (acres)[1/]	Operations-Related Impacts (acres-per-year)[2/]
No Action	0	14
Status Quo	13	8
Natural Gas Emphasis	27	9
Less Environmental Impact	316	5
Resource Diversity	257	6
Firm Purchase	26	7
BPA Independence	54	-5

1/ Includes generating facility, natural gas extraction facility, and pipelines.
2/ Includes annual natural gas extraction and coal mining.

Table 6-12. Soils and Geology Impacts of Alternative Portfolios, Year 2010

Alternative Portfolio	Cumulative Construction-Related Impacts (acres)[1/]	Operations-Related Impacts (acres-per-year)[2/]
No Action	0	38
Status Quo	13	29
Natural Gas Emphasis	68	22
Less Environmental Impact	1,623	7
Resource Diversity	937	15
Firm Purchase	68	17
BPA Independence	96	7

1/ Includes generating facility, natural gas extraction facility, and pipelines.
2/ Includes annual natural gas extraction and coal mining.

Figure 6-4. Impact Magnitude—Plants and Animals

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

natural water flows of rivers or streams as a result of withdrawal for cooling or other uses; air pollution; and potential oil spills. The Less Environmental Impact and Resource Diversity portfolios also have potential impacts from the inclusion of wind and geothermal resources, including bird collisions with wind turbines and potential emission of hydrogen sulfide and other harmful gases from geothermal facilities.

6.2.5 Land Use

The relative magnitude of anticipated impacts to land use of the alternative portfolios is summarized in Figure 6-5.

Figure 6-5. Impact Magnitude—Land Use

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

Construction-related land use impacts could occur from the development of any of the generation resources considered in portfolios. These potential impacts include: (1) temporary and permanent alteration of land use, (2) temporary interference and restriction of land use, and (3) permanent conversion of one land use to another. Among the portfolios, the potential for impacts would be proportional to the amount of land needed for development of the resources. For example, the amount of land required to develop a geothermal facility would be greater than a combustion turbine facility, which in turn would be greater than a fuel cell.

Potential operations-related impacts to land use would primarily be associated with the mining of coal and the extraction of gas and oil for combustion in generation plants. Types of land use impacts related to construction impacts would include temporary and permanent alteration of land use and permanent conversion of land use.

To estimate potential land use impacts, construction- and operations-related impacts have been quantified using impact multipliers for land effects from construction and operations for the various resources (BPA, 1993), presented in Section 4.0 and Appendix C. The results are summarized in Tables 6-13 and 6-14 for the years 2000 and 2010, respectively. Impacts among the alternative resource portfolios differ because of their variations in the amount of land area required for the mix of energy resources. Accurate assessment of potential impacts would require site-specific land use data and an estimate of the potential land areas involved for each resource developed in each portfolio. Generally, however, assuming that environmentally sensitive siting criteria and appropriate mitigation measures are implemented, impacts to land use range from moderate to high-moderate. Although impacts to land use are based in large part on the same quantified measures as those for impacts to soils and geology, impacts to land use are judged to be of generally higher magnitude because they are of a more permanent nature and are not as readily mitigated.

The Less Environmental Impact and Resource Diversity portfolios are judged to have high-moderate rather than moderate impacts because of the considerably larger number of acres that potentially would be disturbed or occupied by new resource construction. This is due to the inclusion of wind resources in the portfolios, which occupy considerably more land per MW of capacity and have lower availability factors than alternative generating resources.

6.2.6 Employment

There would be no adverse impacts to employment from any of the alternative portfolios. However, construction-related employment opportunities would occur from the development of new generation plants as well as from the implementation of additional conservation programs. The generation plants could include simple-cycle combustion turbine and combined-cycle combustion turbine plants, wind and geothermal facilities, and fuel cells. Also, potential operations-related employment opportunities would be available to operate these facilities, mine and extract coal and natural gas, and transport them for use by new coal-and gas-fired generation facilities and fuel cells.

The relative magnitude of potential impacts to employment for the alternative portfolios is summarized in Figure 6-6. Because the employment opportunities of conservation are significantly greater than comparable generation alternatives, those portfolios which include conservation in the mix of new resources are judged to have a moderate beneficial impact on employment.

In the determination of potential construction and operations-related employment opportunities, multipliers for construction and operations presented in Section 4.0 are used

Table 6-13. Land Use Impacts for Alternative Portfolios, Year 2000

Alternative Portfolio	Cumulative Construction-Related Impacts (acres)[1/]	Operations-Related Impacts (acres-per-year)[2/]
No Action	0	14
Status Quo	13	8
Natural Gas Emphasis	27	9
Less Environmental Impact	316	5
Resource Diversity	257	6
Firm Purchase	26	7
BPA Independence	54	-5

1/ Includes generating facility, natural gas extraction facility, and pipelines.
2/ Includes annual natural gas extraction and coal mining.

Table 6-14. Land Use Impacts for Alternative Portfolios, Year 2010

Alternative Portfolio	Cumulative Construction-Related Impacts (acres)[1/]	Operations-Related Impacts (acres-per-year)[2/]
No Action	0	38
Status Quo	13	29
Natural Gas Emphasis	68	22
Less Environmental Impact	1,623	7
Resource Diversity	937	15
Firm Purchase	68	17
BPA Independence	96	7

1/ Includes generating facility, natural gas extraction facility, and pipelines.
2/ Includes annual natural gas extraction and coal mining.

Figure 6-6. Impact Magnitude—Employment

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude		Beneficial		Beneficial	Beneficial		Beneficial

Relative impact level: High High-moderate Moderate Low

to quantify the potential employment opportunities created by the new generation resources. The results are summarized in Tables 6-15 and 6-16 for the years 2000 and 2010, respectively. The calculations are summarized in Appendix C.

6.2.7 Aesthetics and Recreation

Potential construction and operation impacts to aesthetics and recreation resources from the alternative resource portfolios are described below. Construction-related impacts to aesthetics and recreation could occur from the development of any of the resources considered in all portfolios. These potential impacts include: (1) temporary and permanent alteration of natural landscape, (2) construction of visually displeasing structures, (3) creation of dust, (4) encroachment on recreation or aesthetic sites, and (5) temporary or permanent interference and/or restriction of visual and recreation resources. Among the portfolios, the potential for impacts would be proportional to the amount of land required for project development, and the proximity to scenic access, pristine areas, and recreation areas. For instance, the amount of land needed to develop a geothermal facility is greater than the land needed for a combustion turbine facility, and would likely be located in a more remote area, thereby creating potentially greater impacts. Similarly, the land required to site a combustion turbine facility and the size of such generation are significantly greater than the land and plant size for fuel cell generation facilities, thus creating potentially greater impacts.

Operations-related impacts to aesthetics and recreation would include: (1) ongoing visual intrusion in the generation plant vicinity, (2) interference with local and regional scenic visibility due to facility emissions, and (3) the encroachment of natural areas by the development and operation of coal mining and gas extraction.

The relative magnitude of potential impacts to aesthetics and recreation from the alternative portfolios is summarized in Figure 6-7.

In the determination of the relative magnitude of potential aesthetic and recreation impacts, impacts among the alternative resource portfolios differ because of their variations in the extent of visually intrusive structures and the amount of land areas that could be involved in

Table 6-15. Employment Opportunities for Alternative Portfolios, Year 2000

Alternative Portfolio	Cumulative Construction-Related Opportunities (employee-years)[1/]	Operations-Related Opportunities (employees per year)[2/]
No Action	0	0
Status Quo	1,420	10
Natural Gas Emphasis	338	21
Less Environmental Impact	1,638	39
Resource Diversity	1,372	34
Firm Purchase	325	20
BPA Independence	1,939	42

1/ Includes generating facility and installation of conservation measures.
2/ Includes annual natural gas extraction and coal mining.

Table 6-16. Employment Opportunities for Alternative Portfolios, Year 2010

Alternative Portfolio	Cumulative Construction-Related Opportunities (employee-years)[1/]	Operations-Related Opportunities (employees per year)[2/]
No Action	0	0
Status Quo	3,010	10
Natural Gas Emphasis	831	51
Less Environmental Impact	3,982	151
Resource Diversity	3,811	104
Firm Purchase	850	52
BPA Independence	1,933	73

1/ Includes generating facility and installation of conservation measures.
2/ Includes annual natural gas extraction and coal mining.

Figure 6-6. Impact Magnitude—Employment

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude		Beneficial		Beneficial	Beneficial		Beneficial

Relative impact level: High High-moderate Moderate Low

to quantify the potential employment opportunities created by the new generation resources. The results are summarized in Tables 6-15 and 6-16 for the years 2000 and 2010, respectively. The calculations are summarized in Appendix C.

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Operations-related impacts to aesthetics and recreation would include: (1) ongoing visual intrusion in the generation plant vicinity, (2) interference with local and regional scenic visibility due to facility emissions, and (3) the encroachment of natural areas by the development and operation of coal mining and gas extraction.

The relative magnitude of potential impacts to aesthetics and recreation from the alternative portfolios is summarized in Figure 6-7.

In the determination of the relative magnitude of potential aesthetic and recreation impacts, impacts among the alternative resource portfolios differ because of their variations in the extent of visually intrusive structures and the amount of land areas that could be involved in

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Resource Diversity	3,811	104
Firm Purchase	850	52
BPA Independence	1,933	73

1/ Includes generating facility and installation of conservation measures.
2/ Includes annual natural gas extraction and coal mining.

Figure 6-7. Impact Magnitude—Aesthetics and Recreation

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

the mix of energy resources. Accurate assessment of potential impacts would require site-specific information for each resource developed. Generally, however, assuming that visual siting criteria are evaluated during site selection, industry standards are observed, regulatory environmental reviews are conducted, and mitigation measures are implemented, the impacts to aesthetics and recreation could range from moderate to high-moderate. Those portfolios with relatively higher proportions of resources having potentially greater aesthetic impacts (e.g., geothermal, wind) would have correspondingly higher levels of impacts.

6.2.8 Environmental Health (Including Noise)

Potential public health impacts for the various portfolios are discussed below. In general, environmental health risks resulting from construction and operation of power-generating facilities can be significant. Potential impacts from noise, EMF, and accidental release of hazardous substances are direct if SCL builds a plant or contracts services for firm energy; and are indirect if purchased by spot market purchases and regional sales of surplus hydroelectric power. Impacts for the various portfolios will vary but can be kept low for all portfolios through adequate mitigation measures.

The relative magnitude of potential impacts to environmental health from the alternative portfolios is summarized in Figure 6-8.

6.2.9 Cultural and Historical Resources

The following section summarizes the potential impacts to cultural and historical resources from implementation of the various alternative resource portfolios. Cultural and historical resources are defined as non-renewable evidence of human occupation or activity as reflected in any district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature that is important to human history at the national, state, or local level. Such resources are provided special protection under the National Historic Preservation Act, compliance with which is overseen in each state by the State Historic Preservation Office (SHPO). Thus, any federally permitted action involving soil disturbance requires survey and assessment for cultural and historical resources at the affected site prior to ground-disturbing activities.

Figure 6-8. Impact Magnitude—Environmental Health, Including Noise

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

The potential for adverse environmental impacts to cultural and historical resources among portfolios is based on predicted acreages of land disturbance associated with construction of portfolio resources (e.g., Tables 6-11 and 6-12). Land disturbance associated with mining and extraction activities comprise operation impacts. However, assessment of potential impact to cultural and historical resources is associated with the development of the mine, not the operation of the mine. Thus, these are not included in this potential impacts analysis.

Potential effects on cultural and historical resources would be similar across all portfolios for coal-burning emissions that contribute to acid rain, which corrodes metallic and masonry components of buildings and other historic monuments. Such impacts depend on the occurrence and proximity of such resources in affected areas, and a full assessment would require site-specific information. Potential impacts on cultural and historical resources due to coal-burning resources are not analyzed in detail because such differences are considered: (1) much less significant relative to potential direct effects related to land disturbance, and (2) quantification of potential acid rain production is dependent upon the particular size of plants, their location, and surrounding natural features.

In general, to avoid potential impacts to cultural and historical resources, mitigation for all portfolios involving land-disturbing activities would include conducting archaeological and/or historic surveys and consultation with the SHPO. Subsequent mitigation may include detailed documentation of cultural and historical resources and/or relocation of resources. If previously unidentified cultural and historical resources are located after initial surveys, land-disturbing activities would cease and consultation with the SHPO would mitigate potential impacts. These mitigation measures are assumed to apply to all portfolios involving land-disturbing activities as described below.

Figure 6-9 summarizes the relative magnitude of the potential adverse impacts to cultural and historical resources for the alternative portfolios. It is expected that all significant impacts from the development of new energy resources will be able to be avoided or mitigated. However, the Less Environmental Impact and Resource Diversity portfolios have been ranked moderate rather than low because they involve disturbance of considerably

greater land areas than the other portfolios and therefore have a greater potential to impact cultural and historic resources.

Figure 6-9. Impact Magnitude—Cultural and Historical Resources

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

6.2.10 Energy Resources

Potential environmental impacts arise from the consumption of depletable fossil-fuel resources in the generation of electric energy. For example, natural gas is consumed in combustion turbines, cogeneration facilities, gas-fired steam boilers and fuel cells. Coal is consumed to varying degrees in coal-fired generators, including pulverized coal and integrated gasification combined-cycle plants. In addition, fuel oil is often used as a back-up or secondary fuel for natural gas-fired generators. Figure 6-10 summarizes the relative magnitude of the potential adverse impacts to energy resources for the alternative portfolios. These rankings are based on quantitative estimates of the fossil fuels consumed for each of the alternative portfolios, which are summarized in Tables 6-17 and 6-18 for the years 2000 and 2010, respectively. The detailed calculations are found in Appendix C.

Figure 6-10. Impact Magnitude—Energy Resources

Portfolio	No Action (Spot Market)	Status Quo	Natural Gas Emphasis	Less Environmental Impact	Resource Diversity	Firm Purchase	BPA Independence
Impact Magnitude							

Relative impact level: High High-moderate Moderate Low

The Less Environmental Impact and Resource Diversity portfolios have among the lowest estimated consumption of each of natural gas, fuel oil and coal and their impacts are considered of low magnitude. The remaining portfolios are all judged to have moderate impacts to energy resources because they have among the highest consumption of either coal

Table 6-17. Fuel Usages for Alternative Portfolios, Year 2000

	Alternative Resource Portfolio, Year 2000							
Resource	No Action Spot Market	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.	Units
Natural Gas	-1,611,008	-2,984,016	-339,695	-4,488,567	-3,325,065	1,946,628	1,012,418	Thousand cubic ft natural gas per year
Fuel Oil	0	588	1,808	718	1,021	3,226	4,784	Thousand gal backup fuel oil per year
Coal	362,835	243,309	231,199	177,689	193,186	174,892	-94,725	Tons coal per year

Table 6-18. Fuel Usages for Alternative Portfolios, Year 2010

	Alternative Resource Portfolio, Year 2010							
Resource	No Action Spot Market	Status Quo	Natural Gas Emphasis	Less Env. Impact	Resource Diversity	Firm Purchase	BPA Ind.	Units
Natural Gas	9,728,410	6,896,589	13,393,212	-378,387	4,503,843	20,179,042	14,919,792	Thousand cubic ft natural gas per year
Fuel Oil	0	448	3,276	0	1,850	9,303	6,385	Thousand gal backup fuel oil per year
Coal	831,316	650,777	411,121	180,041	332,267	293,779	62,069	Tons coal per year

(No Action and Status Quo) or natural gas (Firm Purchase or BPA Independence) or because they have intermediate levels of consumption of all three fossil fuels (Natural Gas Emphasis).

6.3 ENVIRONMENTAL DISPATCH AS POSSIBLE MITIGATION

During scoping for this EIS, the issue of environmental dispatch was raised as possible mitigation for environmental impacts of resource acquisition decisions. Environmental dispatch is the practice of changing the order in which generating plants' output is increased or decreased based on consideration of their relative environmental impacts, in combination with their operational cost to the utility. Environmental dispatch is an operational issue, addressing how resources are to be operated once they have been constructed. The focus of this EIS is decisions regarding the acquisition of new resources, rather than how resources are to be operated once they have been acquired. However, the following discussion is provided for informational purposes.

Like other utilities, SCL currently operates its existing resources to minimize its cost to meet customer demand, while complying with existing regulatory, negotiated agreement, and license requirements. For SCL, this includes decisions about how to use its nonfirm surplus hydropower, as well as how much energy to purchase from the spot market in order to store water for later energy production, to reduce generation at the Centralia plant, or to displace other sources of supply such as BPA.

Under a policy of environmental dispatch, SCL would dispatch the Centralia plant and use its nonfirm hydropower to reduce operational impacts on the environment. SCL has developed estimates of the external environmental costs of air emissions and land and water impacts of various resource types for use in resource planning (SCL, 1994c). A form of environmental dispatch could be implemented by applying these cost estimates to resource dispatch decisions. SCL would then make decisions about when to run the Centralia coal-fired steam plant and how to dispose of its nonfirm hydropower based on minimizing the total cost to society, including both the utility's and the externality costs. For example, rather than selling its nonfirm hydropower to other utilities in the Northwest or California because it could receive a higher price than the marginal operating cost of Centralia, SCL would use that energy to reduce generation at Centralia instead.

To date there are no proposals to impose environmental dispatch on utilities and power producers in the region or the western U.S., and indeed no agency or body appears to have jurisdiction to do so. In addition, there have been no proposals by other utilities to voluntarily adopt a policy of environmental dispatch. Were SCL to adopt such a policy unilaterally, it is likely that only a small portion of the theoretical environmental benefits would actually be realized.

One of the reasons for this is that SCL's ability to reduce its output from Centralia plant is limited by its contractual obligation to take its share of generation when the plant is running at minimum output. In addition, SCL's decision to significantly reduce its output from the Centralia plant is likely in many circumstances to cause other generation plant owners to

increase their output in response. When the plant is running at less than full capacity, owners have the option of taking more than their equivalent share of energy. SCL is contractually obligated to buy its share of the base coal mined from the Centralia plant coal mine. If SCL were to reduce its annual generation to a level below that of its base coal purchase, it would be forced to sell the excess coal to other owners, perhaps at a discounted price. Because this coal is less expensive than other coal used by the plant, owners may find it economical to operate the plant at higher levels with access to more of the less expensive native Centralia coal.

Beyond the immediate effects of generation at the Centralia plant, other coal plants in the Northwest and western United States would likely respond to the same market conditions and relative prices that SCL would have, absent an environmental dispatch policy. Therefore, they would be expected to increase their generation to make up for SCL's foregone generation not replaced by other Centralia plant owners.

7.0 ALTERNATIVE NEAR-TERM SRA RECOMMENDATIONS

The previous four chapters form the foundation of analysis for the subsequent two chapters in this EIS. These previous chapters described alternative energy resources, seven portfolios of energy resources, and the environmental effects of these alternatives over the long-term planning horizon. The alternative energy resources described were those identified by SCL as being considered for future acquisition. The portfolios of individual resources represent alternative policy choices that would guide SCL's acquisition of individual energy resources in the future. As a reminder, the portfolios included: No Action (spot market purchases), Status Quo, Natural Gas Emphasis, Less Environmental Impact, Resource Diversity, Firm Purchase, and BPA Independence.

In contrast, this chapter describes four alternative courses of action that could guide the near-term acquisition of energy resources over the next two to five years. The specific courses of action are evaluated in detail in SCL's Draft Strategic Resources Assessment (1996). None of these alternatives directly corresponds to any of the resource portfolios described earlier, but they are similar in that they are made up of several types of energy resources that could be acquired to meet the anticipated energy demand. As such, they represent a likely range of alternative choices available to SCL to alter its current portfolio of acquired energy resources in the near term.

7.1 STRATEGIC RESOURCES ASSESSMENT POLICY CHOICES

SCL's current Strategic Resources Assessment (SRA) process is focusing on four specific policy issues of immediate interest to the utility and city decision-makers:

- Level of continued conservation acquisition;
- Level of reliance on the Bonneville Power Administration;
- Acquisition of a dispatchable resource or its contractual equivalent; and
- Consideration of environmental externalities in resource acquisition decisions.

Each of these issues is discussed briefly below, followed by a summary of the four alternative sets of recommendations. The four alternatives, which represent combinations of recommendations for three of the four policy issues, are intended to bracket the likely outcome of the final SRA recommendations. The environmental analysis found in the following chapter focuses on the year 1998 to represent the near-term environmental impacts of the recommendations.

7.1.1 Conservation Acquisition

SCL is now in the third year of implementing the 1992 Conservation Implementation Plan (CIP). In accordance with the recommendations from the 1992 Energy Resources Strategy (SCL, 1992), the CIP calls for SCL to conserve about 100 aMW of energy through 2003,

enough conservation to serve the utility's projected load growth over that same period. One of the plan's key assumptions was the continued availability of conservation funding from BPA. Until recently, BPA funded approximately two-thirds of the cost of SCL's conservation programs.

Significant changes in several areas have led SCL to reassess its conservation goals. The most important is BPA's decision to cease conservation funding to utilities, including SCL, beginning October 1, 1995. In addition, natural gas prices have dropped significantly over the last several years. As a result, the avoided cost of power has declined and with it the projected value of conservation savings.

Two conservation levels are included in the alternative recommendations:

- Continuation of current planned acquisition levels (approximately 9 aMW in 1996, declining to 7 aMW in 2000).
- Approximately 60 percent of current planned levels (approximately 6 aMW in 1996, declining to 4.5 aMW in 2000).

7.1.2 BPA Reliance

BPA faces significant challenges and has proposed sweeping changes in the way it sells power, in its rate structure, and in its contracts with its utility customers. Many of these changes remain uncertain at this time, but they may cause SCL to limit its purchases from BPA. Examples include a general increase in BPA prices or a substantial increase in the availability charge, which is the amount SCL must pay for the right to purchase a unit of power from BPA, whether or not the power is actually taken. This analysis assumes that SCL will no longer be able to rely on BPA to meet its load growth and to provide its load/resource balance, as BPA has been obligated to do under SCL's existing power sales contact.

The alternative recommendations consider two levels of future energy purchases from BPA:

- SCL's 1994 entitlement from BPA, approximately 220 aMW; and
- Half that amount, or 110 aMW.

7.1.3 Gas-Fired Dispatchable Resource

Dispatchable resources, including combustion turbines and fuel cells, are those that can be turned on and off on short notice (including combustion turbines and fuel cells). Fuel cells, however, are not expected to be commercially available or cost-effective in the next several years. In its 1990 Strategic Corporate Plan (SCL, 1990) and the 1992 Energy Resources Strategy (SCL, 1992), SCL recommended acquiring the services of a combustion turbine to complement its hydroelectric resource base. To date, there has been no final decision on whether SCL should proceed to acquire such services. In July 1995, SCL issued a final environmental impact statement addressing the impacts of building and where to site a

combustion turbine and the option of contracting for the output of a combustion turbine to provide equivalent services (SCL, 1995a).

A dispatchable resource is attractive to SCL because it would fit well with its hydroelectric-dominated system. Hydroelectric resources, particularly run-of-river ones such as SCL's Boundary project, are highly variable in their output. Dispatchable resources could be operated to compensate for this variability, thus allowing for more of the hydroelectric project's output to be considered firm. This concept is called firming of nonfirm energy. A dispatchable resource could also supplement increased reliance on the spot market, as well as provide capacity to help meet peak loads. Dispatchable resources such as combustion turbines have low fixed costs compared to baseload resources, an important consideration for resources that in some years may run very little or not at all.

SCL could acquire a dispatchable resource by either building and owning the resource or by contracting with another party for the equivalent services. A contract could be for the output of a particular dispatchable resource, or the source of the power may not be known, such as from a system sale. This analysis assumes the services of a dispatchable resource would be acquired through a contract and that the ultimate source of the power would be a simple-cycle combustion turbine.

For each of the four alternative sets of recommendations, a potentially desirable amount of dispatchable resources was determined using SCL's Integrated Planning Model. To start, the two options for each of the conservation and BPA issues were combined into four possible combinations. Each combination was then used as an initial set of assumptions for the model, which determined the least cost mix of resource options to meet load, including level of dispatchable acquisition and spot market purchases.

7.1.4 Environmental Externalities in Resource Acquisition

Environmental externalities refer to the societal costs of environmental impacts that are not borne by the producers of a product and therefore are not reflected in the product's price. SCL has incorporated a set of externality costs for use in resource planning (SCL, 1994c). Their inclusion in the economic evaluation of resource options allows consideration of a societal perspective.

Environmental externalities were not used explicitly in developing the alternative sets of SRA recommendations analyzed in Section 8.0. However, their inclusion in resource acquisition decisions are likely to favor higher levels of conservation acquisition, as conservation has the lowest environmental externality costs of any alternative resource.

7.2 SUMMARY OF ALTERNATIVE SRA RECOMMENDATIONS

The following table presents the four alternative sets of recommendations analyzed in this draft EIS. As described above, the alternatives were constructed by combining each of the two alternative recommendations for the conservation and BPA reliance issues into four possible combinations. A desirable quantity of dispatchable resource (in MW of capacity)

was then determined for each combination of conservation and BPA, using SCL's Integrated Planning Model. The alternatives, labeled as A through D, are presented in order of increasing need for additional resources. The need for additional resources is created by both the base case forecasted load growth and the reductions in conservation levels or BPA entitlement assumed in the alternatives. The base case forecast was used for analysis of the alternative recommendations because it is expected that the actual resource decisions arising from the SRA will rely on the base case forecast. There is a relatively small risk of it being significantly wrong in the near-term.

Table 7-1. Resources Assumed for Alternative SRA Recommendations, Year 1998

	SRA Issues[1/]		
SRA Recommendation	Conservation	BPA Purchases	Dispatchable Resources[2/]
Alternative A	100% of current planned levels[3/]	100% of 1994 entitlement (220 aMW)	None
Alternative B	60% of current planned levels[4/]	100% of 1994 entitlement (220 aMW)	None
Alternative C	100% of current planned levels[3/]	50% of 1994 entitlement (110 aMW)	55 MW
Alternative D	60% of current planned levels[4/]	50% of 1994 entitlement (110 aMW)	65 MW

1/ Acquisition of energy resources through conservation, BPA purchases, and dispatchable resources are the near-term strategic resource planning issues facing SCL. Spot market purchases also are assumed to be available for each alternative to meet demand.
2/ Contract for services of a simple-cycle combustion turbine (SCCT); capacity given is the maximum assumed to be contracted for.
3/ Assumes approximately 9 aMW in 1996, declining to 7 aMW in 2000.
4/ Assumes approximately 6 aMW in 1996, declining to 4.5 aMW in 2000.

7.3 PREFERRED ALTERNATIVE

Based on the recommendations found in the Draft Strategic Resources Assessment, SCL's preferred alternative is closest to Alternative D above and consists of the following response to each of the four policy issues:

- Conservation acquisition: reduce planned acquisition level to somewhere between five and seven aMW per year by 1999 (from former planned levels of approximately 10 aMW).
- BPA purchase level: continue to purchase at least 100 aMW from BPA (approximately 50 percent of 1994 entitlement) as long as BPA rates and contract terms are reasonable and replace remaining BPA purchases with nonfirm hydroelectric energy and increased reliance on spot market purchases.
- Gas-fired dispatchable resource: depending on the outcome of BPA contract negotiations, consider a short-term contract for dispatchable energy of an undetermined amount to supplement spot market purchases.
- Environmental externalities: include externalities when making resource decisions.

8.0 ENVIRONMENTAL IMPACTS OF AND MITIGATION FOR ALTERNATIVE SRA RECOMMENDATIONS

8.1 ENVIRONMENTAL IMPACTS ASSOCIATED WITH SRA ISSUES

The following section discusses the potential changes in generation patterns and resulting environmental impacts associated with each of the four SRA issue areas in isolation. It is followed by an analysis of the impacts of the four SRA recommendation alternatives, which integrate the four issues into alternative sets of recommendations SCL might consider.

8.1.1 Conservation Acquisition

Reducing SCL's level of conservation from previously planned levels is likely to result in an increase in the electricity produced by fossil-fueled generating plants and a corresponding increase in their operational environmental impacts. These include emissions of air pollutants such as nitrogen oxides, sulfur oxides, and particulates; emissions of carbon dioxide, a greenhouse gas contributing to the potential for global climate change; water consumption and the discharge of wastewater and waste heat into the environment; and increased consumption of fossil fuels and corresponding fuel extraction and transportation impacts.

The fossil-fueled generating plants that would be expected to run more to make up for lower conservation savings could include SCL's share of the Centralia coal plant and existing coal- and natural gas-fired plants in the Northwest and western U.S. SCL could enter into a firm contract for the necessary power, in which case the relative impacts would depend on the type of resource supplying the power. If SCL were to construct or contract for the output of a new natural gas-fired combustion turbine, there would be additional construction-related impacts but the operational impacts, particularly air emissions, would expected to be lower than existing generating plants because of higher efficiencies and more stringent emission control requirements associated with new generating plants. If SCL were to rely on increased spot market purchases to replace conservation, there would be considerable uncertainty regarding the ultimate source of power and its associated impacts, although it would be expected to be from existing coal and gas-fired generating plants. The amount Centralia was used would continue to depend on its operating cost in relation to alternative sources including the spot market and BPA.

8.1.2 Level of BPA Power Purchases

The environmental impacts of differing levels of BPA purchases depend in large part on the source of power that SCL would rely on in place of BPA. BPA obtains the power it sells to its preference public power customers, such as SCL, from a variety of sources, but the great majority comes from the federal hydroelectric system on the Columbia River system. However, within the context of the regional and west coast power system in which BPA and SCL operate, fossil-fuel generating resources are typically on the margin, that is, it is their output which varies to respond to changes in demand.

Until recently, it appeared likely that new demand placed on BPA by utilities such as SCL would be met by BPA contracting for the output of new combined-cycle combustion turbines. However, BPA's recent loss of direct service industry and public utility load and its decision to cancel its contract for the output of the Tenaska II combustion turbine project call this assumption into question. Instead, it appears that BPA is planning to rely on seasonal spot market purchases to supplement its existing resources.

As a result, increases or decreases in SCL's BPA purchase levels are likely to cause corresponding increases or decreases, respectively, of fossil-fueled generation serving the spot market in the Pacific Northwest or western U.S, either directly or indirectly. This effect could occur directly if BPA must increase its spot market purchases to meet SCL's demand, or indirectly if BPA would otherwise sell the power purchased by SCL and as a result displace fossil fuel resources operating on the margin. The source of spot market generation is uncertain but could be either coal- or natural gas-fired plants, depending on what resources are operating on the margin. (To the extent that increased spot market purchases occur at a time when water would otherwise be spilled past hydroelectric generators because water flows exceed generation capacity, then there would be no corresponding increase in the operation of fossil-fuel plants). Therefore, if SCL decreases its existing BPA purchase levels, the net environmental impact would depend on how the source of replacement power compares to an uncertain mix of existing fossil-fuel plants, including both coal and natural gas.

If the replacement power is provided by a firm contract for an existing natural gas-fired resource, such as a combustion turbine, overall impacts would likely be lower than continued BPA purchases because of the avoidance of coal-fired generation. (However, this difference would be lessened to the extent the contracted resource would otherwise have been used to sell to the spot market.) If SCL constructs or contracts for the output of a new natural gas-fired combustion turbine, there would be additional construction-related impacts but the operational impacts, particularly air emissions, would be lower because of higher efficiencies and more stringent emission control requirements. If SCL relies on increased spot market purchases to replace existing levels of BPA purchases, then there likely would be little or no net effect on the operation of fossil-fuel plants in the western U.S. and no associated significant environmental impacts. However, increasing reliance on spot market purchases may increase SCL's risk that it would not have adequate power supplies in the future as energy resources would no longer be either owned by SCL or under long-term contract with the utility.

8.1.3 Gas-Fired Dispatchable Resource

The main reason SCL would contract for the services of a gas-fired dispatchable resource (such as a simple-cycle combustion turbine) is as a backup resource so that SCL could make greater use of its own nonfirm hydropower production to reliably serve its own load. Under the concept of "firming nonfirm," SCL could assume for planning purposes that a portion of its nonfirm hydropower is firm energy as long as the utility has another resource available to substitute for the hydropower during low water conditions.

The potential environmental impacts of contracting for the services of a dispatchable resource, likely a simple-cycle combustion turbine, are expected to be minor and result from two primary factors: (1) the shift in disposition in SCL's nonfirm hydropower, and (2) the expected operation of the dispatchable resource compared to the resource(s) that would have operated otherwise.

The shift in SCL's nonfirm hydropower is expected to result in little change in resource operations and associated environmental impacts. Rather than selling its nonfirm hydropower and displacing others' marginal fossil fuel resources, SCL would use the nonfirm to serve its own load and likely reduce its purchases from BPA and the spot market, which would be expected to result in very similar patterns of resource displacement and little net change in environmental impacts.

Regarding the operation of the dispatchable resource, there could be a net decrease in fossil-fuel generation and associated impacts under two circumstances. The first is if SCL's contract and the operation of the dispatchable resource, assumed to be a simple-cycle combustion turbine, resulted in a net decrease in coal-fired generation. This could occur if SCL relied on power from the dispatchable resource when others would have purchased coal-fired generation instead, for example, through spot market purchases. This is unlikely to occur frequently, because SCL would be relying on the dispatchable resource during periods of low water conditions when regional coal plants likely would be operated at full capacity and more expensive gas-fired plants would be the marginal resource. The other circumstance is if SCL contracted for the development of a new dispatchable resource, which would be more efficient and would have to meet more stringent pollution control requirements than existing plants.

8.1.4 Environmental Externalities

Environmental externalities refer to the societal costs of environmental impacts which are not borne by the producers of a product and therefore are not reflected in product prices. SCL has recommended a set of externality cost adders for use in resource planning (SCL, 1994c and SCL, 1996). Their inclusion in the economic evaluation of resource options allows for the consideration of a societal perspective when determining the relative cost-effectiveness of alternative resources.

The potential environmental impacts of including externalities in resource decisions arise from their effect on the outcome of the other three policy issues discussed above. In this context, their effect would be limited primarily to favoring higher levels of conservation and therefore reducing the impacts associated with construction and operation of generating resources. Conservation is assumed to have an externality cost of zero, consistent with its having the fewest impacts of any alternative resource type.

The consideration of environmental externalities is likely to have little potential effect on decisions regarding the other two issues, BPA purchase levels and contracting for a dispatchable resource, because the alternatives result in a relatively small range of potential environmental impacts and associated externality costs.

8.2 FRAMEWORK FOR ANALYSIS OF ENVIRONMENTAL IMPACTS OF ALTERNATIVE SRA RECOMMENDATIONS

As with the alternative portfolios discussed in Sections 5.0 and 6.0, analysis of the environmental impacts of the near-term alternative SRA recommendations requires estimates of the electricity generation from both new and existing resources whose output is expected to vary between alternatives. Of SCL's existing owned resources, only production from Centralia is expected to vary between the alternatives. The output of SCL's hydroelectric system and the amount of power purchased through existing long-term contracts (other than BPA) are assumed to remain constant across the alternatives for any particular year. Changes in the amount of power produced by resources owned or controlled by others can result from SCL purchasing electricity on the spot market, selling its own surplus electricity, and varying the amount of BPA purchases. See Section 6.1 for a more detailed discussion of analytical assumptions and modeling used in this analysis.

SCL assumes that no new energy facilities will be constructed within the short-term planning horizon of the SRA and generation plants currently under construction were planned, designed, and permitted without specific purchase commitments from SCL. Thus, the analysis of potential environmental impacts of these alternatives does not include any discussion of direct or indirect construction impacts. Rather, potential environmental impacts would occur solely from direct and indirect operational impacts.

This analysis focuses on the year 1998 to represent the near-term environmental impacts of the alternative SRA recommendations. As described in Section 7.0, SCL has developed four sets of alternative SRA recommendations to satisfy the expected need for energy under the base case load forecast. The anticipated generation of individual resources for each alternative is summarized in Table 8-1 and described below. For analysis of each of the alternatives, the level of conservation acquisition, BPA entitlement and available capacity of dispatchable resource were set as assumptions. SCL's Integrated Planning Model then determined the expected levels of BPA purchases, operation of Centralia and the dispatchable resource, spot market purchases, and surplus sales.

As with the alternative portfolios, the source of electricity and the displaced resources are uncertain for spot market purchases, changes in BPA purchases, and surplus sales. For this analysis, though, SCL has made specific assumptions regarding the mix of spot market resources, described in footnote 1 of Table 8-1.

Alternative A

This alternative relies on existing planned conservation levels of 26 aMW through 1998. BPA purchases are estimated at 134 aMW out of an assumed entitlement of 220 aMW. SCL's share of Centralia generation is estimated at 78 aMW, spot market purchases at 78 aMW, and surplus sales at 147 aMW. A dispatchable resource is not acquired under this alternative.

Table 8-1. Generation by Resource Type for Alternative SRA Recommendations, Year 1998

	Alternative SRA Recommendations, Year 1998 (aMW)			
Resource Type	Alternative A	Alternative B	Alternative C	Alternative D
BPA Purchase[1/]	134	137	78	79
Not Purchased[1/]	*(86)*	*(83)*	*(142)*	*(141)*
Centralia	78	78	79	79
Conservation	26[2/]	19[3/]	26[2/]	19[3/]
Dispatchable Resource[4/]	0	0	17	20
Spot Market Purchases[1/]	78	80	102	103
Total Energy	316	314	302	300
Surplus Sales[1/]	147	145	134	131

1/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.

2/ Assumes conservation continues at current planned acquisition levels (9 aMW in 1996, declining to 7 aMW in 2000).

3/ Assumes conservation continues at approximately 60% of current planned acquisition levels (6 aMW in 1996, declining to 4.5 aMW in 2000).

4/ Assumes simple-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

This alternative does not exactly correspond with any one of the alternative long-term portfolios described in Chapters 5 and 6, although it is similar to both the Status Quo and Less Environmental Impact portfolios in its maintenance of existing conservation levels and to the Less Environmental Impact portfolio in the continuation of the level of entitlement to BPA purchases. It is also similar to the No Action portfolio with the absence of a dispatchable resource.

Alternative B

This alternative assumes a reduction in conservation acquisition to approximately 19 aMW through 1998. BPA purchases are estimated at 137 aMW out of an assumed entitlement of 220 aMW. SCL's share of Centralia generation is estimated at 78 aMW, spot market purchases at 80 aMW, and surplus sales at 145 aMW. A dispatchable resource is not acquired under this alternative.

As with Alternative B, this alternative does not exactly correspond with any one of the long-term alternative portfolios. However, it is similar to the Resource Diversity portfolio

in its reduction in currently planned conservation levels and continuation of current entitlement for BPA purchases. Like Alternative A, it is similar to the No Action portfolio in the absence of a dispatchable resource.

Alternative C

This alternative relies on existing planned conservation levels of 26 aMW through 1998. BPA purchases are significantly lower than Alternatives A and B as a result of reduced BPA entitlement; BPA purchases are estimated at 78 aMW out of an assumed entitlement of 110 aMW. SCL's share of Centralia plant generation is estimated at 79 aMW, essentially the same as the previous two alternatives, while spot market purchases increase to 102 aMW. The dispatchable resource with a capacity of 55 MW is estimated to produce 17 aMW. Surplus sales decline somewhat compared to Alternatives A and B to 134 aMW.

As with the previous alternatives, this alternative does not exactly correspond with any one of the long-term alternative portfolios. It is similar to both the Status Quo and Less Environmental Impact portfolios in its maintenance of existing conservation levels and the acquisition of a dispatchable resource. It is also similar to the BPA Independence portfolio in its reduction in the level of BPA entitlement.

Alternative D

This alternative assumes a reduction in conservation acquisition to approximately 19 aMW through 1998. BPA purchases are similar to Alternative C and are estimated at 79 aMW out of an assumed entitlement of 110 aMW. SCL's share of Centralia plant generation is estimated at 79 aMW, the same as Alternative C. Spot market purchases are also very similar to Alternative C at 103 aMW. The dispatchable resource with a capacity of 65 MW is estimated to produce 20 aMW. Surplus sales are slightly lower than Alternative C at 131 aMW.

As with the previous alternatives, this alternative does not exactly correspond with any one of the long-term alternative portfolios. However, it is similar to the Resource Diversity portfolio in its reduction in currently planned conservation levels and the acquisition of a dispatchable resource, and it is similar to the BPA Independence portfolio in its reduction in the level of BPA entitlement.

8.3 ANALYSIS OF IMPACTS AND MITIGATION FOR ALTERNATIVE SRA RECOMMENDATIONS

In comparing the alternatives under each of the environmental elements, a four-category system has been used to rate the relative magnitude of impacts. The four categories are the same as those used in ranking the impacts of the individual resource types in Section 4.0 and the alternative long-term portfolios in Section 6.0: high, high-moderate, moderate, and low. As with the alternative portfolios, the categories apply to the alternative recommendation as a whole, not the individual resource types of which it is composed. The ranking categories have been assigned based on both the relative significance of the impacts

involved and the relative magnitude of the impacts between portfolios. In addition, they are based on both quantified and qualitative estimates of impacts.

8.3.1 Air Quality

The SRA alternatives represent combinations of policy recommendations regarding the acquisition of power generating resources. No new construction is planned for the SRA alternatives. All air quality impacts would be related to the operation of existing power generation equipment.

Figure 8-1 summarizes the relative impact magnitude of each of the four alternative recommendations. Air emissions accounted for in this analysis include those from the operation of SCL's share of the Centralia coal-fired plant, the contracted dispatchable resource, spot market purchases, and displacement of generating plants from SCL's surplus sales and from reductions in BPA purchase levels. Air emissions (in lb/MWh) for the various resources are presented in Table 6-6. The dispatchable resource is assumed to have the emission characteristics of a simple-cycle combustion turbine. The estimated air emissions for each of the alternatives for the year 1998 are presented in Table 8-2. The calculations underlying these totals are summarized in Appendix C.

Figure 8-1. Impact Magnitude—Air Quality

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High High-moderate Moderate Low

All sources of air emissions are assumed to comply with all applicable air quality regulations. Because air discharge permits are based on the physical limitations of the plant, increases in the power generated by a particular facility would not result in violations of the air quality regulations.

The differences in air emission between alternatives is primarily due to two factors. The first is conservation. Alternatives A and C, which both have higher levels of conservation, have correspondingly lower levels of air emissions than Alternatives B and D, respectively.

The second factor is the availability of a contracted dispatchable resource, assumed to be a simple-cycle combustion turbine. When available, this resource has the effect of substituting gas-fired generation for spot market and BPA purchases, which are assumed to be a combination of coal- and gas-fired generation on the margin. As a result, Alternatives C and D, which have a dispatchable resource available, have lower emissions than A and B,

Table 8-2. Air Emissions for Alternative SRA Recommendations by Air Pollutant, Year 1998[1/]

	Alternative SRA Recommendations, Year 1998 (tons of pollutant)			
Air Pollutant[2/]	Alternative A	Alternative B	Alternative C	Alternative D
CO_2	-205,986	-159,665	-215,952	-172,799
NO_x	-464	-367	-612	-547
SO_2	4,092	4,197	3,953	4,009
Particulates	45	49	39	43
VOCs	-22	-21	-21	-19
CO	-165	-152	-171	-158

1/ Air emissions in this table are cumulative for each alternative SRA recommendation for CO_2 and five air pollutants. Emissions include those produced by energy resources acquired or purchased as well as the air emission offsets by SCL surplus sales and BPA entitlement resources not purchased.

2/ CO_2 = carbon dioxide, NO_x = nitrogen oxides, SO_2 = sulfur dioxide, VOCs = volatile organic compounds, and CO = carbon monoxide.

respectively. This is due to the substitution of less-polluting gas-fired generation for some amount of coal-fired generation from BPA and/or the spot market.

The amount of energy provided by the dispatchable resource (17 and 20 aMW for Alternatives C and D, respectively) is considerably greater than the difference in conservation levels for the alternatives (7 aMW). As a result, the emission reductions from the availability of a dispatchable resource are larger than those from higher conservation levels. Alternative C, which has both the higher conservation level and a dispatchable resource, has the lowest air emissions for all of the pollutants except VOCs and its relative air impacts are considered of low magnitude. (VOC emissions tend to be higher for gas-fired resources than for coal-fired ones, so emission trends for this pollutant generally move in the opposite direction from the others.) Alternative B, on the other hand, has lower conservation and no dispatchable resource and so has the highest air emission levels (again, for all but VOCs) and is judged high-moderate. Air emissions from Alternatives A and D lie between the other two and are considered moderate.

The differences in expected Centralia generation between alternatives is relatively small and does not significantly affect the relative air emissions of the portfolios. Finally, the tradeoff between spot market purchases and BPA purchases is expected to have little overall impact on resource operation and resulting air emissions. Instead, it likely results primarily in a shifting of energy among parties within the region and the west coast power system in response to broader market conditions and regional hydroelectric availability.

8.3.2 Surface and Groundwater

Operations-related impacts could occur to both surface and groundwater quantity and quality, mainly associated with fossil-fuel resources including coal plants and gas-fired generating facilities. These impacts would primarily involve: (1) the depletion of surface and groundwater resulting from the cooling water requirements of these plants, (2) degradation of water quality from the discharge of wastewater, and (3) the discharge of waste heat (thermal discharge) to surface waters.

Figure 8-2 summarizes the relative impact magnitude to surface and groundwater of the alternative recommendations. As with air emissions, higher levels of conservation and the presence of a dispatchable resource both result in reduced impacts. Conservation avoids the water impacts associated with fossil-fuel generation. Energy from the dispatchable resource (assumed to be a simple-cycle combustion turbine) substitutes for some amount of higher-impact coal-fired generation from spot market and BPA purchases. Again as with air emissions, the presence of a dispatchable resource in Alternatives C and D reduces the amount of surface and groundwater impacts more than conservation does because of the greater amount of energy involved. If the dispatchable resource were a combined-cycle rather than a simple-cycle combustion turbine, there would be less of a difference between the alternatives due to the higher water-related impacts from the combined-cycle technology, which result from water consumption, wastewater discharge, and thermal discharge from the steam cycle.

Figure 8-2. Impact Magnitude—Surface and Groundwater

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High, High-moderate, Moderate, Low

In evaluating the potential surface and groundwater impacts for the SRA alternatives, operations-related impacts were quantified using impact multipliers for water consumption, wastewater discharge, and thermal discharge presented in Section 4.0 and Appendix C.

Table 8-3 compares the quantified potential impacts to surface and groundwater for the four alternative SRA recommendations.

8.3.3 Soils and Geology

The potential impacts to soils and geology from the SRA alternatives are described below. Potential operations-related impacts could occur to soils, mainly from land disturbance

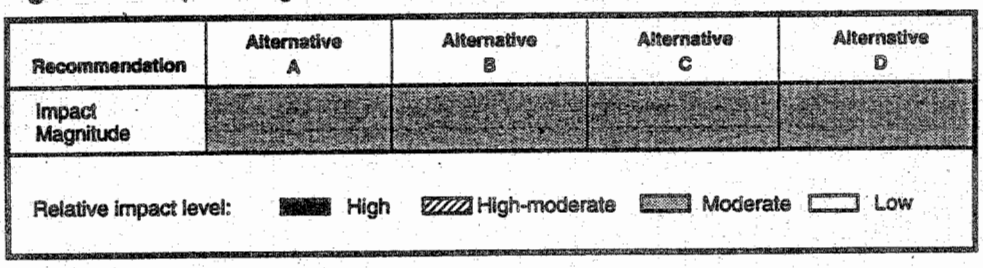
Table 8-3. Comparison of Potential Surface and Groundwater Impacts for Alternative SRA Recommendations, Year 1998

SRA Recommendation	Water Consumption (acre-feet per year)	Wastewater (acre-feet per year)	Thermal Discharge (MMBtu per year)
Alternative A	-10	-86	-1,219,696
Alternative B	30	-75	-1,009,983
Alternative C	-95	-109	-1,701,253
Alternative D	-74	-103	-1,592,021

associated with the mining of coal and the extraction of natural gas for use by coal- and gas-fired generating resources. Impacts would include: (1) soil loss and possible surface water contamination from erosion, and (2) loss of soil fertility and drainage potential from the compaction of soils by heavy vehicles.

Figure 8-3 summarizes the relative magnitude of potential impacts to soils and geology of the alternative recommendations. The differences between alternatives is minor and all are considered to have impacts of moderate magnitude.

Figure 8-3. Impact Magnitude—Soils and Geology



In evaluating the potential impacts from the alternative SRA recommendations, operations-related soils impacts have been quantified for land effects from operations for the various resources, as presented in Section 4.0 and Appendix C. Impacts among the alternative SRA recommendations differ because of their variations in the amount of land disturbance that could occur in the mix of energy resources.

Table 8-4 presents the quantified estimates of land disturbance for each of the alternatives. As with air emissions, higher levels of conservation and the presence of a dispatchable resource both result in reduced impacts. Conservation avoids the land disturbance associated with fossil-fuel generation. Energy from the dispatchable resource (assumed to be a simple-cycle combustion turbine) substitutes for some amount of higher-impact coal-fired generation from spot market and BPA purchases. Again as with air emissions, the

presence of a dispatchable resource reduces the amount of land-disturbance impacts more than conservation does because of the greater amount of energy involved.

Table 8-4. Impacts to Soils and Geology for SRA Alternative Recommendations, Year 1998

SRA Recommendation	Operations-Related Impacts (acres per year)[1/]
Alternative A	3.7
Alternative B	4.4
Alternative C	2.5
Alternative D	3.0

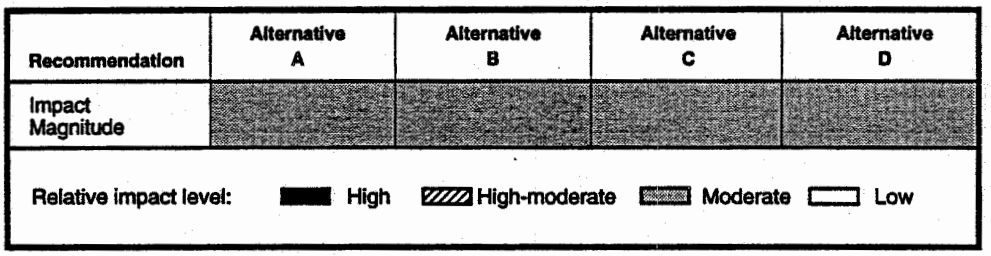
1/ Includes annual natural gas extraction and coal mining.

8.3.4 Plants and Animals

The following section summarizes the predicted qualitative potential impacts to plants and animals from implementation of the four alternative SRA recommendations. In general, all four alternatives rely on existing coal-fired and gas-fired energy resources. Thus, potential effects on plants and animals would be associated with the operation of existing fossil-fuel power plants. Differences in effects among alternatives would occur based on relative use of conservation and fossil-fuel resources. These differences appear to be relatively small. In general, all four alternatives could potentially result in indirect, moderate-level operational effects on plants and animals from operation of existing resources.

Figure 8-4 summarizes the relative magnitude of potential impacts to plants and animals of the alternative SRA recommendations.

Figure 8-4. Impact Magnitude—Plants and Animals



Potential effects due to power plant operation include possible declines in animal and plant populations due to lost or degraded habitats, depending on the occurrence of such species in affected areas. Habitat or individuals could be affected primarily by degradation of water quality (e.g., thermal and contaminant pollution, particularly relevant to fish), reduction of natural water flows of rivers or streams as a result of withdrawal for cooling or other uses, air pollution, and potential oil spills.

8.3.5 Land Use

Potential operations-related land use impacts could occur, mainly from land disturbance associated with the mining of coal and the extraction of gas for use by coal- and gas-fired generating resource. Impacts would include temporary and permanent alteration of land use and permanent conversion of land.

Figure 8-5 summarizes the relative magnitude of potential impacts to land use of the alternative recommendations. The differences between alternatives are minor and all are considered to have impacts of moderate magnitude.

Figure 8-5. Impact Magnitude—Land Use

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High, High-moderate, Moderate, Low

In evaluating potential impacts from the alternative SRA recommendations, operations-related land use impacts have been quantified using multipliers for land effects from operations for the various resources, as presented in Section 4.0 and Appendix C. Impacts among the alternative SRA recommendations differ because of variations in the amount of land disturbance.

Table 8-5 presents the quantified estimates of land disturbance for each of the alternatives. As with air emissions, higher levels of conservation and the presence of a dispatchable resource both result in reduced impacts. Conservation avoids the land disturbance associated with fossil-fuel generation. Energy from the dispatchable resource (assumed to be a simple-cycle combustion turbine) substitutes for some amount of higher-impact coal-fired generation from spot market and BPA purchases. Again as with air emissions, the presence of a dispatchable resource reduces the amount of land-disturbance impacts more than conservation does because of the greater amount of energy involved.

Table 8-5. Land Use Impacts for Alternative SRA Recommendations, Year 1998

SRA Recommendation	Operations-Related Impacts (acres per year)[1/]
Alternative A	3.7
Alternative B	4.4
Alternative C	2.5
Alternative D	3.0

1/ Includes annual natural gas extraction and coal mining.

8.3.6 Employment

There would be no significant adverse environmental impacts on employment for 1998 from any of the alternative SRA recommendations. No new construction is assumed in the near future resulting from SCL actions, and no new construction jobs would be created. No new employment opportunities would be available from the operation of existing generating facilities.

Employment opportunities per aMW from new conservation programs are considerably more than the employment from fossil fuel extraction and transportation. Therefore Alternatives A and C, which have higher levels of conservation acquisition, would have greater employment opportunities. Such jobs are more likely to be in or near the utility service territory. Figure 8-6 summarizes the relative impact magnitude to employment of the alternative SRA recommendations.

Figure 8-6. Impact Magnitude—Employment

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude	Beneficial		Beneficial	

Relative impact level: High, High-moderate, Moderate, Low

8.3.7 Aesthetics and Recreation

Because no new construction would occur for any of the alternative SRA recommendations, there would be no direct or indirect construction-related potential adverse impacts to

aesthetics and recreation. Impacts from the operation of existing facilities are not expected to differ significantly between the alternatives and are considered low. Figure 8-7 summarizes the relative magnitude of potential impacts to aesthetics and recreation of the alternative SRA recommendations.

Figure 8-7. Impact Magnitude—Aesthetics and Recreation

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High High-moderate Moderate Low

8.3.8 Environmental Health

Potential impacts to environmental health would vary between alternatives primarily as a result of differences in conservation levels and corresponding variation in the operation of fossil-fuel resources. Alternatives B and D, with lower conservation levels, would be expected to have somewhat increased environmental health effects from increased air emissions, although the magnitude of the difference is not significant. Increased generation from existing fossil fuel plants is not expected to significantly increase ambient noise levels. Overall impact levels are expected to be moderate for all four alternatives. Figure 8-8 summarizes the relative magnitude of impacts to environmental health of the alternative SRA recommendations.

Figure 8-8. Impact Magnitude—Environmental Health, Including Noise

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High High-moderate Moderate Low

8.3.9 Cultural and Historical Resources

Because no new construction is proposed in any of the four alternative SRA recommendations, no associated direct adverse effects are expected on cultural and

historical resources. Potential indirect operational effects on cultural and historical resources consist of coal-fired plant emissions that contribute to acid rain, which corrodes metallic and masonry components of buildings and other historic artifacts. In addition, excavation and extraction of natural gas, fuel oil, and coal could indirectly impact cultural resources. However, such indirect impacts would depend on the occurrence and proximity of such resources in affected areas and are difficult to assess and compare between alternatives.

In general, increased reliance on conservation and/or contracting for a dispatchable gas-fired resource are likely to result in decreased coal-fired air emissions from spot market purchases. Alternatives with those features would be expected to have less potential indirect impacts to historical buildings and artifacts. However, the difference in impacts between alternatives is not significant and the impact level for all four alternatives is considered low. Figure 8-9 summarizes the relative magnitude of impacts to cultural and historical resources of the alternative SRA recommendations.

Figure 8-9. Impact Magnitude—Cultural and Historical Resources

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High High-moderate Moderate Low

8.3.10 Energy Resources

Figure 8-10 summarizes the relative magnitude of potential impacts to energy resources of the alternative recommendations. The differences between alternatives is minor and all are considered to have impacts of moderate magnitude.

Figure 8-10. Impact Magnitude—Energy Resources

Recommendation	Alternative A	Alternative B	Alternative C	Alternative D
Impact Magnitude				

Relative impact level: High High-moderate Moderate Low

Table 8-6 presents the quantified estimates of fossil fuel consumption for each of the alternatives. Higher levels of conservation result in reduced fossil fuel consumption. Alternatives C and D, which include a dispatchable resource (assumed to be a simple-cycle combustion turbine), consume more natural gas and less coal than the other alternatives as a result of the substitution of gas-fired resources for some amount of coal-fired generation from spot market and BPA purchases.

Table 8-6. Fuel Usages for Alternative SRA Recommendations, Year 1998

Alternative Recommendations, Year 1998				
Alternative A	Alternative B	Alternative C	Alternative D	Units
-8,044,646	-7,686,067	-7,490,829	-7,004,857	Thousand cubic feet natural gas per year
0	0	578	693	Thousand gal. backup fuel oil per year
177,685	192,427	149,017	156,681	Tons coal per year

8.4 SALE OR LOSS OF SEATTLE CITY LIGHT'S EXISTING RESOURCES

The Draft Strategic Resources Assessment includes a recommendation to reevaluate SCL's existing resource base to decide whether changes should be made. Such a reevaluation is prompted by ongoing changes in the structure and regulation of the electric utility industry and by the possibility that the drastic reductions in recent years in the cost of alternative sources of electricity could continue into future years. SCL's resource base is described in greater detail in Section 1.0. As described in Section 5.0, the analysis of alternative resource portfolios and alternative recommendations assumes SCL's continued ownership and operation of those resources it currently owns, such as the Skagit and Boundary Hydroelectric projects and its Centralia coal plant share. It also assumes continuation of existing long-term power sales contracts until but not beyond their expiration. The following section qualitatively addresses the potential environmental impacts associated with SCL's decision to sell or otherwise dispose of an existing owned or contracted resource. It begins with a general discussion, and then more specifically addresses two representative resources: Centralia and Lucky Peak.

8.4.1 Environmental Impacts of the Sale of an Existing Resource

The answers to two key questions determine the environmental impacts of SCL's sale of an existing resource. First, what difference would there be in the operation of the resource because of the change in ownership? Second, what difference would there be between the alternative resource the purchaser would have acquired and the resource SCL acquires as a replacement. For each of these two factors, referred to below as resource operation and

alternative resource acquisition, there are three possible outcomes: (1) no difference; (2) the sale results in greater environmental impacts; and (3) the sale results in less environmental impacts.

Differences in resource operation are likely to depend on the purchaser's load shape, resource mix and contractual rights and obligations as compared to SCL. These factors will influence when the resource's output is needed, when its output can be displaced by less expensive sources, and the degree to which its generation can be stored for later use. For example, a purchaser with no hydroelectric resources will not have nonfirm or surplus hydroelectricity with which to displace the purchased resource. Conversely, a purchaser with power sales contracts with take-or-pay provisions or high availability charges (levied for the right to purchase power, even if it is not taken) may find it economical to displace the purchased resource with that power.

In addition, resources with less flexible operation will by definition be less likely to have their operation affected by a change in ownership. For example, run-of-the river hydroelectric plants have limited capabilities to store water and must generate electricity with available flows. The operation and generation patterns for such a resource are likely to be similar regardless of who owns it. At the other extreme, a dispatchable resource such as a combustion turbine can be operated very flexibly to match the loads and system needs of a particular owner.

Differences in alternative resource acquisition are inherently uncertain at this programmatic level of analysis. However, for both SCL and a potential purchaser, a likely range includes conservation as the resource with the least environmental impact through spot market purchases as that with the greatest environmental impacts. Spot market purchases are likely to include a mix of existing fossil fuel resources at the margin, including coal and natural gas. (New natural gas-fired resources, which would be more efficient and required to meet more stringent pollution control requirements, would fall between conservation and spot market purchases in the severity of their impacts. Renewables such as wind and geothermal would have different types of impacts not directly comparable to fossil-fuel resources. Development of new resources of any kind would have construction-related impacts, while reliance on existing resources would not.)

Given this range, the greatest impacts would result from a combination of the purchaser foregoing conservation and SCL relying on spot market purchases as a replacement. The least serious environmental impacts would result if the purchaser would have otherwise relied on spot market purchases and SCL acquired additional conservation to replace the resource.

8.4.2 Existing SCL Resources

Given the uncertainty regarding potential buyers were SCL to propose sale of an existing resource, the following discussion is necessarily general and focuses exclusively on potential changes in resource operations.

8.4.2.1 Centralia

SCL currently owns an eight percent share of the Centralia coal-fired steam plant. The plant has consistently been in compliance with existing environmental regulations and currently provides reliable power at moderate cost. However, along with the general economic considerations applicable to all existing resources, several factors may cause SCL to reconsider its ownership position. These include public concern over the environmental impacts of coal-fired generation; foreseeable increased capital expenditures and operational costs to meet the requirements of the 1990 Clean Air Act Amendments, including more stringent control of sulfur dioxide and nitrogen oxides; and uncertainty regarding future environmental regulation.

It is expected that sale of Centralia to another owner would have a relatively minor effect on its pattern of generation and corresponding environmental impacts, for two main reasons. First, while a utility or other purchaser with hydroelectric resources would tend to displace Centralia generation more than a thermal-based utility when water was plentiful (and less when it was not), broader market conditions (typically dictated by regional water conditions and transmission availability) are likely to play a more significant role in its operation, regardless of ownership. For example, even if SCL has surplus hydropower available, its decision about whether or not to use it to displace Centralia is based on the spot market price it can be sold for. Second, Centralia's relatively low run cost means that it will be economical for any owner to displace it under only the lowest-price market conditions, again regardless of ownership.

8.4.2.2 Lucky Peak Hydroelectric Project

Under a 50-year contract commencing in 1988, SCL purchases all the output of the Lucky Peak power project, which is located at the Corps of Engineers' Lucky Peak Dam near Boise, Idaho. The dam releases irrigation water and provides flood protection to the Boise area. The contract was signed at a time when estimates of avoided cost—the cost of alternative power—were considerably higher than they are currently, and the power from the project is now quite expensive compared to market sources and potential new resources.

Because the reservoir is operated primarily for irrigation and flood control purposes, the project has little operational flexibility, producing when water is released under the direction of the Army Corps of Engineers and Bureau of Reclamation. Therefore, a transfer of the contractual rights to the power would be expected to have no effect on project operations and no adverse environmental impacts.

9.0 GLOSSARY

anadromous
Fish that hatch in freshwater, migrate to the ocean, mature there, and return to freshwater to spawn. For example, salmon or steelhead trout.

average megawatt (aMW)
Energy produced by the continuous operation of one megawatt of capacity over a specified period, typically a year. If the actual energy level varies throughout the year, average megawatts can be computed as the sum of all megawatt-hours divided by the number of hours in the time period. In this EIS, aMW is equivalent to an annual average megawatt (or MW-year) and 8,760 MWh.

baseload
Operation of a plant continuously except for scheduled maintenance or outages.

Biological Opinion
A ruling of the National Marine Fisheries Service intended to protect endangered fish; the 1995 Biological Opinion requires increased spill and increased spring flow levels to hasten the downstream migration of young salmon; as a result, some hydro projects lose firm energy output and the ability to shape energy from low- to high-value periods.

Bonneville Power Administration (BPA, Bonneville)
The federal agency that markets power from federally owned projects and projects acquired under terms of the Northwest Power Planning Act.

Btu
British thermal unit. The amount of heat energy necessary to raise the temperature of one pound of water by one degree Fahrenheit. 3,413 Btus are equal to one kilowatt-hour.

capacity
The maximum power that can be produced by a generating resource under specified conditions. The capacity of generating equipment is expressed in kilowatts (kW) or megawatts (MW).

carbon dioxide
An emission from the combustion of fossil fuels that may be linked to global warming.

coal gasification
The process of converting coal to a synthetic gaseous fuel. The process used in integrated gasification combined-cycle (IGCC) plants.

cogeneration
The simultaneous production of electricity and useful heat energy from a common fuel source.

combined-cycle combustion turbine (CCCT)
The combination of a gas turbine and a steam turbine in an electric generation plant; the waste heat from the gas-turbine cycle provides heat for the steam-turbine cycle.

combustion turbine (CT)
A turbine-engine generator, turned by exhaust gases rather than heat-created steam, used to generate electricity.

conservation
Reductions in the use of electricity through improvements in end-use efficiency.

critical period
The sequence of low water conditions during which the regional hydropower system's least amount of energy can be generated (see "critical water") while drafting storage reservoirs from full to empty. Under the Pacific Northwest Coordination Agreement, critical period is based on the lowest multimonth streamflow observed since 1928. Based on analysis of streamflows at the Dalles Dam, this is also the lowest streamflow since recordkeeping began in 1879.

critical water
The sequence of streamflows in the critical period under which the hydropower system will generate about 12,500 average megawatts. In an average year, the Northwest hydropower system will produce about 16,600 average megawatts.

discount rate
The rate used in comparing values observed at different points in time.

dispatch
Operating control of an integrated electrical system involving operations such as control of the operation of specific power plants, high-voltage lines, substations, or other equipment.

dispatchable
Resources which the utility has control over when the resource is generating, and at what level of generation.

distribution
Electric equipment which takes power from the transmission system and transports it directly to the customer's delivery point. Includes equipment from the substation to the customer's meter.

energy
Total amount of electricity needed or used to serve customers over a period of time.

entitlement (BPA)
The right to buy from BPA an amount of power equal to the difference between a utility's own firm resources and its firm load.

environmental dispatch
A way to dispatch the utility's generating plants which assumes that the operating cost of each plant includes an additional amount representing environmental externality values, even though the utility does not have to pay that environmental cost.

externalities (or environmental externalities)
Societal costs not reflected in the price of a product.

firm energy
The minimum energy that can be relied upon 90 percent of the time.

firm (capability)
The minimum resource capability that can be relied upon 90 percent of the time.

fossil fuels
Coal, oil, natural gas, and other fuels derived from fossilized geologic deposits.

fuel switching
A customer changing energy-using equipment from one fuel source to another. Typically, this is thought of as a residential customer changing a water heater or space-heating equipment from electricity to natural gas.

gasifier
Part of integrated gasification combined-cycle which takes pulverized coal and produces an intermediate Btu gas.

generation
The process of producing electricity from other forms of energy (from falling water, coal, gas, wind, solar, or other energy sources).

geothermal fluids
Natural underground moisture that contains the heat used for geothermal energy.

heat rate
The amount of input (fuel) energy required by a power plant to produce one kilowatt-hour of electricity. Expressed as Btu/kWh.

integrated gasification combined cycle (IGCC)
A combined-cycle combustion turbine (CCCT) which uses, instead of natural gas, coal that has been gasified as its source of fuel.

interruptible
Load that, by contract, can be interrupted in the event of a power supply deficiency. Typically, a contract between an individual customer and the company specifies the conditions under which the customer's load can be interrupted, in exchange for lower rates to the customer or specific payments to the customer.

kilowatt (kW)
A unit of electrical energy use. The amount of power being used or produced at one moment in time. Used as a measure for peak or capacity. One kilowatt will light up ten 100-watt light bulbs.

kilowatt-hour (kWh)
A unit of electrical energy use. The amount of energy used over a specified time period, typically one year, measured in kilowatts.

load
The amount of electricity used by a customer or group of customers during a specified time period.

load growth
The increase in demand for electric power that occurs over time as new customers move into an area and new uses for electricity are adopted.

megawatt (MW)
A unit of electric power equal to 1,000,000 watts or 1,000 kilowatts. The amount of power being used or produced at one moment in time. Used as a measure for peak or capacity.

megawatt-hour (MWh)
A unit of electrical energy use. The amount of energy used over a specified time period, typically one year, measured in megawatts.

MMBtu
Millions of British thermal units or Btus.

model
A theory that is intended to capture the workings of the real world. A model used for electricity resource planning is intended to capture all of the factors that utilities consider in making resource acquisition decisions. It attempts to put into rules how each of these factors affects resource decisions, and how they interrelate.

nonfirm
Any production above the firm capability of a resource.

Northwest Power Planning Council
A federally chartered council comprising Oregon, Washington, Idaho, and Montana that establishes policy on Northwest electrical energy and related fish and wildlife issues.

Pacific Northwest Coordination Agreement
Agreement signed in 1964 between owners of major hydropower resources governing water releases and signatory rights and obligations; intended to maximize usable energy after nonpower requirements are met.

peak demand
The maximum rate of electrical power required during a specified unit of time.

photovoltaic
Solar technology that directly converts sunlight into electricity.

pulverized coal plant
Conventional coal plant, which uses a subcritical steam boiler that burns subituminous coal.

pumped storage
A generation technology which uses water in two reservoirs. The water is allowed to fall from the higher reservoir into the lower reservoir, passing through turbines and generators on the way, producing electricity. It is then pumped back up to the upper reservoir, using power from another power plant.

reliability
The ability of a system to provide customers with uninterrupted power at their point of service.

renewable resource
A resource that uses solar, wind, water (hydro), geothermal, biomass or similar sources of energy, and is used either for electric power generation or for reducing the electric power requirements of a customer.

resource planning
The process of predicting the future electricity and energy service needs of customers, and planning which new resources should be used to provide the services required.

resource supply
The system of generating plants available to a utility to meet the electricity needs of its customers.

retail wheeling

Rather than taking service from the utility in its own service area, a retail customer contracts with a utility in another designated service area to provide electricity. This requires the first utility to provide wheeling services to deliver the power to the customer.

spot purchases

Short-term power purchases (typically for a few hours to a few days) arranged with short notice (from a few hours to a day).

transmission

Electrical equipment which takes power from generating plants and transports it over long distances to a load area. At a substation it is delivered to the distribution system.

watt

A basic unit of electrical power equal to 0.00134 horsepower.

wheeling

Transmission of electricity from one party to another over a third party's transmission system.

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APPENDIX B

RESOURCE CAPACITY AND GENERATION REFERENCE TABLES FOR ALTERNATIVE RESOURCE PORTFOLIOS AND SRA RECOMMENDATIONS

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Table B-1. Estimated Capacity (MW) and Generation (aMW) For Alternative Portfolios, Years 2000 and 2010.

	No Action				Status Quo			
	2000		2010		2000		2010	
Resource Type	Cap.	Gen.	Cap.	Gen.	Cap.	Gen.	Cap.	Gen.
BPA Purchase[1/]	220	143	220	202	263	185	475	357
Not Purchased	-	*(77)*	-	*(18)*	-	*(35)*	-	*(-137)*
Centralia	-	69	-	76	-	67	-	71
Conservation	-	0	-	0	-	42	-	95
Wind	0	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0	0
Cogeneration[2/]	0	0	0	0	0	0	0	0
CCCT[3/]	0	0	0	0	0	0	0	0
SCCT[4/]	0	0	0	0	85	17	85	13
Fuel Cells[5/]	0	0	0	0	0	0	0	0
Firm Purchases[6/]	0	0	0	0	0	0	0	0
Spot Market Purchases[1/]		146		271		85		104
Total Energy[7/]		358		549		396		640
Surplus Sales[1/]		101		66		136		130

Note: See page 5 of table for footnotes.

Table B-1. Estimated Capacity (MW) and Generation (aMW) For Alternative Portfolios, Years 2000 and 2010.

	Natural Gas Emphasis				Less Environmental Impact			
	2000		2010		2000		2010	
Resource Type	Cap.	Gen.	Cap.	Gen.	Cap.	Gen.	Cap.	Gen.
BPA Purchase[1/]	220	129	220	171	220	126	220	159
Not Purchased	-	*(91)*	-	*(49)*	-	*(94)*	-	*(61)*
Centralia	-	68	-	72	-	68	-	68
Conservation	-	0	-	0	-	42	-	95
Wind	0	0	0	0	50	6	267	20
Geothermal	0	0	0	0	30	28	130	114
Cogeneration[2/]	0		87	80	0	0	49	45
CCCT[3/]	95	45	270	108	0	0	0	0
SCCT[4/]	85	21	85	19	85	21	0	0
Fuel Cells[5/]	0	0	31	22	0	0	95[8/]	65
Firm Purchases[6/]	0	0	0	0	0	0	0	0
Spot Market Purchases[1/]		104		132		90		91
Total Energy[7/]		367		604		381		657
Surplus Sales[1/]		108		99		119		154

Note: See page 5 of table for footnotes.

Table B-1. Estimated Capacity (MW) and Generation (aMW) For Alternative Portfolios, Years 2000 and 2010.

	Resource Diversity				Firm Purchase			
	2000		2010		2000		2010	
Resource Type	Cap.	Gen.	Cap.	Gen.	Cap.	Gen.	Cap.	Gen.
BPA Purchase[1/]	220	127	220	165	220	126	220	164
Not Purchased	-	*(93)*	-	*(55)*	-	*(94)*	-	*(56)*
Centralia	-	68	-	71	-	68	-	71
Conservation	-	34	-	95	-	0	-	0
Wind	40	5	150	12	0	0	0	0
Geothermal	16	15	54	48	0	0	0	0
Cogeneration[2/]	0	0	33	30	0	0	0	0
CCCT[3/]	27	13	124	48	23	10	157	56
SCCT[4/]	85	21	85	20	85	20	85	17
Fuel Cells[5/]	0	0	21	15	0	0	0	0
Firm Purchases[6/]	0	0	0	0	65	65	210	210
Spot Market Purchases[1/]		94		114		91		101
Total Energy[7/]		377		618		380		619
Surplus Sales[1/]		115		112		119		118

Note: See page 5 of table for footnotes.

Table B-1. Estimated Capacity (MW) and Generation (aMW) For Alternative Portfolios, Years 2000 and 2010.

	BPA Independence			
	2000		2010	
Resource Type	Cap.	Gen.	Cap.	Gen.
BPA Purchase[1/]	10	5	10	8
Not Purchased		*(215)*		*(212)*
Centralia	-	68	-	74
Conservation	-	42	-	25
Wind	0	0	0	0
Geothermal	0	0	0	0
Cogeneration[2/]	41	38	136	125
CCCT[3/]	170	69	343	140
SCCT[4/]	85	24	85	22
Fuel Cells[5/]	0	0	41	29
Firm Purchases[6/]	65	65	65	65
Spot Market Purchases[1/]		77		110
Total Energy[7/]		388		598
Surplus Sales[1/]		123		98

Note: See page 5 of table for footnotes.

Table B-1. Estimated Capacity (MW) and Generation (aMW) For Alternative Portfolios, Years 2000 and 2010.

1/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.

2/ Assumes cogeneration is fueled by natural gas.

3/ CCCT = combined-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

4/ SCCT = simple-cycle combustion turbine fueled by 95% natural gas and 5% fuel oil.

5/ Assumes fuel cells are fueled by natural gas.

6/ Assumes firm purchases are generated by SCCT fueled by 95% natural gas and 5% fuel oil.

7/ Totals have been rounded.

8/ Assumes fuel cells include 85 MW for firming 30 aMW of non-firm SCL hydroelectric energy as a substitute for SCCT, and 10 MW of additional fuel cell capacity.

Table B-2. Estimated Generation for SRA Recommendations, Year 1998 (aMW).

	SRA Recommendations			
Resource Type	Alternative A	Alternative B	Alternative C	Alternative D
BPA Purchase[1/]	134	137	78	79
Not Purchased	*(86)*	*(83)*	*(142)*	*(141)*
Centralia	78	78	79	79
Conservation	26[2/]	19[3/]	26[2/]	19[3/]
Dispatchable Resource[4/]	0	0	17	20
Spot Market Purchases[1/]	78	80	102	103
Total Energy[5/]	316	314	302	300
Surplus Sales[1/]	147	145	134	131

1/ Spot market purchases, displacement from surplus sales, and changes in BPA purchases from SCL's 1994 entitlement of approximately 220 aMW are assumed equivalent to a melded marginal resource based on 10% existing simple-cycle combustion turbine, 5% existing combined-cycle combustion turbine, 45% existing gas-fired steam boiler generation, 35% existing coal-fired generation, and 5% avoided hydro spill. Increases in BPA purchases result in increased emissions and reductions in BPA purchases result in reduced emissions.

2/ Assumes conservation continues at current planned acquisition levels (9 aMW in 1996, declining to 7 aMW in 2000).

3/ Assumes conservation continues at approximately 60% of current planned acquisition levels (6 aMW in 1996, declining to 4.5 aMW in 2000).

4/ Assumes 100% SCCT fueled by 95% natural gas and 5% fuel oil.

5/ Totals have been rounded.

APPENDIX C

CALCULATIONS FOR QUANTIFIED ENVIRONMENTAL EFFECTS FOR ALTERNATIVE RESOURCE PORTFOLIOS AND SRA RECOMMENDATIONS

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APPENDIX C

CALCULATIONS FOR QUANTIFIED ENVIRONMENTAL IMPACTS FOR ALTERNATIVE RESOURCE PORTFOLIOS AND SRA RECOMMENDATIONS

The tables on the following pages summarize the calculation of quantified impacts for the alternative resource portfolios in the years 2000 and 2010 and for the alternative SRA recommendations in the year 1998. There are three sections, each consisting of a particular set of impacts as follows:

Section	Impacts
C-1	Air Emissions
C-2	Non-Air & Fuel (Water, Employment, Soil/Land Use)
C-3	Fuel Use

Each section is organized by the three years for which impacts are estimated, in the following order: 2000, 2010, and 1998. The pages are numbered by section using the pattern C-x-y, where x is the section and y is the page number for that section.

For each year in a particular section, the first page summarizes the impact factors by resource type, in either units/MWh of energy (for operational impacts) and units/MW of capacity (for construction impacts). The next one or two pages summarize the energy and capacity provided by each resource type for the alternative portfolio or SRA recommendations, as appropriate. Sections C-1 and C-3 include only the energy summary. Because all air emissions and fuel use impacts are operational rather than construction-related, resource capacities are not relevant for calculating these impacts. The remaining pages summarize the individual quantified impacts, both by resource and in total.

The quantified impacts are calculated by multiplying the impact factors for each resource by the amount of energy or capacity provided by that resource. The quantified impacts are then summed for all resource types in a particular year to determine the total.

Reductions in quantified impacts are assumed to occur in two cases: first, when SCL sells surplus power and thereby displaces or reduces generation from others' resources, and second, when we reduce the amount of power purchased from the Bonneville Power Administration (BPA) below the approximate level of our 1994 entitlement of 220 aMW.

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YEAR 2000	Air Emission Factors					
	CO2	NOx	SO2	TSP	VOC	CO
Resource Type	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh
Centralia (existing pulverized coal)	2303.400	4.712	17.800	0.418	0.041	0.370
Conservation	0.000	0.000	0.000	0.000	0.000	0.000
Wind	0.000	0.000	0.000	0.000	0.000	0.000
Geothermal	160.640	0.000	0.000	0.000	0.000	0.000
Cogeneration	807.300	0.210	0.007	0.035	0.063	0.150
CC Combustion Turbines	883.220	0.233	0.082	0.037	0.067	0.170
SC Combusiton Turbines	1316.600	0.997	0.123	0.056	0.100	0.370
Fuel Cells	690.000	0.009	0.000	0.000	0.000	0.000
Firm Purchases (SW SCCT)	1316.600	0.997	0.123	0.056	0.100	0.370
Spot Market	1465.919	3.061	2.945	0.145	0.035	0.430
Total Generation/Purchase						
Surplus Sales	1465.919	3.061	2.945	0.145	0.035	0.430
BPA Purchase Reduction	1465.919	3.061	2.945	0.145	0.035	0.430
Net Total						

		RESOURCE ASSUMPTIONS					
YEAR 2000		aMW Generation			Operation Impacts		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	68.8	67.1	67.9	67.7	67.8	67.5	67.5
Conservation	0.0	42.0	0.0	42.0	34.0	0.0	42.0
Wind				5.8	4.6		
Geothermal				28.0	15.0		
Cogeneration							38.0
CC Combustion Turbines			45.0		12.5	10.3	69.1
SC Combusiton Turbines		16.8	20.8	20.5	20.6	20.1	24.3
Fuel Cells							
Firm Purchases (SW SCCT)						65.0	65.0
Spot Market	146.3	84.6	103.6	90.4	93.7	90.7	77.1
Total Generation/Purchase	**215.1**	**210.5**	**237.3**	**254.4**	**248.2**	**253.6**	**383.0**
Surplus Sales	100.6	136.2	108.3	118.5	115.1	119.3	123.2
BPA Purchase Reduction	76.7	35.1	90.7	94.0	93.1	94.3	214.5
Net Total	37.8	39.2	38.3	41.9	40.0	40.0	45.3

YEAR 2000		**Air Emissions**		**CO2 (tons)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	694,116	676,965	685,036	683,018	684,027	681,000	681,000
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	19,701	10,554	0	0
Cogeneration	0	0	0	0	0	0	134,367
CC Combustion Turbines	0	0	174,083	0	48,356	39,846	267,314
SC Combusiton Turbines	0	96,881	119,948	118,218	118,794	115,911	140,131
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	374,836	374,836
Spot Market	939,352	543,193	665,187	580,434	601,622	582,360	495,038
Total Generation/Purchase	**1,633,468**	**1,317,039**	**1,644,253**	**1,401,370**	**1,463,353**	**1,793,952**	**2,092,686**
Surplus Sales	645,925	874,503	695,365	760,856	739,025	765,993	791,033
BPA Purchase Reduction	492,470	225,367	582,360	603,548	597,770	605,474	1,377,246
Net Total	**495,073**	**217,168**	**366,529**	**36,966**	**126,558**	**422,486**	**-75,593**

YEAR 2000		Air Emissions		NOx (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	1,419.9	1,384.8	1,401.4	1,397.2	1,399.3	1,393.1	1,393.1
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	35.0
CC Combustion Turbines	0.0	0.0	45.9	0.0	12.8	10.5	70.5
SC Combusiton Turbines	0.0	73.4	90.8	89.5	90.0	87.8	106.1
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	283.8	283.8
Spot Market	1,961.5	1,134.2	1,389.0	1,212.0	1,256.3	1,216.0	1,033.7
Total Generation/Purchase	**3,381.4**	**2,592.5**	**2,927.1**	**2,698.8**	**2,758.3**	**2,991.3**	**2,922.2**
Surplus Sales	1,348.8	1,826.1	1,452.0	1,588.8	1,543.2	1,599.5	1,651.8
BPA Purchase Reduction	1,028.3	470.6	1,216.0	1,260.3	1,248.2	1,264.3	2,875.8
Net Total	**1,004.3**	**295.8**	**259.1**	**-150.3**	**-33.1**	**127.5**	**-1,605.4**

YEAR 2000		**Air Emissions**		**SO2 (tons)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	5,363.9	5,231.4	5,293.8	5,278.2	5,286.0	5,262.6	5,262.6
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	1.2
CC Combustion Turbines	0.0	0.0	16.2	0.0	4.5	3.7	24.8
SC Combusiton Turbines	0.0	9.1	11.2	11.0	11.1	10.8	13.1
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	35.0	35.0
Spot Market	1,887.1	1,091.3	1,336.3	1,166.1	1,208.6	1,169.9	994.5
Total Generation/Purchase	**7,251.1**	**6,331.7**	**6,657.5**	**6,455.3**	**6,510.2**	**6,482.1**	**6,331.2**
Surplus Sales	1,297.6	1,756.9	1,397.0	1,528.5	1,484.7	1,538.9	1,589.2
BPA Purchase Reduction	989.4	452.8	1,169.9	1,212.5	1,200.9	1,216.4	2,766.9
Net Total	**4,964.1**	**4,122.1**	**4,090.5**	**3,714.2**	**3,824.6**	**3,726.8**	**1,975.2**

YEAR 2000		Air Emissions		TSP (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	126.0	122.8	124.3	123.9	124.1	123.6	123.6
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	5.8
CC Combustion Turbines	0.0	0.0	7.3	0.0	2.0	1.7	11.2
SC Combusiton Turbines	0.0	4.1	5.1	5.0	5.1	4.9	6.0
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	15.9	15.9
Spot Market	92.9	53.7	65.8	57.4	59.5	57.6	49.0
Total Generation/Purchase	**218.9**	**180.7**	**202.5**	**186.4**	**190.7**	**203.7**	**211.5**
Surplus Sales	63.9	86.5	68.8	75.3	73.1	75.8	78.2
BPA Purchase Reduction	48.7	22.3	57.6	59.7	59.1	59.9	136.2
Net Total	106.3	71.9	76.1	51.4	58.5	68.1	-3.0

YEAR 2000		Air Emissions		VOC (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	12.4	12.0	12.2	12.2	12.2	12.1	12.1
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	10.5
CC Combustion Turbines	0.0	0.0	13.2	0.0	3.7	3.0	20.3
SC Combusiton Turbines	0.0	7.4	9.1	9.0	9.0	8.8	10.6
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	28.5	28.5
Spot Market	22.4	13.0	15.9	13.9	14.4	13.9	11.8
Total Generation/Purchase	**34.8**	**32.4**	**50.4**	**35.0**	**39.2**	**66.3**	**93.8**
Surplus Sales	15.4	20.9	16.6	18.2	17.6	18.3	18.9
BPA Purchase Reduction	11.8	5.4	13.9	14.4	14.3	14.5	32.9
Net Total	**7.6**	**6.1**	**19.9**	**2.4**	**7.3**	**33.6**	**42.0**

YEAR 2000		Air Emissions		CO (tons)			
	Alternative Resource Portfolios						
Resource Type	No Action Iternative	Status Quo	Nat. Gas Emphasis	Less Env Impact	Resource Diversity	Firm Purchase	BPA Indep.
Centralia (existing pulverized coal)	111.5	108.7	110.0	109.7	109.9	109.4	109.4
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	25.0
CC Combustion Turbines	0.0	0.0	33.5	0.0	9.3	7.7	51.5
SC Combusiton Turbines	0.0	27.2	33.7	33.2	33.4	32.6	39.4
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	105.3	105.3
Spot Market	275.5	159.3	195.1	170.3	176.5	170.8	145.2
Total Generation/Purchase	**387.0**	**295.3**	**372.4**	**313.2**	**329.0**	**425.8**	**475.7**
Surplus Sales	189.5	256.5	204.0	223.2	216.8	224.7	232.0
BPA Purchase Reduction	144.5	66.1	170.8	177.0	175.3	177.6	404.0
Net Total	**53.1**	**104.9**	**-2.4**	**-87.0**	**-63.1**	**23.5**	**-160.3**

YEAR 2010	**Air Emission Factors**					
	CO2	NOx	SO2	TSP	VOC	CO
Resource Type	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh
Centralia (existing pulverized coal)	2319.000	3.689	9.486	0.421	0.042	0.370
Conservation	0.000	0.000	0.000	0.000	0.000	0.000
Wind	0.000	0.000	0.000	0.000	0.000	0.000
Geothermal	160.640	0.000	0.000	0.000	0.000	0.000
Cogeneration	807.300	0.210	0.007	0.035	0.063	0.150
CC Combustion Turbines	883.220	0.233	0.082	0.037	0.067	0.170
SC Combustion Turbines	1316.600	0.997	0.123	0.056	0.100	0.370
Fuel Cells	690.000	0.009	0.000	0.000	0.000	0.000
Firm Purchases (SW SCCT)	1316.600	0.997	0.123	0.056	0.100	0.370
Spot Market	1465.919	3.061	2.945	0.145	0.035	0.430
Total Generation/Purchase						
Surplus Sales	1465.919	3.061	2.945	0.145	0.035	0.430
BPA Purchase Reduction	1465.919	3.061	2.945	0.145	0.035	0.430
Net Total						

		RESOURCE ASSUMPTIONS					
YEAR 2010		aMW (Generation)			Operation Impacts		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	75.5	70.6	72.0	68.4	70.8	71.1	73.6
Conservation		95.0		95.0	95.0		25.0
Wind				19.7	12.1		
Geothermal				114.1	47.8		
Cogeneration			80.0	45.0	30.0		125.0
CC Combustion Turbines			108.2		48.2	56.3	139.6
SC Combustion Turbines		12.8	19.4		19.8	17.2	21.7
Fuel Cells			22.3	65.3	14.5		29.4
Firm Purchases (SW SCCT)						210.0	65.0
Spot Market	271.2	104.0	131.5	91.2	113.9	101.2	110.3
Total Generation/Purchase	**346.7**	**282.4**	**433.4**	**498.7**	**452.1**	**455.8**	**589.6**
Surplus Sales	65.8	130.2	98.9	153.5	112.1	118.4	97.8
BPA Purchase Reduction	18.2	-136.6	49.0	60.8	54.7	56.3	212.2
Net Total	262.7	288.8	285.5	284.4	285.3	281.1	279.6

YEAR 2010		**Air Emissions**		**CO2 (tons)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	766,870	717,100	731,320	694,754	719,131	722,178	747,571
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	80,281	33,632	0	0
Cogeneration	0	0	282,878	159,119	106,079	0	441,997
CC Combustion Turbines	0	0	418,572	0	186,462	217,797	540,043
SC Combustion Turbines	0	73,814	111,874	0	114,181	99,187	125,138
Fuel Cells	0	0	67,395	197,350	43,822	0	88,853
Firm Purchases (SW SCCT)	0	0	0	0	0	1,211,009	374,836
Spot Market	1,741,301	667,755	844,325	585,570	731,321	649,777	708,206
Total Generation/Purchase	**2,508,171**	**1,458,669**	**2,456,364**	**1,717,074**	**1,934,628**	**2,899,949**	**3,026,643**
Surplus Sales	422,484	835,978	635,010	985,581	719,763	760,214	627,947
BPA Purchase Reduction	116,857	-877,071	314,616	390,380	351,214	361,487	1,362,478
Net Total	**1,968,830**	**1,499,762**	**1,506,739**	**341,112**	**863,651**	**1,778,248**	**1,036,219**

YEAR 2010		Air Emissions		NOx (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	1,219.9	1,140.7	1,163.4	1,105.2	1,144.0	1,148.8	1,189.2
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	73.6	41.4	27.6	0.0	115.0
CC Combustion Turbines	0.0	0.0	110.4	0.0	49.2	57.5	142.5
SC Combustion Turbines	0.0	55.9	84.7	0.0	86.5	75.1	94.8
Fuel Cells	0.0	0.0	0.9	2.6	0.6	0.0	1.2
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	917.0	283.8
Spot Market	3,636.0	1,394.3	1,763.0	1,222.7	1,527.1	1,356.8	1,478.8
Total Generation/Purchase	**4,855.9**	**2,591.0**	**3,196.0**	**2,371.9**	**2,834.9**	**3,555.2**	**3,305.2**
Surplus Sales	882.2	1,745.6	1,326.0	2,058.0	1,502.9	1,587.4	1,311.2
BPA Purchase Reduction	244.0	-1,831.4	657.0	815.2	733.4	754.8	2,845.0
Net Total	3,729.7	2,676.8	1,213.1	-501.3	598.6	1,213.0	-851.0

YEAR 2010		**Air Emissions**		**SO2 (tons)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	3,136.9	2,933.3	2,991.5	2,841.9	2,941.6	2,954.1	3,058.0
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	2.5	1.4	0.9	0.0	3.8
CC Combustion Turbines	0.0	0.0	38.9	0.0	17.3	20.2	50.1
SC Combustion Turbines	0.0	6.9	10.5	0.0	10.7	9.3	11.7
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	113.1	35.0
Spot Market	3,498.2	1,341.5	1,696.2	1,176.4	1,469.2	1,305.4	1,422.8
Total Generation/Purchase	**6,635.2**	**4,281.7**	**4,739.5**	**4,019.7**	**4,439.8**	**4,402.1**	**4,581.4**
Surplus Sales	848.8	1,679.5	1,275.7	1,980.0	1,446.0	1,527.3	1,261.5
BPA Purchase Reduction	234.8	-1,762.0	632.1	784.3	705.6	726.2	2,737.2
Net Total	**5,551.6**	**4,364.3**	**2,831.7**	**1,255.4**	**2,288.2**	**2,148.6**	**582.7**

YEAR 2010		**Air Emissions**		**TSP (tons)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	139.2	130.2	132.8	126.1	130.6	131.1	135.7
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	12.3	6.9	4.6	0.0	19.2
CC Combustion Turbines	0.0	0.0	17.5	0.0	7.8	9.1	22.6
SC Combustion Turbines	0.0	3.1	4.8	0.0	4.9	4.2	5.3
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	51.5	15.9
Spot Market	172.2	66.1	83.5	57.9	72.3	64.3	70.1
Total Generation/Purchase	**311.5**	**199.4**	**250.8**	**190.9**	**220.2**	**260.2**	**268.8**
Surplus Sales	41.8	82.7	62.8	97.5	71.2	75.2	62.1
BPA Purchase Reduction	11.6	-86.8	31.1	38.6	34.7	35.8	134.8
Net Total	258.1	203.4	156.9	54.8	114.2	149.3	71.9

YEAR 2010		**Air Emissions**		**VOC (tons)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	13.9	13.0	13.2	12.6	13.0	13.1	13.5
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	22.1	12.4	8.3	0.0	34.5
CC Combustion Turbines	0.0	0.0	31.8	0.0	14.1	16.5	41.0
SC Combustion Turbines	0.0	5.6	8.5	0.0	8.7	7.5	9.5
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	92.0	28.5
Spot Market	41.6	15.9	20.2	14.0	17.5	15.5	16.9
Total Generation/Purchase	**55.5**	**34.5**	**95.7**	**39.0**	**61.6**	**144.6**	**143.9**
Surplus Sales	10.1	20.0	15.2	23.5	17.2	18.2	15.0
BPA Purchase Reduction	2.8	-20.9	7.5	9.3	8.4	8.6	32.5
Net Total	**42.6**	**35.5**	**73.1**	**6.1**	**36.0**	**117.8**	**96.4**

YEAR 2010		Air Emissions		CO (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Iternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	122.4	114.4	116.7	110.8	114.7	115.2	119.3
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	52.6	29.6	19.7	0.0	82.1
CC Combustion Turbines	0.0	0.0	80.6	0.0	35.9	41.9	103.9
SC Combustion Turbines	0.0	20.7	31.4	0.0	32.1	27.9	35.2
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	340.3	105.3
Spot Market	510.8	195.9	247.7	171.8	214.5	190.6	207.7
Total Generation/Purchase	**633.1**	**331.0**	**528.9**	**312.2**	**416.9**	**715.9**	**653.6**
Surplus Sales	123.9	245.2	186.3	289.1	211.1	223.0	184.2
BPA Purchase Reduction	34.3	-257.3	92.3	114.5	103.0	106.0	399.7
Net Total	474.9	343.1	250.4	-91.4	102.8	386.9	69.7

YEAR 1998	Air Emission Factors					
	CO2	NOx	SO2	TSP	VOC	CO
Resource Type	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh
Centralia (existing pulverized coal)	2303.400	4.712	17.800	0.418	0.041	0.370
Conservation	0.000	0.000	0.000	0.000	0.000	0.000
Wind	0.000	0.000	0.000	0.000	0.000	0.000
Geothermal	160.640	0.000	0.000	0.000	0.000	0.000
Cogeneration	807.300	0.210	0.007	0.035	0.063	0.150
CC Combustion Turbines	883.220	0.233	0.082	0.037	0.067	0.170
SC Combustion Turbines	1316.600	0.997	0.123	0.056	0.100	0.370
Fuel Cells	690.000	0.009	0.000	0.000	0.000	0.000
Firm Purchases (SW SCCT)	1316.600	0.997	0.123	0.056	0.100	0.370
Spot Market	1465.919	3.061	2.945	0.145	0.035	0.430
Total Generation/Purchase						
Surplus Sales	1465.919	3.061	2.945	0.145	0.035	0.430
BPA Purchase Reduction	1465.919	3.061	2.945	0.145	0.035	0.430
Net Total						

		RESOURCE ASSUMPTIONS					
YEAR 1998		aMW (Generation)			Operation Impacts		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	78.1	78.3	79.2	79.3			
Conservation	26.0	19.0	26.0	19.0			
Wind							
Geothermal							
Cogeneration							
CC Combustion Turbines							
SC Combustion Turbines	0.0	0.0	16.5	19.8			
Fuel Cells							
Firm Purchases (SW SCCT)							
Spot Market	77.8	80.2	102.1	103.2			
Total Generation/Purchase	**181.9**	**177.5**	**223.8**	**221.3**			
Surplus Sales	146.8	145.4	133.8	131.8			
BPA Purchase Reduction	85.8	82.7	141.2	140.7			
Net Total	-50.7	-50.6	-51.2	-51.2			

YEAR 1998		**Air Emissions**		**CO2 (tons)**			
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	787942	789,960	799,040	800,049			
Conservation	0	0	0	0			
Wind	0	0	0	0			
Geothermal	0	0	0	0			
Cogeneration	0	0	0	0			
CC Combustion Turbines	0	0	0	0			
SC Combustion Turbines	0	0	95,151	114,181			
Fuel Cells	0	0	0	0			
Firm Purchases (SW SCCT)	0	0	0	0			
Spot Market	499532	514,942	655,556	662,619			
Total Generation/Purchase	**1,287,475**	**1,304,902**	**1,549,747**	**1,576,849**			
Surplus Sales	942,562	933,573	859,093	846,252			
BPA Purchase Reduction	550,898	530,994	906,606	903,396			
Net Total	-205,986	-159,665	-215,952	-172,799			

YEAR 1998		Air Emissions		NOx (tons)			
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	1611.9	1616.0	1634.6	1636.6			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	72.1	86.5			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	1043.1	1075.3	1368.9	1383.6			
Total Generation/Purchase	**2,655.0**	**2,691.3**	**3,075.5**	**3,106.7**			
Surplus Sales	1968.2	1949.4	1793.9	1767.1			
BPA Purchase Reduction	1150.3	1108.8	1893.1	1886.4			
Net Total	-463.6	-366.9	-611.5	-546.7			

YEAR 1998		**Air Emissions**		**SO2 (tons)**			
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	6089.0	6104.6	6174.7	6182.5			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	8.9	10.7			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	1003.5	1034.5	1317.0	1331.2			
Total Generation/Purchase	**7,092.5**	**7,139.1**	**7,500.6**	**7,524.4**			
Surplus Sales	1893.6	1875.5	1725.9	1700.1			
BPA Purchase Reduction	1106.7	1066.8	1821.4	1814.9			
Net Total	**4092.2**	**4196.8**	**3953.4**	**4009.4**			

YEAR 1998		**Air Emissions**		**TSP (tons)**			
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	143.0	143.4	145.0	145.2			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	4.0	4.9			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	49.4	50.9	64.8	65.5			
Total Generation/Purchase	**192.4**	**194.3**	**213.9**	**215.6**			
Surplus Sales	93.2	92.3	85.0	83.7			
BPA Purchase Reduction	54.5	52.5	89.7	89.4			
Net Total	44.7	49.4	39.2	42.5			

YEAR 1998		**Air Emissions**		**VOC (tons)**			
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	14.0	14.1	14.2	14.2			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	7.2	8.7			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market							
Total Generation/Purchase	**14.0**	**14.1**	**21.4**	**22.9**			
Surplus Sales	22.5	22.3	20.5	20.2			
BPA Purchase Reduction	13.2	12.7	21.6	21.6			
Net Total	**-21.6**	**-20.9**	**-20.7**	**-18.9**			

YEAR 1998		Air Emissions		CO (tons)				
	Alternative SRA Recommendations							
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D				
Centralia (existing pulverized coal)	126.6	126.9	128.4	128.5				
Conservation	0.0	0.0	0.0	0.0				
Wind	0.0	0.0	0.0	0.0				
Geothermal	0.0	0.0	0.0	0.0				
Cogeneration	0.0	0.0	0.0	0.0				
CC Combustion Turbines	0.0	0.0	0.0	0.0				
SC Combustion Turbines	0.0	0.0	26.7	32.1				
Fuel Cells	0.0	0.0	0.0	0.0				
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0				
Spot Market	146.5	151.0	192.3	194.4				
Total Generation/Purchase	**273.1**	**277.9**	**347.4**	**355.0**				
Surplus Sales	276.5	273.8	252.0	248.2				
BPA Purchase Reduction	161.6	155.8	265.9	265.0				
Net Total	-165.0	-151.7	-170.5	-158.3				

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000	Quantified Impact Factors						
	Water Consumed	Waste Water	Thermal Discharge	Employment Construction	Employment Operations	Soil/Land mining/extrac	Soil/Land construction
Resource Type	ac-ft/aMW	ac-ft/aMW	MMBtu/aMW	employ-yr/MW	employ/MW	acres/aMW	acres/MW
Centralia (existing pulverized coal)	10.69	1.87	42200	0.00	0.000	0.250	0.00
Conservation	0.00	0.00	0	30.00	0.000	0.000	0.00
Wind	0.00	0.00	0	1.90	0.400	0.000	5.90
Geothermal	0.00	0.00	0	4.10	0.300	0.000	0.27
Cogeneration	3.40	1.67	28800	1.88	0.116	0.025	0.15
CC Combustion Turbines	3.40	1.67	28800	1.88	0.116	0.025	0.15
SC Combusiton Turbines	0.148	0.148	0	1.88	0.116	0.025	0.15
Fuel Cells	0.97	0.00	0	0.00	0.000	0.020	0.05
Firm Purchases (SW SCCT)	0.148	0.148	0	1.88	0.116	0.025	0.15
Spot Market	5.46	1.50	29170	0.00	0.000	0.1025	0.00
Total Generation/Purchase							
Surplus Sales	5.46	1.50	29170	0.000	0.000	0.1025	0.000
BPA Purchase Reduction	5.46	1.50	29170	0.000	0.000	0.1025	0.000
Net Total							

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

		RESOURCE ASSUMPTIONS					
YEAR 2000		MW Capacity		Construction Impacts			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)							
Conservation	0	42	0	42	34	0	42
Wind				50	40		
Geothermal				30	16		
Cogeneration							41
CC Combustion Turbines			95		27	23	170
SC Combusiton Turbines	0	85	85	85	85	85	85
Fuel Cells							
Firm Purchases (SW SCCT)						65	65
Spot Market							
Total Generation/Purchase							
Surplus Sales							
BPA Purchase Reduction							
Net Total							

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

		RESOURCE ASSUMPTIONS					
YEAR 2000		aMW Generation			Operation Impacts		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	68.8	67.1	67.9	67.7	67.8	67.5	67.5
Conservation	0.0	42.0	0.0	42.0	34.0	0.0	42.0
Wind				5.8	4.6		
Geothermal				28.0	15.0		
Cogeneration							38.0
CC Combustion Turbines			45.0		12.5	10.3	69.1
SC Combusiton Turbines		16.8	20.8	20.5	20.6	20.1	24.3
Fuel Cells							
Firm Purchases (SW SCCT)						65.0	65.0
Spot Market	146.3	84.6	103.6	90.4	93.7	90.7	77.1
Total Generation/Purchase	**215.1**	**210.5**	**237.3**	**254.4**	**248.2**	**253.6**	**383.0**
Surplus Sales	100.6	136.2	108.3	118.5	115.1	119.3	123.2
BPA Purchase Reduction	76.7	35.1	90.7	94.0	93.1	94.3	214.5
Net Total	**37.8**	**39.2**	**38.3**	**41.9**	**40.0**	**40.0**	**45.3**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		Operational Impact			Water Consumed (ac-ft)		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	735.5	717.3	725.9	723.7	724.8	721.6	721.6
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	129.2
CC Combustion Turbines	0.0	0.0	153.0	0.0	42.5	35.0	234.9
SC Combusiton Turbines	0.0	2.5	3.1	3.0	3.0	3.0	3.6
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	9.6	9.6
Spot Market	798.8	461.9	565.7	493.6	511.6	495.2	421.0
Total Generation/Purchase	1,534.3	1,181.7	1,447.6	1,220.3	1,281.9	1,264.4	1,519.9
Surplus Sales	549.3	743.7	591.3	647.0	628.4	651.4	672.7
BPA Purchase Reduction	418.8	191.6	495.2	513.2	508.3	514.9	1,171.2
Net Total	566.2	246.4	361.0	60.1	145.2	98.2	-323.9

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		Operational Impact			Waste Water (ac-ft)		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Iternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	128.7	125.5	127.0	126.6	126.8	126.2	126.2
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	63.5
CC Combustion Turbines	0.0	0.0	75.2	0.0	20.9	17.2	115.4
SC Combusiton Turbines	0.0	2.5	3.1	3.0	3.0	3.0	3.6
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	9.6	9.6
Spot Market	219.5	126.9	155.4	135.6	140.6	136.1	115.7
Total Generation/Purchase	**348.1**	**254.9**	**360.6**	**265.2**	**291.3**	**292.1**	**433.9**
Surplus Sales	150.9	204.3	162.5	177.8	172.7	179.0	184.8
BPA Purchase Reduction	115.1	52.7	136.1	141.0	139.7	141.5	321.8
Net Total	**82.2**	**103.2**	**62.1**	**-53.5**	**-21.0**	**-28.3**	**-72.6**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		Operational Impact			Thermal Discharge (MMBtu)		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	2,903,360	2,831,620	2,865,380	2,856,940	2,861,160	2,848,500	2,848,500
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	0	0	0	0	1,094,400
CC Combustion Turbines	0	0	1,296,000	0	360,000	296,640	1,990,080
SC Combusiton Turbines	0	0	0	0	0	0	0
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	0	0
Spot Market	4,267,571	2,467,782	3,022,012	2,636,968	2,733,229	2,645,719	2,249,007
Total Generation/Purchase	**7,170,931**	**5,299,402**	**7,183,392**	**5,493,908**	**5,954,389**	**5,790,859**	**8,181,987**
Surplus Sales	2,934,502	3,972,954	3,159,111	3,456,645	3,357,467	3,479,981	3,593,744
BPA Purchase Reduction	2,237,339	1,023,867	2,645,719	2,741,980	2,715,727	2,750,731	6,256,965
Net Total	1,999,090	302,581	1,378,562	-704,717	-118,805	-439,853	-1,668,722

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		Construction Impacts			Employment (employee-yrs)		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conservation	0.0	1,260.0	0.0	1,260.0	1,020.0	0.0	1,260.0
Wind	0.0	0.0	0.0	95.0	76.0	0.0	0.0
Geothermal	0.0	0.0	0.0	123.0	65.6	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	77.1
CC Combustion Turbines	0.0	0.0	178.6	0.0	50.8	43.2	319.6
SC Combusiton Turbines	0.0	159.8	159.8	159.8	159.8	159.8	159.8
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	122.2	122.2
Spot Market	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Generation/Purchase	**0.0**	**1,419.8**	**338.4**	**1,637.8**	**1,372.2**	**325.2**	**1,938.7**
Surplus Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BPA Purchase Reduction	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Total	**0.0**	**1,419.8**	**338.4**	**1,637.8**	**1,372.2**	**325.2**	**1,938.7**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		Operational Impacts			New Employment (employees)		
	Alternative Resource Portfolios						
Resource Type	No Action Alternativ	Status Quo	Nat. Gas Emphasis	Less Env Impact	Resource Diversity	Firm Purchase	BPA Indep.
Centralia (existing pulverized coal)	0	0	0	0	0	0	0
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	20	16	0	0
Geothermal	0	0	0	9	5	0	0
Cogeneration	0	0	0	0	0	0	5
CC Combustion Turbines	0	0	11	0	3	3	20
SC Combusiton Turbines	0	10	10	10	10	10	10
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	8	8
Spot Market	0	0	0	0	0	0	0
Total Generation/Purchase	0	10	21	39	34	20	42
Surplus Sales	0	0	0	0	0	0	0
BPA Purchase Reduction	0	0	0	0	0	0	0
Net Total	0	10	21	39	34	20	42

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		**Operational Impact**				**Land (acres)**	
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	17.2	16.8	17.0	16.9	17.0	16.9	16.9
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	1.0
CC Combustion Turbines	0.0	0.0	1.1	0.0	0.3	0.3	1.7
SC Combusiton Turbines	0.0	0.4	0.5	0.5	0.5	0.5	0.6
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	1.6	1.6
Spot Market	15.0	8.7	10.6	9.3	9.6	9.3	7.9
Total Generation/Purchase	**32.2**	**25.9**	**29.2**	**26.7**	**27.4**	**28.6**	**29.7**
Surplus Sales	10.3	14.0	11.1	12.1	11.8	12.2	12.6
BPA Purchase Reduction	7.9	3.6	9.3	9.6	9.5	9.7	22.0
Net Total	**14.0**	**8.3**	**8.8**	**4.9**	**6.0**	**6.7**	**-4.9**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2000		Construction Impacts			Land (acres)		
	Alternative Resource Portfolios						
Resource Type	No Action Alternativ	Status Quo	Nat. Gas Emphasis	Less Env Impact	Resource Diversity	Firm Purchase	BPA Indep.
Centralia (existing pulverized coal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	295.0	236.0	0.0	0.0
Geothermal	0.0	0.0	0.0	8.1	4.3	0.0	0.0
Cogeneration	0.0	0.0	0.0	0.0	0.0	0.0	6.2
CC Combustion Turbines	0.0	0.0	14.3	0.0	4.1	3.5	25.5
SC Combusiton Turbines	0.0	12.8	12.8	12.8	12.8	12.8	12.8
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	9.8	9.8
Spot Market	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Generation/Purchase	**0.0**	**12.8**	**27.0**	**315.9**	**257.1**	**26.0**	**54.2**
Surplus Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BPA Purchase Reduction	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Total	0.0	12.8	27.0	315.9	257.1	26.0	54.2

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010	**Quantified Impact Factors**						
	Water	Waste	Thermal	Employment	Employment	Soil/Land	Soil/Land
	Consumed	Water	Discharge	Construction	Operations	mining/extrac	construction
Resource Type	ac-ft/aMW	ac-ft/aMW	MMBtu/aMW	employ-yr/MW	employ/MW	acres/aMW	acres/MW
Centralia (existing pulverized coal)	10.69	1.870	42200	0.00	0.000	0.250	0.00
Conservation	0.00	0.000	0	30.00	0.000	0.000	0.00
Wind	0.00	0.000	0	1.90	0.400	0.000	5.90
Geothermal	0.00	0.000	0	4.10	0.300	0.000	0.27
Cogeneration	3.40	1.670	28800	1.88	0.116	0.025	0.15
CC Combustion Turbines	3.40	1.670	28800	1.88	0.116	0.025	0.15
SC Combustion Turbines	0.148	0.148	0	1.88	0.116	0.025	0.15
Fuel Cells	0.97	0.000	0	0.00	0.000	0.020	0.05
Firm Purchases (SW SCCT)	0.148	0.148	0	1.88	0.116	0.025	0.15
Spot Market	5.46	1.50	29170	0.000	0.000	0.1025	0.000
Total Generation/Purchase							
Surplus Sales	5.46	1.50	29170	0.000	0.000	0.1025	0.000
BPA Purchase Reduction	5.46	1.50	29170	0.000	0.000	0.1025	0.000
Net Total							

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

		RESOURCE ASSUMPTIONS					
YEAR 2010		MW Capacity		Construction Impacts			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)							
Conservation	0	95	0	95	95	0	25
Wind				267	150		
Geothermal				130	54		
Cogeneration			87	49	33		136
CC Combustion Turbines			270		124	157	343
SC Combustion Turbines		85	85		85	85	85
Fuel Cells			31	95	21	0	41
Firm Purchases (SW SCCT)						210	65
Spot Market							
Total Generation/Purchase							
Surplus Sales							
BPA Purchase Reduction							
Net Total							

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

		RESOURCE ASSUMPTIONS					
YEAR 2010		aMW Generation			Operation Impacts		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	75.5	70.6	72.0	68.4	70.8	71.1	73.6
Conservation		95.0		95.0	95.0		25.0
Wind				19.7	12.1		
Geothermal				114.1	47.8		
Cogeneration			80.0	45.0	30.0		125.0
CC Combustion Turbines			108.2		48.2	56.3	139.6
SC Combustion Turbines		12.8	19.4		19.8	17.2	21.7
Fuel Cells			22.3	65.3	14.5		29.4
Firm Purchases (SW SCCT)						210.0	65.0
Spot Market	271.2	104.0	131.5	91.2	113.9	101.2	110.3
Total Generation/Purchase	**346.7**	**282.4**	**433.4**	**498.7**	**452.1**	**455.8**	**589.6**
Surplus Sales	65.8	130.2	98.9	153.5	112.1	118.4	97.8
BPA Purchase Reduction	18.2	-136.6	49.0	60.8	54.7	56.3	212.2
Net Total	**262.7**	**288.8**	**285.5**	**284.4**	**285.3**	**281.1**	**279.6**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		Operational Impact			Water Consumed (ac-ft)		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	807.1	754.7	769.7	731.2	756.9	760.1	786.8
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	272.0	153.0	102.0	0.0	425.0
CC Combustion Turbines	0.0	0.0	367.9	0.0	163.9	191.4	474.6
SC Combustion Turbines	0.0	1.9	2.9	0.0	2.9	2.5	3.2
Fuel Cells	0.0	0.0	21.6	63.3	14.1	0.0	28.5
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	31.1	9.6
Spot Market	1,480.8	567.8	718.0	498.0	621.9	552.6	602.2
Total Generation/Purchase	2,287.8	1,324.4	2,162.1	1,445.5	1,661.6	1,537.7	2,330.0
Surplus Sales	359.3	710.9	540.0	838.1	612.1	646.5	534.0
BPA Purchase Reduction	99.4	-745.8	267.5	332.0	298.7	307.4	1,158.6
Net Total	1,829.2	1,359.4	1,344.5	275.4	750.9	583.8	637.4

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		**Operational Impact**			**Waste Water (ac-ft)**		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Iternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	141.2	132.0	134.6	127.9	132.4	133.0	137.6
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	133.6	75.2	50.1	0.0	208.8
CC Combustion Turbines	0.0	0.0	180.7	0.0	80.5	94.0	233.1
SC Combustion Turbines	0.0	1.9	2.9	0.0	2.9	2.5	3.2
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	31.1	9.6
Spot Market	406.8	156.0	197.3	136.8	170.9	151.8	165.5
Total Generation/Purchase	**548.0**	**289.9**	**649.1**	**339.9**	**436.8**	**412.4**	**757.8**
Surplus Sales	98.7	195.3	148.4	230.3	168.2	177.6	146.7
BPA Purchase Reduction	27.3	-204.9	73.5	91.2	82.1	84.5	318.3
Net Total	**422.0**	**299.5**	**427.2**	**18.4**	**186.6**	**150.4**	**292.8**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		Operational Impact			Thermal Discharge (MMBtu)		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	3,186,100	2,979,320	3,038,400	2,886,480	2,987,760	3,000,420	3,105,920
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	2,304,000	1,296,000	864,000	0	3,600,000
CC Combustion Turbines	0	0	3,116,160	0	1,388,160	1,621,440	4,020,480
SC Combustion Turbines	0	0	0	0	0	0	0
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	0	0
Spot Market	7,910,904	3,033,680	3,835,855	2,660,304	3,322,463	2,952,004	3,217,451
Total Generation/Purchase	**11,097,004**	**6,013,000**	**12,294,415**	**6,842,784**	**8,562,383**	**7,573,864**	**13,943,851**
Surplus Sales	1,919,386	3,797,934	2,884,913	4,477,595	3,269,957	3,453,728	2,852,826
BPA Purchase Reduction	530,894	-3,984,622	1,429,330	1,773,536	1,595,599	1,642,271	6,189,874
Net Total	8,646,724	6,199,688	7,980,172	591,653	3,696,827	2,477,865	4,901,151

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		**Construction Impacts**			**Employment (employee-yrs)**		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conservation	0.0	2,850.0	0.0	2,850.0	2,850.0	0.0	750.0
Wind	0.0	0.0	0.0	507.3	285.0	0.0	0.0
Geothermal	0.0	0.0	0.0	533.0	221.4	0.0	0.0
Cogeneration	0.0	0.0	163.6	92.1	62.0	0.0	255.7
CC Combustion Turbines	0.0	0.0	507.6	0.0	233.1	295.2	644.8
SC Combustion Turbines	0.0	159.8	159.8	0.0	159.8	159.8	159.8
Fuel Cells	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	394.8	122.2
Spot Market	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Generation/Purchase	**0.0**	**3,009.8**	**831.0**	**3,982.4**	**3,811.4**	**849.8**	**1,932.5**
Surplus Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BPA Purchase Reduction	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Total	**0.0**	**3,009.8**	**831.0**	**3,982.4**	**3,811.4**	**849.8**	**1,932.5**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		Operational Impacts			New Employment (employees)		
	Alternative Resource Portfolios						
Resource Type	No Action Alternativ	Status Quo	Nat. Gas Emphasis	Less Env Impact	Resource Diversity	Firm Purchase	BPA Indep.
Centralia (existing pulverized coal)	0	0	0	0	0	0	0
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	107	60	0	0
Geothermal	0	0	0	39	16	0	0
Cogeneration	0	0	10	6	4	0	16
CC Combustion Turbines	0	0	31	0	14	18	40
SC Combustion Turbines	0	10	10	0	10	10	10
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	24	8
Spot Market	0	0	0	0	0	0	0
Total Generation/Purchase	0	10	51	151	104	52	73
Surplus Sales	0	0	0	0	0	0	0
BPA Purchase Reduction	0	0	0	0	0	0	0
Net Total	0	10	51	151	104	52	73

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		Operational Impact				Land (acres)	
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	18.9	17.7	18.0	17.1	17.7	17.8	18.4
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Geothermal	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Cogeneration	0.0	0.0	2.0	1.1	0.8	0.0	3.1
CC Combustion Turbines	0.0	0.0	2.7	0.0	1.2	1.4	3.5
SC Combustion Turbines	0.0	0.3	0.5	0.0	0.5	0.4	0.5
Fuel Cells	0.0	0.0	0.4	1.3	0.3	0.0	0.6
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	5.3	1.6
Spot Market	27.8	10.7	13.5	9.3	11.7	10.4	11.3
Total Generation/Purchase	**46.7**	**28.6**	**37.1**	**28.9**	**32.1**	**35.2**	**39.1**
Surplus Sales	6.7	13.3	10.1	15.7	11.5	12.1	10.0
BPA Purchase Reduction	1.9	-14.0	5.0	6.2	5.6	5.8	21.8
Net Total	38.1	29.3	22.0	6.9	15.0	17.3	7.3

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 2010		Construction Impacts			Land (acres)		
	Alternative Resource Portfolios						
Resource Type	No Action Alternativ	Status Quo	Nat. Gas Emphasis	Less Env Impact	Resource Diversity	Firm Purchase	BPA Indep.
Centralia (existing pulverized coal)	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Conservation	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Wind	0.0	0.0	0.0	1,575.3	885.0	0.0	0.0
Geothermal	0.0	0.0	0.0	35.1	14.6	0.0	0.0
Cogeneration	0.0	0.0	13.1	7.4	5.0	0.0	20.4
CC Combustion Turbines	0.0	0.0	40.5	0.0	18.6	23.6	51.5
SC Combustion Turbines	0.0	12.8	12.8	0.0	12.8	12.8	12.8
Fuel Cells	0.0	0.0	1.6	4.8	1.1	0.0	2.1
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0	0.0	31.5	9.8
Spot Market	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Total Generation/Purchase	**0.0**	**12.8**	**67.9**	**1,622.5**	**936.9**	**67.8**	**96.4**
Surplus Sales	0.0	0.0	0.0	0.0	0.0	0.0	0.0
BPA Purchase Reduction	0.0	0.0	0.0	0.0	0.0	0.0	0.0
Net Total	**0.0**	**12.8**	**67.9**	**1,622.5**	**936.9**	**67.8**	**96.4**

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998	Quantified Impact Factors						
	Water	Waste	Thermal	Employment	Employment	Soil/Land	Soil/Land
	Consumed	Water	Discharge	Construction	Operations	mining/extrac	construction
Resource Type	ac-ft/aMW	ac-ft/aMW	MMBtu/aMW	employ-yr/MW	employ/MW	acres/aMW	acres/MW
Centralia (existing pulverized coal)	10.69	1.870	42200	0.00	0.000	0.250	0.00
Conservation	0.00	0.000	0	30.00	0.000	0.000	0.00
Wind	0.00	0.000	0	1.90	0.400	0.000	5.90
Geothermal	0.00	0.000	0	4.10	0.300	0.000	0.27
Cogeneration	3.40	1.670	28800	1.88	0.116	0.025	0.15
CC Combustion Turbines	3.40	1.670	28800	1.88	0.116	0.025	0.15
SC Combustion Turbines	0.148	0.148	0	1.88	0.116	0.025	0.15
Fuel Cells	0.97	0.000	0	0.00	0.000	0.020	0.05
Firm Purchases (SW SCCT)	0.148	0.148	0	1.88	0.116	0.025	0.15
Spot Market	5.46	1.50	29170	0.000	0.000	0.1025	0.000
Total Generation/Purchase							
Surplus Sales	5.46	1.50	29170	0.000	0.000	0.1025	0.000
BPA Purchase Reduction	5.46	1.50	29170	0.000	0.000	0.1025	0.000
Net Total							

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

		RESOURCE ASSUMPTIONS					
YEAR 1998		MW Capacity		Construction Impacts			
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)							
Conservation	28	19	26	19			
Wind							
Geothermal							
Cogeneration							
CC Combustion Turbines							
SC Combustion Turbines							
Fuel Cells							
Firm Purchases (SW SCCT)							
Spot Market							
Total Generation/Purchase							
Surplus Sales							
BPA Purchase Reduction							
Net Total							

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

		RESOURCE ASSUMPTIONS					
YEAR 1998		aMW Generation			Operation Impacts		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	78.1	78.3	79.2	79.3			
Conservation	26.0	19.0	26.0	19.0			
Wind							
Geothermal							
Cogeneration							
CC Combustion Turbines							
SC Combustion Turbines	0.0	0.0	16.5	19.8			
Fuel Cells							
Firm Purchases (SW SCCT)							
Spot Market	77.8	80.2	102.1	103.2			
Total Generation/Purchase	**181.9**	**177.5**	**223.8**	**221.3**			
Surplus Sales	146.8	145.4	133.8	131.8			
BPA Purchase Reduction	85.8	82.7	141.2	140.7			
Net Total	-50.7	-50.6	-51.2	-51.2			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Operational Impact			Water Consumed (ac-ft)		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	834.9	837.0	846.6	847.7			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	2.4	2.9			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	424.8	437.9	557.5	563.5			
Total Generation/Purchase	1,259.7	1,274.9	1,406.6	1,414.1			
Surplus Sales	801.5	793.9	730.5	719.6			
BPA Purchase Reduction	468.5	451.5	771.0	768.2			
Net Total	-10.3	29.5	-94.9	-73.7			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Operational Impact			Waste Water (ac-ft)		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	146.0	146.4	148.1	148.3			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	2.4	2.9			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	116.7	120.3	153.2	154.8			
Total Generation/Purchase	**262.7**	**266.7**	**303.7**	**306.0**			
Surplus Sales	220.2	218.1	200.7	197.7			
BPA Purchase Reduction	128.7	124.1	211.8	211.1			
Net Total	-86.2	-75.4	-108.8	-102.7			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Operational Impact			Thermal Discharge (MMBtu)		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	3,295,820	3,304,260	3,342,240	3,346,460			
Conservation	0	0	0	0			
Wind	0	0	0	0			
Geothermal	0	0	0	0			
Cogeneration	0	0	0	0			
CC Combustion Turbines	0	0	0	0			
SC Combustion Turbines	0	0	0	0			
Fuel Cells	0	0	0	0			
Firm Purchases (SW SCCT)	0	0	0	0			
Spot Market	2,269,426	2,339,434	2,978,257	3,010,344			
Total Generation/Purchase	**5,565,246**	**5,643,694**	**6,320,497**	**6,356,804**			
Surplus Sales	4,282,156	4,241,318	3,902,946	3,844,606			
BPA Purchase Reduction	2,502,786	2,412,359	4,118,804	4,104,219			
Net Total	-1,219,696	-1,009,983	-1,701,253	-1,592,021			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Construction Impacts			Employment (employee-yrs)		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	0.0	0.0	0.0	0.0			
Conservation	780.0	570.0	780.0	570.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	0.0	0.0			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	0.0	0.0	0.0	0.0			
Total Generation/Purchase	780.0	570.0	780.0	570.0			
Surplus Sales	0.0	0.0	0.0	0.0			
BPA Purchase Reduction	0.0	0.0	0.0	0.0			
Net Total	780.0	570.0	780.0	570.0			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Operational Impacts			New Employment (employees)		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	0	0	0	0			
Conservation	0	0	0	0			
Wind	0	0	0	0			
Geothermal	0	0	0	0			
Cogeneration	0	0	0	0			
CC Combustion Turbines	0	0	0	0			
SC Combustion Turbines	0	0	0	0			
Fuel Cells	0	0	0	0			
Firm Purchases (SW SCCT)	0	0	0	0			
Spot Market							
Total Generation/Purchase	0	0	0	0			
Surplus Sales	0	0	0	0			
BPA Purchase Reduction	0	0	0	0			
Net Total	0	0	0	0			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Operational Impact				Land (acres)	
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	19.5	19.6	19.8	19.8			
Conservation	0.0	0.0	0.0	0.0			
Wind	0.0	0.0	0.0	0.0			
Geothermal	0.0	0.0	0.0	0.0			
Cogeneration	0.0	0.0	0.0	0.0			
CC Combustion Turbines	0.0	0.0	0.0	0.0			
SC Combustion Turbines	0.0	0.0	0.4	0.5			
Fuel Cells	0.0	0.0	0.0	0.0			
Firm Purchases (SW SCCT)	0.0	0.0	0.0	0.0			
Spot Market	8.0	8.2	10.5	10.6			
Total Generation/Purchase	27.5	27.8	30.7	30.9			
Surplus Sales	15.0	14.9	13.7	13.5			
BPA Purchase Reduction	8.8	8.5	14.5	14.4			
Net Total	3.7	4.4	2.5	3.0			

SCL SRA EIS
Quantified Impacts, Non-Air&Fuel

YEAR 1998		Construction Impacts			Land (acres)		
	Alternative SRA Recommendations						
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)							
Conservation							
Wind							
Geothermal							
Cogeneration							
CC Combustion Turbines							
SC Combustion Turbines							
Fuel Cells							
Firm Purchases (SW SCCT)							
Spot Market							
Total Generation/Purchase							
Surplus Sales							
BPA Purchase Reduction							
Net Total							

SCL SRA DEIS
Quantified Impacts, Fuel Use

YEAR 2000	Fuel Use Rates		
		Natural	Backup
	Coal	Gas	Fuel Oil
Resource Type	tons/aMW	1000cf/aMW	1000gal/aMW
Centralia (existing pulverized coal)	6156	0	0
Conservation	0	0	0
Wind	0	0	0
Geothermal	0	0	0
Cogeneration	0	59704	0
CC Combustion Turbines	0	60759	24
SC Combusiton Turbines	0	90572	35
Fuel Cells	0	51029	0
Firm Purchases (SW SCCT)	0	90572	35
Spot Market	1958	51968	0
Total Generation/Purchase			
Surplus Sales	1958	51968	0
BPA Purchase Reduction	1958	51968	0
Net Total			

		RESOURCE ASSUMPTIONS					
YEAR 2000		aMW Generation			Operation Impacts		
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	68.8	67.1	67.9	67.7	67.8	67.5	67.5
Conservation	0.0	42.0	0.0	42.0	34.0	0.0	42.0
Wind				5.8	4.6		
Geothermal				28.0	15.0		
Cogeneration							38.0
CC Combustion Turbines			45.0		12.5	10.3	69.1
SC Combusiton Turbines		16.8	20.8	20.5	20.6	20.1	24.3
Fuel Cells							
Firm Purchases (SW SCCT)						65.0	65.0
Spot Market	146.3	84.6	103.6	90.4	93.7	90.7	77.1
Total Generation/Purchase	**215.1**	**210.5**	**237.3**	**254.4**	**248.2**	**253.6**	**383.0**
Surplus Sales	100.6	136.2	108.3	118.5	115.1	119.3	123.2
BPA Purchase Reduction	76.7	35.1	90.7	94.0	93.1	94.3	214.5
Net Total	37.8	39.2	38.3	41.9	40.0	40.0	45.3

YEAR 2000		Fuel Use		Coal (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	423,533	413,068	417,992	416,761	417,377	415,530	415,530
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	0	0	0	0	0
CC Combustion Turbines	0	0	0	0	0	0	0
SC Combusiton Turbines	0	0	0	0	0	0	0
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	0	0
Spot Market	286,455	165,647	202,849	177,003	183,465	177,591	150,962
Total Generation/Purchase	**709,988**	**578,714**	**620,841**	**593,764**	**600,841**	**593,121**	**566,492**
Surplus Sales	196,975	266,680	212,051	232,023	225,366	233,589	241,226
BPA Purchase Reduction	150,179	68,726	177,591	184,052	182,290	184,639	419,991
Net Total	362,835	243,309	231,199	177,689	193,186	174,892	-94,725

YEAR 2000		Fuel Use		Natural Gas (1000 cf)			
	Alternative Resource Portfolios						
Resource Type	No Action Alternative	Status Quo	Nat. Gas Emphasis	Less Env Impact	Resource Diversity	Firm Purchase	BPA Indep.
Centralia (existing pulverized coal)	0	0	0	0	0	0	0
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	0	0	0	0	2,268,752
CC Combustion Turbines	0	0	2,734,155	0	759,488	625,818	4,198,447
SC Combusiton Turbines	0	1,521,610	1,883,898	1,856,726	1,865,783	1,820,497	2,200,900
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	5,887,180	5,887,180
Spot Market	7,602,918	4,396,493	5,383,885	4,697,907	4,869,402	4,713,498	4,006,733
Total Generation/Purchase	**7,602,918**	**5,918,102**	**10,001,937**	**6,554,633**	**7,494,672**	**13,046,993**	**18,562,011**
Surplus Sales	5,227,981	7,078,042	5,628,134	6,158,208	5,981,517	6,199,782	6,402,458
BPA Purchase Reduction	3,985,946	1,824,077	4,713,498	4,884,992	4,838,221	4,900,582	11,147,136
Net Total	-1,611,008	-2,984,016	-339,695	-4,488,567	-3,325,065	1,946,628	1,012,418

YEAR 2000		Fuel Use		Backup Fuel Oil (1000gals)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	0	0	0	0	0	0	0
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	0	0	0	0	0
CC Combustion Turbines	0	0	1,080	0	300	247	1,658
SC Combusiton Turbines	0	588	728	718	721	704	851
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	2,275	2,275
Spot Market	0	0	0	0	0	0	0
Total Generation/Purchase	**0**	**588**	**1,808**	**718**	**1,021**	**3,226**	**4,784**
Surplus Sales	0	0	0	0	0	0	0
BPA Purchase Reduction	0	0	0	0	0	0	0
Net Total	**0**	**588**	**1,808**	**718**	**1,021**	**3,226**	**4,784**

YEAR 2010	Fuel Use Rates		
		Natural	Backup
	Coal	Gas	Fuel Oil
Resource Type	tons/aMW	1000cf/aMW	1000gal/aMW
Centralia (existing pulverized coal)	6156	0	0
Conservation	0	0	0
Wind	0	0	0
Geothermal	0	0	0
Cogeneration	0	59704	0
CC Combustion Turbines	0	60759	24
SC Combustion Turbines	0	90572	35
Fuel Cells	0	51029	0
Firm Purchases (SW SCCT)	0	90572	35
Spot Market	1958	51968	0
Total Generation/Purchase			
Surplus Sales	1958	51968	0
BPA Purchase Reduction	1958	51968	0
Net Total			

		RESOURCE ASSUMPTIONS					
YEAR 2010		Alternative Resource Portfolios					
		aMW (Generation)			Operation Impacts		
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	75.5	70.6	72.0	68.4	70.8	71.1	73.6
Conservation		95.0		95.0	95.0		25.0
Wind				19.7	12.1		
Geothermal				114.1	47.8		
Cogeneration			80.0	45.0	30.0		125.0
CC Combustion Turbines			108.2		48.2	56.3	139.6
SC Combustion Turbines		12.8	19.4		19.8	17.2	21.7
Fuel Cells			22.3	65.3	14.5		29.4
Firm Purchases (SW SCCT)						210.0	65.0
Spot Market	271.2	104.0	131.5	91.2	113.9	101.2	110.3
Total Generation/Purchase	**346.7**	**282.4**	**433.4**	**498.7**	**452.1**	**455.8**	**589.6**
Surplus Sales	65.8	130.2	98.9	153.5	112.1	118.4	97.8
BPA Purchase Reduction	18.2	-136.6	49.0	60.8	54.7	56.3	212.2
Net Total	**262.7**	**288.8**	**285.5**	**284.4**	**285.3**	**281.1**	**279.6**

YEAR 2010		Fuel Use		Coal (tons)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternativ	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	464,778	434,614	443,232	421,070	435,845	437,692	453,082
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	0	0	0	0	0
CC Combustion Turbines	0	0	0	0	0	0	0
SC Combustion Turbines	0	0	0	0	0	0	0
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	0	0
Spot Market	531,010	203,632	257,477	178,570	223,016	198,150	215,967
Total Generation/Purchase	**995,788**	**638,246**	**700,709**	**599,640**	**658,861**	**635,841**	**669,049**
Surplus Sales	128,836	254,932	193,646	300,553	219,492	231,827	191,492
BPA Purchase Reduction	35,636	-267,463	95,942	119,046	107,103	110,235	415,488
Net Total	831,316	650,777	411,121	180,041	332,267	293,779	62,069

YEAR 2010		**Fuel Use**		**Natural Gas (1000 cf)**			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	0	0	0	0	0	0	0
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	4,776,320	2,686,680	1,791,120	0	7,463,000
CC Combustion Turbines	0	0	6,574,124	0	2,928,584	3,420,732	8,481,956
SC Combustion Turbines	0	1,159,322	1,757,097	0	1,793,326	1,557,838	1,965,412
Fuel Cells	0	0	1,137,947	3,332,194	739,921	0	1,500,253
Firm Purchases (SW SCCT)	0	0	0	0	0	19,020,120	5,887,180
Spot Market	14,093,722	5,404,672	6,833,792	4,739,482	5,919,155	5,259,162	5,732,070
Total Generation/Purchase	**14,093,722**	**6,563,994**	**21,079,279**	**10,758,355**	**13,172,105**	**29,257,852**	**31,029,872**
Surplus Sales	3,419,494	6,766,234	5,139,635	7,977,088	5,825,613	6,153,011	5,082,470
BPA Purchase Reduction	945,818	-7,098,829	2,546,432	3,159,654	2,842,650	2,925,798	11,027,610
Net Total	**9,728,410**	**6,896,589**	**13,393,212**	**-378,387**	**4,503,843**	**20,179,042**	**14,919,792**

YEAR 2010		Fuel Use		Backup Fuel Oil (1000gals)			
	Alternative Resource Portfolios						
	No Action	Status	Nat. Gas	Less Env	Resource	Firm	BPA
Resource Type	Alternative	Quo	Emphasis	Impact	Diversity	Purchase	Indep.
Centralia (existing pulverized coal)	0	0	0	0	0	0	0
Conservation	0	0	0	0	0	0	0
Wind	0	0	0	0	0	0	0
Geothermal	0	0	0	0	0	0	0
Cogeneration	0	0	0	0	0	0	0
CC Combustion Turbines	0	0	2,597	0	1,157	1,351	3,350
SC Combustion Turbines	0	448	679	0	693	602	760
Fuel Cells	0	0	0	0	0	0	0
Firm Purchases (SW SCCT)	0	0	0	0	0	7,350	2,275
Spot Market	0	0	0	0	0	0	0
Total Generation/Purchase	**0**	**448**	**3,276**	**0**	**1,850**	**9,303**	**6,385**
Surplus Sales	0	0	0	0	0	0	0
BPA Purchase Reduction	0	0	0	0	0	0	0
Net Total	0	448	3,276	0	1,850	9,303	6,385

YEAR 1998	Fuel Use Rates		
		Natural	Backup
	Coal	Gas	Fuel Oil
Resource Type	tons/aMW	1000cf/aMW	1000gal/aMW
Centralia (existing pulverized coal)	6156	0	0
Conservation	0	0	0
Wind	0	0	0
Geothermal	0	0	0
Cogeneration	0	59704	0
CC Combustion Turbines	0	60759	24
SC Combustion Turbines	0	90572	35
Fuel Cells	0	51029	0
Firm Purchases (SW SCCT)	0	90572	35
Spot Market	1958	51968	0
Total Generation/Purchase			
Surplus Sales	1958	51968	0
BPA Purchase Reduction	1958	51968	0
Net Total			

		RESOURCE ASSUMPTIONS					
YEAR 1998		Alternative SRA Recommendations					
		aMW (Generation)			Operation Impacts		
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	78.1	78.3	79.2	79.3			
Conservation	26.0	19.0	26.0	19.0			
Wind							
Geothermal							
Cogeneration							
CC Combustion Turbines							
SC Combustion Turbines	0.0	0.0	16.5	19.8			
Fuel Cells							
Firm Purchases (SW SCCT)							
Spot Market	77.8	80.2	102.1	103.2			
Total Generation/Purchase	**181.9**	**177.5**	**223.8**	**221.3**			
Surplus Sales	146.8	145.4	133.8	131.8			
BPA Purchase Reduction	85.8	82.7	141.2	140.7			
Net Total	-50.7	-50.6	-51.2	-51.2			

YEAR 1998		**Fuel Use**		**Coal (tons)**			
		Alternative SRA Recommendations					
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	480784	482,015	487,555	488,171			
Conservation	0	0	0	0			
Wind	0	0	0	0			
Geothermal	0	0	0	0			
Cogeneration	0	0	0	0			
CC Combustion Turbines	0	0	0	0			
SC Combustion Turbines	0	0	0	0			
Fuel Cells	0	0	0	0			
Firm Purchases (SW SCCT)	0	0	0	0			
Spot Market	152332	157,032	199,912	202,066			
Total Generation/Purchase	**633,116**	**639,046**	**687,467**	**690,236**			
Surplus Sales	287,434	284,693	261,980	258,064			
BPA Purchase Reduction	167,996	161,927	276,470	275,491			
Net Total	**177,685**	**192,427**	**149,017**	**156,681**			

YEAR 1998		Fuel Use		Natural Gas (1000 cf)			
		Alternative SRA Recommendations					
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	0	0	0	0			
Conservation	0	0	0	0			
Wind	0	0	0	0			
Geothermal	0	0	0	0			
Cogeneration	0	0	0	0			
CC Combustion Turbines	0	0	0	0			
SC Combustion Turbines	0	0	1494438	1793326			
Fuel Cells	0	0	0	0			
Firm Purchases (SW SCCT)	0	0	0	0			
Spot Market	4043110	4167834	5305933	5363098			
Total Generation/Purchase	4043110	4167834	6800371	7156423			
Surplus Sales	7628902	7556147	6953318	6849382			
BPA Purchase Reduction	4458854	4297754	7337882	7311898			
Net Total	-8044646	-7686067	-7490829	-7004857			

YEAR 1998		**Fuel Use**		**Backup Fuel Oil (1000gals)**			
		Alternative SRA Recommendations					
Resource Type	Alt. A	Alt. B	Alt. C	Alt. D			
Centralia (existing pulverized coal)	0	0	0	0			
Conservation	0	0	0	0			
Wind	0	0	0	0			
Geothermal	0	0	0	0			
Cogeneration	0	0	0	0			
CC Combustion Turbines	0	0	0	0			
SC Combustion Turbines	0	0	578	693			
Fuel Cells	0	0	0	0			
Firm Purchases (SW SCCT)	0	0	0	0			
Spot Market	0	0	0	0			
Total Generation/Purchase	0	0	578	693			
Surplus Sales	0	0	0	0			
BPA Purchase Reduction	0	0	0	0			
Net Total	0	0	578	693			

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