Integrated Resource Plan

Draft Environmental Impact Statement

September 2006

Seattle City Light

FACT SHEET

Project Title: Seattle City Light Integrated Resource Plan

Proposed Action: Seattle City Light is preparing an Integrated Resource Plan (IRP) to determine strategies for the type, amount, and timing of new resource acquisitions over a time period between 2007 and 2026. Potential resources options include generation options, contract and market purchases, and conservation.

Location: The Integrated Resource Plan is not site specific, and evaluates resources that could be developed in the Pacific Northwest (Washington, Oregon, Idaho, and western Montana) and wholesale electricity markets in the western region.

Alternatives: A number of alternative resource portfolios that would satisfy City Light's future energy needs were evaluated. Each portfolio consists of different combinations of individual resources. The nine alternative portfolios are:

1. No Action – Rely on the Market
2. Renewables
3. Gas, 100% Block
4. Gas, Wind, 50% Block
5. Gas, Wind, Hydro
6. Gas, Biomass, Wind
7. Gas
8. Gas, Coal (Pulverized)
9. Wind, Coal (IGCC)IGCC

Proponent and Lead Agency: Seattle City Light

Responsible Official: Jorge Carrasco, Superintendent
Seattle City Light
PO Box 34023
Seattle, Washington 98124-4023

Required Approvals:	Adoption of the Integrated Resource Plan by the Mayor and Seattle City Council. No licenses or permits are required for the City Council to adopt the IRP. Development of new energy resources could require specific permits or approvals. Permitting would be considered in any project-specific environmental review.
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Date of Draft EIS Issuance:	**September 18, 2006**
Date Draft EIS Comments Due:	**October 18, 2006** Send comments to: Corinne Grande Seattle City Light, Environmental Affairs Division 700 Fifth Avenue PO Box 34023 Seattle, Washington 98124-4023 (206)386-4517 corinne.grande@seattle.gov
Public Hearing:	A Public Hearing comment on the Draft EIS is scheduled from **5:30 PM to 8 PM on October 10, 2006**, at: Seattle City Light 700 Fifth Avenue Room 4050/60 Seattle, WA 98104

Draft EIS Availability:	Copies of the Draft EIS may be reviewed at Seattle Public Library Downtown Branch, at 1000 Fourth Avenue, Seattle, WA, and at the Seattle City Light Visitor's Center at 700 Fifth Avenue, 32nd Floor, Seattle, WA 98104. The EIS is available at City Light's web site at www.seattle.gov/light/news/issues/irp Individual copies will be provided free of charge, upon request. Call (206) 386-4569.
Nature and Date of Final Action:	Final adoption of the IRP by the City Council could occur by the end of 2006.
Subsequent Environmental Review:	Development of individual energy resources by City Light would require project-specific environmental review.
Location of Background Data:	Seattle City Light Environmental Affairs Division 700 Fifth Avenue, Suite 3300 Seattle, WA 98104

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CHAPTER 1

Summary

1.1 Proponent/Lead Agency/Project Location

Seattle City Light is proposing an Integrated Resource Plan that evaluates alternatives for meeting electrical demand over a 20-year period. The proposed action is not site-specific, though only resources that could be acquired or developed within the Pacific Northwest (Washington, Oregon, Idaho, and western Montana) are included. The one exception is a Hydro Efficiency Improvement, which is site specific.

1.2 Project Overview

Seattle City Light (City Light) is a municipal electric utility serving Seattle and areas to the north and south. It owns and operates electricity generating, transmission, and distribution facilities and serves 370,000 metered customers. City Light is proposing an Integrated Resource Plan (IRP) covering the amount and timing of new resource acquisitions needed during the 2007 to 2026 time period. For the purposes of analysis, these resources are organized into nine resource portfolios (combinations of resources) that could meet anticipated future needs. Resources encompass both generation of electricity and conservation. Washington State law requires that City Light perform a detailed and consistent analysis of a wide range of commercially available resources. A draft of the proposed IRP is being prepared for submittal to the Seattle Mayor and Council in the fall of 2006.

The general steps involved in creating the IRP are:

- Description of existing City Light resources;
- Forecast of demand for electricity by month and year through 2027;
- Determination of when additional resources will be needed and how much, taking into account variable conditions and reliability criteria;
- Development of alternative "resource portfolios" or combinations of resources and measures to meet customers needs;
- Evaluation and comparison of alternatives based on cost, risk, reliability, and environmental impacts; and
- Additional assessment of alternatives considering different assumptions about future market conditions.

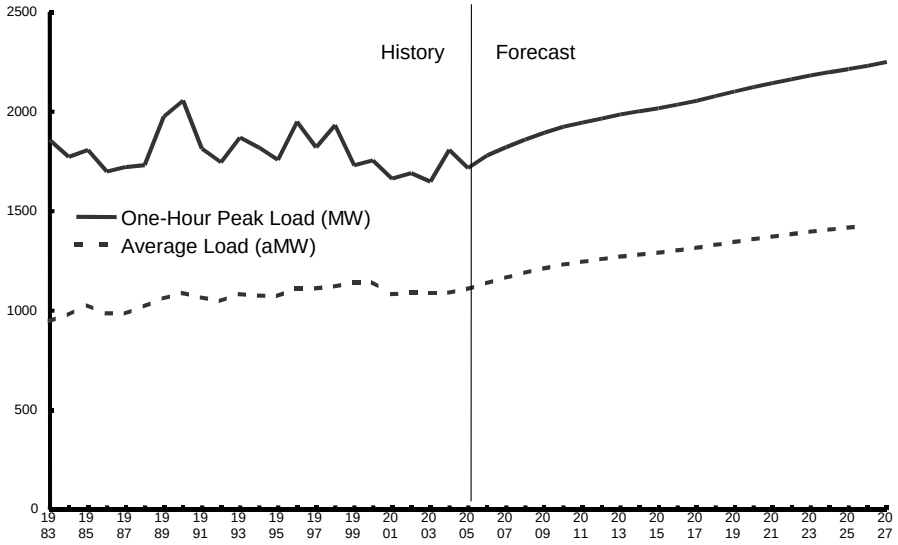
1.3 Purpose and Need for the Proposed Action

1.3.1 Load Forecasts

Seattle City Light's service area covers about 131 square miles and includes all of the City of Seattle, plus all or part of several political entities to the north and south of the City limits. These include Shoreline, Lake Forest Park, Mountlake Terrace, Tukwila, seat, Burin, Renton, Normandy Park, and parts of unincorporated King County.

Annual system energy load[1] (adjusted for weather) reached a high of 1,140 average megawatts (aMW) in 2000 but fell by 5.5 percent to 1,077 aMW during the most recent economic down turn. System load rebounded in 2005 to 1,107 aMW, still 33 aMW less than in 2000. Load is forecast to grow at an average annual rate of 1.2 percent though 2026, assuming no new conservation programs. Although there will be some years in which annual energy load growth will not be positive, the historical growth trend is expected to continue into the future. Figure 1-1 shows load history from 1980 though 2005 and the annual energy load forecast (with no new conservation resource) through 2026.

Figure 1-1. System Annual Energy Load and Peak Load History and Forecast
(with no new conservation program resources)



[1] Generating capacity-equivalent demand.

1.3.2 Seattle City Light's Existing Resources

City Light's existing resource portfolio consists of several hydroelectric projects it owns, and purchase contracts with the Bonneville Power Administration and several other utilities. The resource portfolio also includes energy savings from conservation resources that City Light and its customers have already implemented.

The resources City Light currently relies on are hydroelectric power (86 percent), conservation, wind (3 percent), natural gas (5 percent), nuclear (4 percent), and a small amount of other resources such as coal, biomass, and petroleum. Nearly one-half of City Light's generation comes from its own hydroelectric resources.

In planning for new resources, the IRP compared the forecasted differences between future load and existing resources that City Light owns or has contracts for over the planning period 2007 to 2026. Figure 1-2 compares forecast annual energy load with expected annual energy generation from existing resources.

Figure 1-2. Annual Energy Load Forecast and Expected Generation

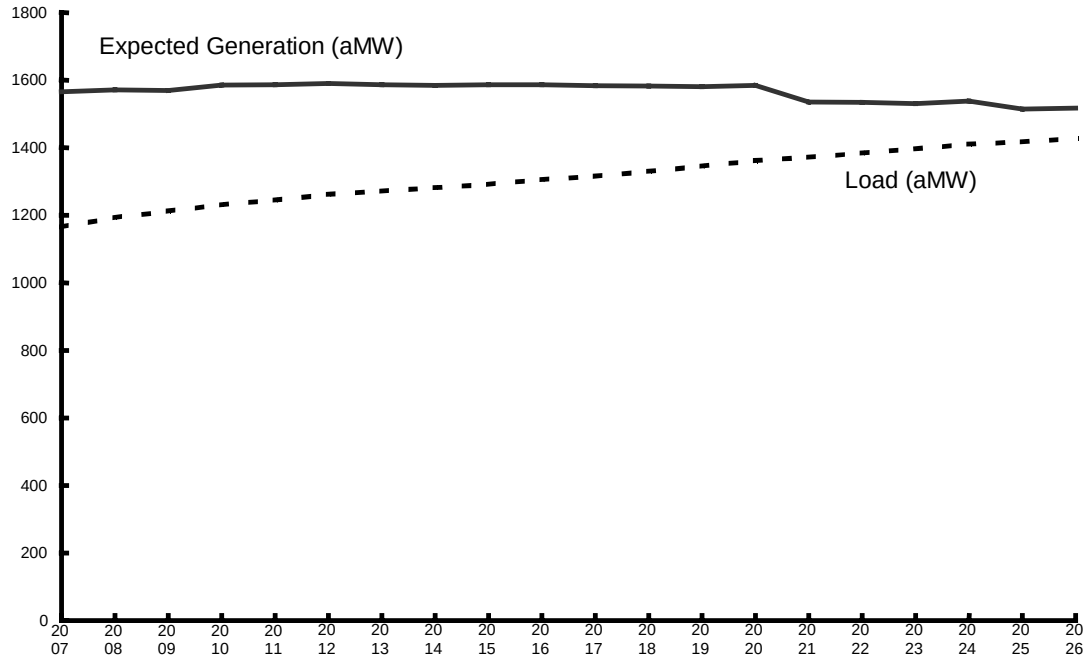


Figure 1-2 shows that *expected* generation on an annual basis appears to be sufficient to meet forecast annual energy load throughout the 20-year planning period. However, two factors may cause *actual* generation from existing resources to be less than energy load.

First, actual generation can be much less than expected due to variation in precipitation in the watersheds of the dams that City Light primarily relies upon.

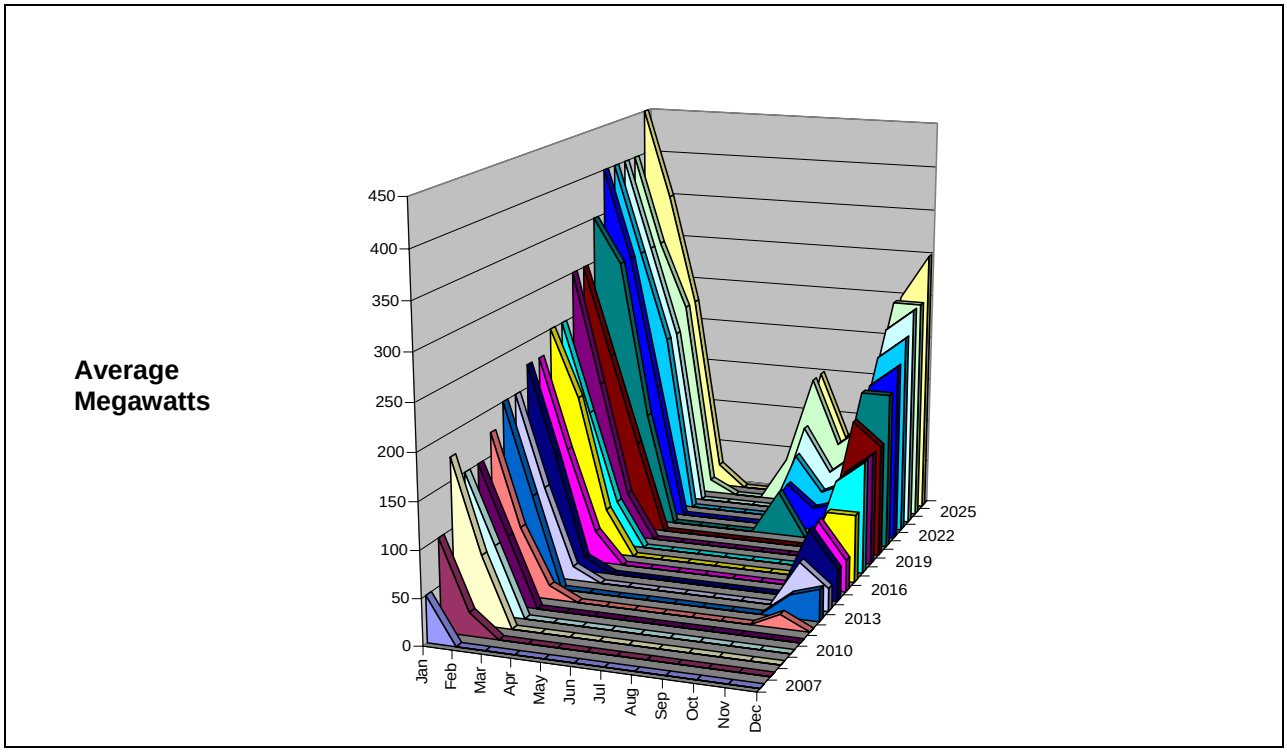
Secondly, the monthly profiles for loads and generation are not the same. For example, energy loads reach their highest levels during the winter months of each year, while power generation is usually highest in May and June. As a result, there is risk that monthly generation from existing resources may not meet monthly energy loads in winter months beginning in 2007, under low water conditions.

If severe weather occurs in the winter of a drought year, the system is stressed from both the generation and consumption sides. The one-hour peak load could easily surpass the all-time peak of 2,055 MW that occurred in 1990. The joint probabilities of low water and low temperatures, as well as the effects of load growth and other factors, are taken into account in assessing the performance of the existing and alternative resource portfolios.

1.3.3 Resource Adequacy and Need

City Light used a highly detailed computer model to simulate over a thousand possible combinations of demand and hydro conditions, and to determine the resource requirements necessary to achieve a 95-percent confidence level of having no unsaved energy in a month. The result is depicted in Figure 1-3.

Figure 1-3. Energy Resource Needs – 2007 to 2026



The analysis demonstrates City Light's resource needs are very seasonal in nature. Through 2026, City Light's resources are insufficient to meet a 95-percent confidence level during November through February. The greatest need occurs in January, growing from 50 aMW in 2007 to 450 aMW in 2026. No additional resources are needed in November and December until the year 2011. The remaining months (March through October) do not require any additional resources before the year 2021. In 2021, summer loads are forecast to have grown sufficiently to require additional summer resources to maintain a 95-percent confidence level.

1.4 Description of the Proposed Action and Alternatives

1.4.1 Resources

Based on future conditions that are considered most likely, referred to in the IRP as the Reference Case, it is anticipated that most growth in electric power resources in the Pacific Northwest will come from natural gas-fired generation. Hydro, nuclear, and coal-fired resources are forecast to remain relatively constant, while natural gas will grow from 14,126 GWh in 2006 to 40,581 GWh in 2026, an average annual rate of 5.4 percent per year. Renewables also see significant growth, from 4,821 GWh in 2006 to 10,551 GWh in 2026, an average annual rate of 4.0 percent per year.

The resources that City Light considered in its evaluation are listed in Table 1-1 and fully described in Chapter 2.

Table 1-1. IRP Resource Options

Conservation	100% BPA Block[2]
Hydro Contract	50% BPA Block
Hydro Efficiency Improvements	50% BPA Slice[3]
Seasonal Exchange	Combined Cycle Combustion Turbine
Seasonal Call Option	Combined Heat and Power Combustion Turbine (co-generation)
Wind	Simple Cycle Combustion Turbine
Landfill Gas	Integrated Coal Gasification Combined Cycle
Geothermal	Pulverized Coal
Biomass	Wholesale Power Market

[2] *Block* is a power product offered by the BPA for a fixed amount of power, delivered at a constant rate through the month.

[3] *Slice* is a power product offered by the BPA for an amount of power that varies year to year according to the amount of water flowing through the BPA hydroelectric system. In a good water year (above average precipitation), more power is delivered to the same customer than in a poor water year (below average precipitation).

1.4.2 Alternative Portfolios

1.4.2.1 Specification of Portfolios

The Proposed Action covered in this EIS is adoption of an Integrated Resource Plan containing City Light's long-term strategy (types of resources, amounts, and timing) for meeting electrical load over a 20-year period. Once electricity needs were defined, City Light developed a number of possible combinations of new resource additions that could meet the need. These combinations are called "portfolios". City Light has not yet identified a Preferred Alternative.

Three key objectives were considered in constructing the resource portfolios:

1. Develop a wide range of resource portfolios, including those containing predominantly renewable resources, those containing predominantly non-renewable resources, and those with a mixture of renewable and non-renewable resources.
2. Ensure sufficient supplies of generation each month during the 20-year period to avoid unserved energy needs with a 95-percent degree of confidence.
3. Utilize a mix of resources believed to be commercially available to Seattle City Light and resources specifically recommended for inclusion in the portfolios through the public input process.

Nine alternative resource portfolios that would satisfy City Light’s future energy needs were formulated. Each portfolio, consisting of different combinations of individual resources, represents an alternative “theme”. Evaluation criteria covering cost minimization, risk management, reliability, and minimization of environmental impacts were established for the portfolios, and each was subjected to analysis to determine how well they would perform under different future conditions. City Light used a computer model, EnerPrise Planning and Risk, to evaluate the performance of each portfolio. Assumptions about fuel and electricity prices, electricity supply and demand, and environmental regulations were varied. The Draft EIS uses the baseline assumptions about these variables (compiled as the Reference Case). The nine alternative portfolios are listed below and depicted in Table 1-2:

1. No Action – Rely on the Market
2. Renewables
3. Gas, 100% Block
4. Gas, Wind, 50% Block
5. Gas, Wind, Hydro
6. Gas, Biomass, Wind
7. Gas
8. Gas and Coal (Pulverized)
9. Wind and Coal (IGCC)

Table 1-2 depicts the new resources acquired in each of the resource portfolios between 2007 and 2026[4]. Common to all resource portfolios are 140 megawatts of conservation and 100 megawatts of exchange. Conservation and seasonal exchanges with utilities in other regions are seen as cost-effective approaches to meeting seasonal resource needs.

Five of eight portfolios contain a call option, with the amounts varying by portfolio. Call options (a 'reservation' on generating capacity that can be called on to produce electricity when needed, for a fee), help to improve the seasonal load-resource balance and can be a very effective tool for addressing seasonal resource needs. Hydro resources occur in two forms: a 10-megawatt efficiency upgrade to existing SCL hydro capacity and a 50-megawatt contract for existing hydro capacity from another utility. Wind resources are found in five portfolios, with the largest amount (750 megawatts) occurring in the Renewables portfolio.

Table 1-2. Total New Resources by Round 1 Portfolio
(Megawatts of Capacity in 2026)

	Resource Portfolio								
Resource	**1 Rely on Market**	**2 Renewables**	**3 Gas, 100% Block**	**4 Gas, Wind, 50% Block**	**5 Gas, Wind, Hydro**	**6 Gas, Biomass, Wind**	**7 Gas**	**8 Gas and Coal**	**9 Wind, IGCC**
Conservation		140	140	140	140	140	140	140	140
Exchange*		100	100	100	100	*100*	100	100	100
Call Option*		*70*	*100*		*50*	*50*			*70*
Hydro (Efficiency and Contract)		60			60				
Wind		750		150	150	150			450
Geothermal		25							
Landfill Gas		25			25	25			
Biomass		25				50			
CHP (co-gen.)					25				
CC Turbine			350	350	150	100	300	225	
SC Turbine			50		50	50	50		
IGCC - Coal									300
PV Coal								150	
2026 Total	**0**	**1,125**	**990**	**640**	**750**	**615**	**590**	**615**	**990**

*Call options and exchanges are temporary resources and may no longer be in the portfolio by 2026.

[4] The totals in Table 1-2 are for the year 2026. Please note that the totals may vary among portfolios because they represent generation capacity vs. energy actually produced. For example, because of the lesser reliability of wind energy, a greater generation capacity is required to produce an amount of electricity equal to that produced by another resource with higher reliability.

Geothermal occurs in one portfolio, landfill gas in three portfolios, biomass in two portfolios, and Combined Heat and Power (CHP, also called cogeneration) in one portfolio. All four of these resources are comparatively small, at 25 megawatts per unit.

Simple cycle and combined-cycle natural gas turbines are included in five portfolios. In three of the five portfolios, natural gas turbines make up more than one-half of the total resources added. Conversion of the BPA slice product to block in the 100-percent Block portfolio results in less BPA generation being available for the existing resources portion of the portfolio (see Section 1.3.2) because the potentially higher amounts of electricity available under the slice product would be foregone. Additional new resources must be added to make up for the loss to existing hydro resources. The 100-percent Block portfolio contains the most natural gas turbines (400 megawatts) of any portfolio.

City Light has not yet identified a Preferred Alternative. These portfolios will be refined base on the results of a second round of analysis and comments received. A Preferred Alternative may be identified through this process and will be described on the Final EIS.

1.4.2.2 Evaluation of Portfolios

To compare the portfolios, a series of calculations were completed for measures of cost, environmental impact, risk, and reliability. These criteria were selected for evaluating the relative performance of the resource portfolios being studied. The criteria and corresponding measures are shown in Table 1-3.

Table 1-3. Portfolio Objectives and Evaluation Criteria

Evaluation Criteria	Criteria Measures
Minimize Costs to Customers	20-Year Net Present Value of Portfolio Costs
Manage Risks	Volatility of Portfolio Costs
Provide Reliable Service	Occurrence of Unserved Customer Energy Need
Minimize Environmental Impacts	Level of Environmental Impacts including Monetized Values for Emissions of Pollutants including CO_2, SO_2, NOx, Mercury

Because the impacts in the elements of the environment cannot be combined into a single measure of environmental impact, this table shows the Direct Generation air emissions as a measure of environmental impact. The results of the portfolio evaluations using these measures are depicted in Figure 1-4.

Figure 1-4. Portfolio Comparison

	Total Cost	Environ-mental Impacts	Cost Risk	Market Risk	Revenue Less Cost ($5/ton for CO2)	Revenue Less Cost ($25/ton for CO2)
1. Rely on Market-No Action						
2. Renewables						
3. Gas, 100% Block						
4. Gas, Wind, 50% Block						
5. Gas, Wind, Hydro						
6. Gas, Biomass, Wind						
7. Gas						
8. Gas, Coal						
9. Wind, IGCC						

	Best Performing
	Mid Performing
	Worst Performing

The portfolios performing among the top third of portfolios across all six measures are:

- Renewables
- Gas, Wind, Hydro
- Gas

The top three portfolios in terms of net present value of net power costs (revenues net of costs) assuming a $5 per ton costs for CO2 emissions, are:

- Renewables
- Gas, Wind, Hydro
- Gas, Coal

If a $25 per ton cost for CO2 emissions is used, then the top three portfolios are:

- Renewables
- Gas, Wind, Hydro
- Gas, Biomass, Wind

The top three performing portfolios with respect to the lowest environmental impact, as measured by residual air emissions (carbon dioxide, sulfur dioxide, nitrogen oxide, particulates, and mercury) from generation, are:

- Renewables
- Gas, Wind, Hydro
- Gas, Biomass, Wind

1.5 Summary of Impacts and Mitigation

1.5.1 Impact Evaluation

The analysis of impacts draws upon assessments of individual resources presented in Appendix C. Appendix C is organized by energy resource, with impact conclusions presented for each element of the environment. The evaluations assign impact according to four levels: none, low, moderate, high. Each level reflects a subjective judgment about the "severity" of an impact, with the level of severity determined by considering the magnitude, extent, duration, and probability of an impact. This environmental assessment is programmatic in that specific sites or projects are not known or proposed.

The evaluation of air quality impacts is more extensive than for the other elements of the environment. This is because of its importance in evaluating the impacts of generating resources, and because emissions are easier to quantify without having site-specific information about resource location.

The impact evaluations for the individual resources and for the resource portfolios are summarized in Tables 1-5 and 1-6, respectively. The results are presented for each element of the environment separately for construction and operation. Where a range of potential impacts has been identified in the assessments in *Appendix C*, the highest level is depicted in Table 1-5. For example, the level of construction and operation impacts on Soils and Geology for coal-fired energy resources (4a and 4b) was determined to range from moderate to high; the "high" level of impact is shown in Table 1-5. The range of impact levels are attributable to uncertainty about the types and effectiveness of mitigation, site conditions, fuel extraction operations, methods of waste disposal, etc. Therefore, in some cases, the level of actual impacts may be less than shown in Table 1-5.

Table 1-5. Summary of Resource Impacts

Elements of the Environment	Resources											
	Landfill Gas	Wind	Gas - SCCT	Gas - CCCT	Coal - Pulver-ized	Coal - IGCC	Trans-mission	Geother-mal	Biomass	Hydro Gorge Tunnel	Conser-vation	Market Trans-actions
Soils and Geology												
Construction	L	M	M	M	H	H	M	H	L	M	N/A	0
Operation	0	L	M	M	H	H	L	H	M	0	0	M
Air Quality												
Construction	L	L	L	L	L	L	L	L	L	L	N/A	0
Operation	L	L	M	M	H	H	L	L	M	L	L	H
Surface and Groundwater												
Construction	L	L	L	L	L	L	M	L	L	L	N/A	0
Operation	L	L	M	M	H	H	M	M	M	0	0	M
Plants and Animals												
Construction	L	M	M	M	H	H	M	H	M	L	N/A	0
Operation	L	M	L	L	H	H	M	M	M	0	0	M
Energy and Natural Resources												
Construction	L	L	L	L	M	M	M	L	L	L	N/A	0
Operation	+	0	H	H	H	H	M	L	L	+	+	H
Environmental Health												
Construction	0	L	L	L	M	M	H	M	M	L	N/A	0
Operation	+	M	M	M	H	H	L	M	M	0	L	M
Land Use												
Construction	L	M	M	M	H	H	H	M	M	L	N/A	0
Operation	L	M	M	M	H	H	H	H	H	L	0	M
Aesthetics and Recreation												
Construction	L	M	M	M	M	M	M	H	M	M	N/A	0
Operation	L	H	M	M	H	H	H	H	H	L	0	M
Cultural Resources												
Construction	0	M	M	M	M	M	L	M	M	L	N/A	0
Operation	0	M	M	M	H	H	M	L	L	0	L	M
Economy												
Construction	+L	+L	+M	+M	+M	+M	+L	+L	+L	+L	+H	0
Operation	+L	+L	+L	+L	+M	+M	+L	+L	+L	+L	+L	+L

L	= Low impact	M	= Moderate impact	H	= High impact	+, +L, +M	= Positive impact
0	= No impact	N/A	= Not applicable				

Table 1-6. Summary of Portfolio Impacts

	Portfolios[a]								
	1	2	3	4	5	6	7	8	9
Elements of the Environment	Rely on the Market-No Action	Renew-ables	Gas, 100% Block	Gas, Wind, 50% Block	Gas, Wind, Hydro	Gas, Wind, Biomass	Gas	Gas, Coal	Wind, IGCC
Soils and Geology									
Construction	0	H	M	M	M	M	M	H	H
Operation	M	H	M	M	M	M	M	H	H
Air Quality									
Construction	0	L	L	L	L	L	L	L	L
Operation	H	M	H	M	H	M	H	H	H
Surface and Groundwater									
Construction	0	L	L	L	L	L	L	L	L
Operation	M	M	M	M	M	M	M	H	H
Plants and Animals									
Construction	0	H	M	M	M	M	M	H	H
Operation	M	M	M	M	M	M	M	H	H
Energy and Natural Resources									
Construction	0	L	L	L	L	L	L	M	M
Operation	H	L	H	H	H	H	H	H	H
Environmental Health									
Construction	0	M	L	L	L	M	L	M	M
Operation	M	M	M	M	M	M	M	H	H
Land Use									
Construction	0	M	M	M	M	M	M	H	H
Operation	M	H	M	M	M	H	M	H	H
Aesthetics and Recreation									
Construction	0	M	M	M	M	M	M	M	M
Operation	M	H	H	H	H	H	M	H	H
Cultural Resources									
Construction	0	M	M	M	M	M	M	M	M
Operation	M	M	M	M	M	M	M	H	H
Economy									
Construction	0	+L	+M	+M	+M	+M	+M	+M	+M
Operation	+L	+L	+L	+L	+L	+L	+L	+M	+M
	L	= Low impact		M	= Moderate impact		H	= High impact	
	+, +L, +M	= Positive impact		0	= No impact				

Note that +, +L, and +M represent positive impacts.

In general, the highest levels of potential impact are associated with coal-fired resources and, to a lesser extent, geothermal and biomass. Conservation, hydro efficiency improvements at an existing SCL hydro facility (Gorge tunnel) and landfill gas resources are expected to have the fewest environmental impacts, followed by wind and gas-fired combustion turbine resources. Overall, the following resources could potentially cause significant impacts:

- Both coal-fired resources (pulverized and IGCC)– due to several factors (e.g., extensive ground-disturbing activities at a plant site as well as for fuel extraction and air pollutant emissions).
- Gas turbines -- due to air quality impacts.
- Market Transactions -- the analysis assumes market transaction resources would be used that would have high levels of air emissions and fuel extraction.
- Geothermal – potential physical disturbance to geologic structures, groundwater impacts, and the possibility of development in pristine areas where land use and recreation impacts would be an issue.
- Biomass – if a dedicated crop is the fuel source, impacts could be high if extensive land areas are required involving substantial land disturbance, as well as impacts from transporting biomass fuel
- Wind – due to potential high aesthetic impacts and possible impacts on birds and bats.

The impact evaluations for the alternative portfolios shown in Table 1-6 combine the results for the individual resources and vary according to the composition and amount of resources in each portfolio. Accordingly, the portfolios with resources expected to create high levels of impact also are deemed to have high levels of impact. Portfolios 8, and 9 (Gas/Coal, and Wind/IGCC) could reach high levels of impact for all or nearly all elements of the environment. Several elements of the environment are also rated high for the portfolio 2 (Renewables) due to the possible high impacts that could occur with geothermal energy resource development and the aesthetic impacts of wind and portfolio 1 (Rely On Market - No Action) would have high air quality impacts/

Portfolio 7 (Gas), containing simple cycle and combined-cycle combustion turbines, would incur significant impacts for Air Quality. Portfolios 3 and 5(Gas/100% Block and Gas/Wind/Hydro) would incur significant impacts for Air Quality and Aesthetics and of wind energy development.

Much of the analysis is presented in relative terms in order to distinguish the alternative portfolios. The evaluation does not weigh the relative importance of impacts among elements of the environment. However, the cumulative impacts are reflected in the impact ratings for resource portfolios (see Sections 3.3 through 3.12). That is, the impact ratings for resource portfolios reflect the highest rating of the individual resources in the portfolio for each element of the environment. For example, Land Use impacts during operation for Portfolio 8 (Gas/Coal) would be “moderate” for Gas and “high” for Coal. The Land Use impact rating for the portfolio is “high”. In addition, even if the relative amounts of resources vary between portfolios, the highest rating of the individual re-

sources in the portfolio is applied. For air quality, both total direct emissions and indirect emissions for each portfolio due to market transactions were assessed and used to rate the level of impact.

1.5.2 Mitigation

The mitigating measures listed below will be considered in energy development decisions as appropriate. Some measures are required under governmental regulations, some may become part of specific development proposals, and some may be optional.

Geology and Soils

- Minimize the extent of ground disturbance required, such as by using existing roads to the extent possible. Locate new access roads to follow the local topography, and minimize sidehill cuts.
- Cover and stabilize exposed areas consistent with applicable standards, salvage removed topsoils and reclaim disturbed areas as soon as possible.
- Identify and avoid unstable slopes and other geologic hazards, and avoid creating excessive slopes during construction; use special construction techniques where applicable.
- Develop and implement a temporary storm water management system to control runoff, erosion, and sedimentation during construction.
- Implement a Spill Prevention Control and Countermeasure (SPCC) Plan.
- Employ Best Management Practices (BMPs) such as using straw, silt fences, and water detention ponds to reduce soil erosion and control storm water runoff.
- Implement a permanent storm water pollution prevention plan (SWPPP) to minimize soil erosion.

Air Quality

- Abide by regulations promulgated under the federal Clean Air Act.
- Implement Best Available Control Technology (BACT) on new plants.
- Demonstrate compliance with the National Ambient Air Quality Standards (NAAQS) for all air pollutants.
- Monitor emissions during operation to show they remain in compliance.
- Avoid emissions of greenhouse gas to the extent possible, through energy conservation and renewable resource acquisition.
- Purchase high quality greenhouse gas offsets at the lowest cost possible to cover any emissions that result from energy purchased from resources that emit CO_2.

Surface and Groundwater

- Use a recirculating system for cooling to reduce water requirements.
- Use treated wastewater where applicable.

- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.
- Characterize the surface and groundwater hydrology prior to construction, develop an understanding of discharge and recharge relationships, and avoid creating new hydrologic connections through grading and related activities.
- Monitor water quantity and quality conditions if construction activity is to occur near aquifer recharge areas.
- Implement BMPs for use, handling, and storage of fuels, pesticides and other hazardous materials during both construction and operation.
- Dispose of ash at approved sites.

Plants and Animals

- Conduct adequate surveys of plant and animal resources.
- Avoid siting facilities in areas that support unique or sensitive plants or wildlife habitat. Site facilities to avoid migration routes or other sensitive areas where plants and animals could experience significant impacts.
- Where possible, use existing roads and disturbed areas for project development, and minimize the area disturbed for project construction.
- Design necessary stream crossings to minimize disturbance and maintain aquatic habitat conditions.
- Develop and implement a restoration plan to restore disturbed plant and animal habitat.
- Purchase or reserve areas to replace habitat values lost through project development.
- Implement measures to minimize establishment of invasive species.
- Landscape site buffer areas with native plant species.
- Establish a monitoring program to assess impacts on the area's plants and animal species.

Energy and Natural Resources

- Use high efficiency technologies, regardless of fuel, which reduce the impacts to the energy resource, either directly by avoiding use of that resource in the plant or by producing more electricity from renewable sources, thus avoiding the use of a non-renewable source.
- Use conservation to reduce the need for new resources.

Environmental Health

- Restrict construction activities to daylight hours.
- Design and lay out plant facilities so that noise standards are not exceeded at the site boundary.
- Ensure adherence to all applicable occupational safety regulations and standards and project health and safety plans in construction and operation.

- Establish safety zones and setbacks to prevent public exposure to potential safety hazards during both construction and operation.
- Plan and design projects to comply with FAA requirements for notification and marking of tall structures to ensure aviation safety.
- Monitor noise conditions during project operation to ensure compliance with applicable community and occupational noise standards.
- Consider implementing a noise complaint and investigation program for the project operation period.
- Use precautionary measures such as low field designs to minimize increases in EMF exposure.

Land Use

- Locate the plant site to minimize land use impacts.
- Evaluate the project site before construction to make sure it conforms to local planning and zoning requirements and avoids compatibility issues with nearby uses.
- Locate new transmission facilities within or parallel to existing rights-of-way and avoid bisecting land uses such as cultivated farmland.
- Develop construction management plans that avoid or minimize disruptions to adjacent existing uses.

Aesthetics and Recreation

- If possible, locate facilities in areas with less viewer exposure and away from popular recreation areas and scenic vistas.
- Integrate facility design and configuration of structures into the surrounding landscape or otherwise incorporate aesthetic objectives into design.
- Minimize surface disturbance for roads and other project features, particularly on steep slopes, and avoid significant alteration of natural topographic features.
- If possible, provide vegetative screening to obstruct views of project facilities and fuel extraction sites from surrounding sensitive areas.
- Keep project facilities clean and well maintained throughout project operation.
- Compensate for impacts by implementing aesthetic improvements in other areas such as reclamation of unneeded roads.

Cultural Resources

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and Native American tribes with interests in the project area to determine the likelihood of any cultural resources within or near the project area, including the proposed route for transmission facilities.
- Conduct records searches and field surveys, if necessary, to identify and assess resources that may be present.
- Modify the project configuration, to the extent possible, to avoid cultural resources identified through the inventory process.
- If cultural resources are present in development areas and impacts cannot be avoided, develop and implement a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO and any affected tribes, develop an appropriate mitigation program, and negotiate next steps.

1.6 Unavoidable Significant Adverse Environmental Impacts

An unavoidable impact is a significant impact that cannot be mitigated.

As resource locations and facility designs have not been determined as part of the IRP, there is considerable uncertainty associated with identifying impacts that are both significant and unavoidable. Site locations and characteristics, generation technology, and mitigation designed to address specific impacts are unknown. This section makes general conclusions based upon available information.

Generally, there would be no unavoidable significant adverse impacts associated with conservation and system efficiency improvements for hydro.

All new generation facilities are likely to have unavoidable adverse impacts for:

- Displacement of land uses
- Temporary soil disturbance
- Water resource quantity and quality
- Permanent loss of vegetation and wildlife habitat
- Visual, aesthetic, and/or recreation resources

In addition, fossil-fueled generation facilities would likely have unavoidable adverse impacts for:

- Emissions of air pollutants
- Emission of greenhouse gases, contributing the climate change
- Consumption of water for cooling and other purposes

- Discharge of waste heat to the environment

Whether the impacts would rise to a level of being significant with mitigation is unknown.

For resource types such as wind and geothermal, whose siting is restricted by the location and availability of the primary energy source, there is a greater possibility of the following unavoidable adverse impacts rising to a level of significant:

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

Unavoidable adverse impacts on air quality will result from all the portfolios, but will have different magnitudes, duration, and extent. See section 3.4.2 for a detailed description of air emissions form each portfolio.

Carbon dioxide emissions contribute to climate change on a global level, and its impacts are not confined to the immediate area in which it is emitted. Carbon dioxide has a long lifetime in the atmosphere. Since there are currently no commercially available capture and control technologies for carbon dioxide, there is no feasible option for avoiding these emissions for a thermal power plant. City Light has committed to obtaining offsets for any unavoidable greenhouse gas emissions.

Nitrogen oxide emissions will occur in portfolios with electricity created through combustion of fuel, including fuel from sources that are considered renewable, such as biomass/wood and landfill gas. The impact of nitrogen oxide (NO_X) emissions can be significant, depending on the existing air quality and the presence of other pollution sources in the vicinity. Other emission sources play a role because one of the ways NO_X affects air quality is through combining with other air pollutants and forming ground level ozone (smog). Therefore, the extent to which unavoidable impacts occur depends on location and nearby activities. Generally, NO_X emissions have impacts on both local air quality and at locations far from the site, as they can be transported long distances through wind movement. In addition, NO_X contributes to acidification of precipitation and water bodies, and the subsequent damage to wildlife, vegetation, and the built environment.

The SO_X emissions from coal combustion are significant, even after control equipment is installed. Like NO_X, SO_X emissions can degrade air quality near the source plant and can be carried long distances away from the plant by winds. Mercury (HG) emissions from generation occur only in the portfolios that contain coal. Mercury controls are under development, and at the current time there is no way to prevent mercury emissions entirely in plants that combust coal, whether the traditional pulverized technology or in the advanced Integrated Gasification Combined Cycle (IGCC) technology. Due to the highly toxic characteristics of mercury, and its impacts to the health of humans and wildlife, even small emissions are considered significant. Like other pollutants, it is possible for mercury emissions to affect the local area around the plant and distant areas. There

is currently a great deal of debate about the potential for mercury transport and the potential for development of improved control technologies.

Particulates can be efficiently, but not completely, controlled in many power plants. However, emissions will remain. As for mercury and SO_X, the portfolios with coal emit the most particulates. Often particulates impact the general vicinity of the plant the most, because their mass causes them to 'fall' out of the air within shorter distances than gaseous pollutants, but there is still the potential that particulates could be transported longer distances.

1.7 Next Steps

The portfolios described in this Draft EIS will be refined based on the results of the analysis and comments received. They will be designed to perform better under the four portfolio evaluation criteria (Cost, Environmental Impacts, Risk, and Reliability) evaluated in the IRP. They will be designed to match City Light's energy needs more closely. It is anticipated that the environmental impacts of the adjusted portfolios will be within the range of those analyzed in this EIS. A Preferred Alternative may be identified through this process and will be described in the Final EIS.

CHAPTER 2

Description of the Proposed Action and Alternatives

2.1 Name of the Proposal

The proposal is adoption of an Integrated Resource Plan.

2.2 Proponent and Lead Agency

Seattle City Light

2.3 Location

The proposed action is not site-specific. The Integrated Resource Plan evaluates resources at potential locations throughout the Pacific Northwest (Washington, Oregon, Idaho, and western Montana).

2.4 Objectives of the Proposed Action

2.4.1 Need for and Purpose of an Integrated Resource Plan

2.4.1.1 Overview

Seattle City Light (City Light) is the municipal electric utility for the City of Seattle. It owns and operates electricity generation, transmission, and distribution facilities, and serves 370,000 metered customers. City Light is preparing an Integrated Resource Plan (IRP) whose overall objective is to determine strategies for the type, amount, and timing of new resource acquisitions over a time period between 2007 and 2026. Resources are the methods by which City Light is planning to meet its electricity needs and encompasses generation options and conservation. The purpose of this Draft Environmental Impact Statement (EIS) is to evaluate and disclose the potential environmental impacts of implementing the IRP.

The Need and Purpose section provides background on the IRP planning process and the context for how City Light evaluates its resource choices and their environmental impacts. In this section (Section 2.4.1), the existing conditions and forecasts for the future of City Light's electricity resources and demand for electricity (load) are described, followed by a brief description of existing City Light generation resources. Then, the standard for having enough electricity to meet load under a variety of conditions, called Resource Adequacy, is defined. Next, since resource planning also must consider factors beyond supply and demand, there is a section describing the policies, both internal and external to the City of Seattle and City Light, that influence the resource choices City Light makes.

Once this background has been established, Section 2.5, *Development of Alternatives* provides further detail on the quantity of resources that may need to be acquired and

their acquisition timeframe. The section also describes the potential resource types that are being evaluated, and the analytical process used to evaluate resource options, including a description of the computer model and inputs and assumptions used in the analysis. It also describes the potential range of future conditions for fuel and electricity prices in the wholesale market and resource performance.

Section 2.6, *Description of Alternatives*, describes the combinations of resources, called Portfolios, which are the Alternatives evaluated in this Draft EIS. The resources contained in each Portfolio are described, along with the megawatts of resource capacity that each would add to City Light's existing resources. Finally, Section 2.7, *Portfolio Evaluation*, describes the relative performance of the alternative portfolios against the evaluation criteria.

2.4.1.2 Seattle City Light Load (Demand for Electricity, 2007-2026)

Seattle City Light's service area covers about 131 square miles and includes all of the City of Seattle, plus all or part of several political entities to the north and south of the City limits. These entities include Shoreline, Lake Forest Park, Mountlake Terrace, Tukwila, SeaTac, Burien, Renton, Normandy Park, and parts of unincorporated King County.

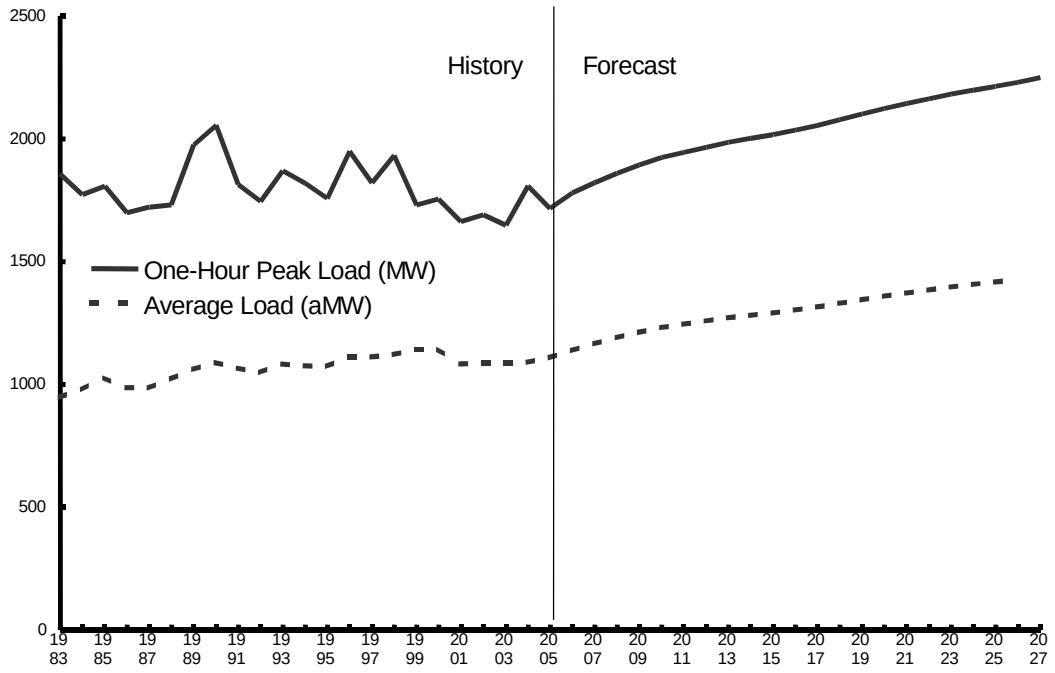
Annual system energy load[1] (adjusted for weather) reached a high of 1,140 average megawatts (aMW) in 2000 but fell by 5.5 percent to 1,077 aMW during the most recent economic downturn. The local economy has rebounded and so has load. System load in 2005 was 1,107 aMW -- 30 megawatts more than in 2001, but still 33 aMW less than in 2000. Load is forecast to grow at an average annual rate of 1.2 percent though 2026, before consideration of new conservation programs. Although there will be some years in which annual energy load growth will not be positive, the historical growth trend is expected to continue into the future. Figure 2-1 shows load history from 1980 though 2005 and the annual energy load forecast (with no new conservation resource) through 2026.

Load growth is driven primarily by increases in employment and residential density. The City's Comprehensive Plan and the State's Growth Management Act both direct higher development density in urban areas. Multifamily housing construction is strong in City Light's service area. Although employment for the metropolitan area (Seattle-Everett-Bellevue) area is 37,500 less than its level in 2000, State economic forecasters expect employment to reach pre-recession levels as early as the end of 2006.

Residential load accounts for about 42 percent of service area retail sales, with industrial at about 12 percent, and commercial/government about 45 percent. The commercial sector is growing the fastest. System load peaks in the winter, primarily due to residential heating loads, with power consumption peaking in early evening and early morning. There is a secondary peak in late afternoon during the July-August period caused by commercial sector air conditioning systems.

[1] Generating capacity-equivalent demand

Figure 2- 1. System Annual Energy Load and Peak Load History and Forecast
(with no new conservation program resources)



2.4.1.3 Seattle City Light Resources (Existing Resource Portfolio, 2007-2026)

City Light's resource portfolio consists of several owned hydroelectric projects and purchase contracts with the Bonneville Power Administration and several other utilities. The resource portfolio also includes energy savings from conservation resources that City Light and its customers have already implemented.

Conservation Programs

Since 1977, City Light has delivered a comprehensive menu of energy efficiency services and programs to serve the energy needs of City Light customers in all sectors. These programs have offered a wide variety of financial incentives and technical assistance to encourage customers, for example, to insulate their homes, install energy efficient water heaters, or install energy efficient lights and HVAC equipment in commercial and industrial establishments. From 1977 through 2005, City Light's conservation programs have saved over 10 million megawatt-hours. In 2005, still-active energy efficiency measures installed under a City Light conservation program served over 10 percent of City Light's customer loads, or 115 aMW.

Generating Resources Owned By City Light

Boundary Project. The Boundary Project is a hydroelectric generating facility located on the Pend Oreille River in northeastern Washington. It is City Light's largest resource and has a peaking capability of 1,055 MW and average generation of about 400 aMW annually. This project's peak generation is typically during May-June and it is at its lowest in September. During an average winter it produces about 300 aMW. It is a "run-of-the-river" project and is affected by other projects in the river basin. Since this project is located in the Columbia River Basin, it is also subject to the flow regulations established by the Biological Opinion issued by the National Marine Fisheries Service for the protection of fish populations. Like all hydroelectric projects, it is licensed by the Federal Energy Regulatory Commission (FERC). The current license expires in October 2011. Under the current license, part of Boundary output must be sold to Pend Oreille County Public Utility District (PUD) No. 1 to meet its load growth. In addition, about 5 aMW of energy must be delivered to the PUD in compensation for the encroachment of their Box Canyon Dam caused by the Boundary Project. Energy from Boundary is wheeled to consumers over BPA's transmission grid.

Skagit Project. The Skagit Project includes three large hydroelectric projects owned by Seattle City Light: Ross, Diablo, and Gorge. They are located on the Skagit River, about 80 miles northeast of Seattle. These three projects are operated as a single system. Ross has a major water reservoir, and water released from Ross flows to Diablo and Gorge. The combined one-hour peak capability is 690 MW. The output in a winter month can exceed 350 aMW. During June and July, when the snow melts, production can be as high as 300 aMW per month. Production is lowest during late summer. The license for these projects was renewed in 1995 and will be in effect for 30 years. City Light has committed to mitigating measures for fisheries, wildlife, erosion control, archaeology, historical preservation, tribal cultural resources, recreation, visual quality and environmental education. Generation from the Skagit Project is transmitted to Seattle over transmission lines owned by City Light.

South Fork of the Tolt Project. This small hydroelectric project, located in north central King County on the south fork of the Tolt River, went into commercial operation in 1995. This facility uses surplus water from an existing reservoir constructed for the City of Seattle's water supply. Its one-hour peaking capability is less than 17 MW. Monthly production ranges between 3 aMW and 15 aMW, with an average of about 6 aMW. Power is transmitted by Puget Sound Energy.

Newhalem Project. This small hydroelectric project is located on Newhalem Creek, a tributary of the Skagit River. It was built in 1921 to provide power for the construction of the Skagit Projects. During an average water year, this project produces slightly more than 1 aMW per month, but during late summer and early fall it produces less than 0.5 aMW per month. In 1970 it was modernized and now operates under a FERC license that will expire in 2027. Power is delivered through transmission lines owned by City Light.

Cedar Falls Project. The Cedar Falls Project was built in 1905 on the Cedar River, about 30 miles southeast of Seattle. This is City Light's oldest generating resource; it was constructed by Seattle's Water Department, which retains priority rights to the water. Maximum output of this project is 30 MW; it can produce up to 18 aMW in a winter month in an average water year. Minimum months typically occur during mid-summer, when production drops to 1 or 2 aMW per month. Cedar Falls was constructed before the adoption of the Federal Power Act of 1920 and, therefore, does not require a license from FERC to operate. Power is transmitted by Puget Sound Energy.

Power Purchase Contracts

Bonneville Power Administration. City Light's largest power purchase contract is with Bonneville Power Administration (BPA). The contract allows the utility to receive power from 29 hydroelectric projects and several thermal and renewable projects in the Pacific Northwest. Energy is delivered through BPA's transmission grid. A Block and Slice Power Sales Agreement with Bonneville provides for purchases of power by the utility over the 10-year period beginning October 1, 2001. Under the contract, power is delivered in two forms: a shaped Block and a Slice. Through the Block product, power is delivered to the utility in monthly amounts shaped to the utility's monthly net requirement, which is defined as the difference between the utility's projected monthly load and the utility's non-BPA resources available to serve that load under critical water conditions. During the winter months, the Block product provides over 220 aMW per month, but during the period when snow melts and City Light's current production is close to its peak, the block product provides nothing. Under the Slice product, the utility receives a fixed percentage of the actual output of the Federal System and pays the same percentage of the actual costs of the system each year. During an average water year, the Slice product can provide in excess of 410 aMW of energy per month during the winter period, between 450 aMW and 500 aMW during the snowmelt period of May and June, but only 340 aMW per month during late summer. Payments for the Slice product are subject to an annual adjustment to reflect actual costs. Power available under the Slice product varies with water conditions, federal generating capabilities, and fish and wildlife protection and restoration requirements.

High Ross Agreement. City Light originally planned the Skagit hydroelectric projects to be constructed in stages. In order to fulfill that vision, in the early 1980s City Light intended to raise the height of its Ross Dam. Raising the dam would have increased the area of the reservoir, and increased inundation of land in Canada. The Canadian Province of British Columbia and City of Seattle entered into negotiations over the proposal to raise the dam and its consequences in Canada, and as a result, the 80-year High Ross Agreement was signed in 1986. The agreement provided that City Light would abandon its plans and instead would purchase power from the British Columbia Power Exchange. Power would be delivered and priced to mimic the generation and costs that would have resulted from the construction of the High Ross Dam. Thus, power delivered during the winter is expected to be about 60 aMW/month, while spring

and early summer generation is expected to be about 35 aMW per month. The low delivery is in late summer at 13 aMW. The output received from this contract has a relatively high cost through 2020. At that point, the cost will drastically decrease to a few dollars per MWh because the portion of costs equal to the cost of servicing the debt, which would have been issued to build the High Ross Dam, will terminate. The agreement is subject to review by the parties every ten years. The most recent review, concluded in 1998, did not result in any changes to the agreement. Power is wheeled by BPA.

Lucky Peak Project. Lucky Peak, another hydroelectric project, was built by several irrigation districts in mid-1980 near Boise, Idaho. In an average water year, it produces about 33 aMW. During the winter, its period of lowest operation, it produces about 2 aMW. During the summer, its period of highest operation, it may produce 70 to 80 aMW per month. Power operations started in 1988 under a FERC license that terminates in 2030. Generation of power is secondary to the project's irrigation purpose, and most of the power output is available only in the summer months. Project costs were reduced when the outstanding long-term bonds were refinanced in early 2002. The power from this project is wheeled over facilities owned by Idaho Power and BPA.

Priest Rapids Project. The Priest Rapids hydroelectric project is owned and operated by Grant County PUD. The Project consists of the Priest Rapids Development and the Wanapum Development on the Columbia River up-river from the Hanford Reservation. City Light purchases power from this project under an agreement executed with Grant County PUD in 2002. Effective November 1, 2005, 70 percent of the Priest Rapids Project output was allocated to Grant County PUD. Seattle City Light is entitled to a share of the difference between the allocation to Grant County PUD and Grant County PUD's load requirements. As Grant County PUD's load grows, the amount of power available to City Light will decrease. City Light's share will come from the Priest Rapids Development from November 1, 2005, through October 31, 2009. Effective November 1, 2009, City Light's share will come from both the Priest Rapids Development and the Wanapum Development. The term of the contracts runs through the end of the new FERC license period. City Light's share is expected to be about 2-3 aMW in 2007-09, with a small increase in 2010, followed by gradual reduction as Grant County PUD's load increases**.**

Grand Coulee Project Hydroelectric Authority (GCPHA*).* City Light has 40-year contracts to buy half of the output from five hydroelectric projects built by irrigation districts in the Columbia River Basin. The City of Tacoma buys the remainder of the output from the projects. The contracts expire over the period 2022-27. Electricity is generated mainly in the summer months and is wheeled by local entities and BPA. On an annual basis, City Light receives about 27 aMW from this contract. However, during an average water year, none is received during the winter months, and the amount received from spring until fall can vary from 20 aMW to nearly 60 aMW per month.

Stateline Wind Project. City Light has an agreement with PPM Energy to purchase wind energy and associated environmental attributes from the Stateline Wind Project

located in Walla Walla County, Washington, and Umatilla County, Oregon. Project capacity is 175 MW. Energy delivered under the contract is expected to average about 26 percent of capacity, or about 45.5 aMW. City Light also has an agreement through 2011 to purchase integration and exchange services from PacifiCorp. This resource began producing in 2002. Early observations indicate that production is driven by storms in the winter and thermal currents during the summer. This suggests that production may be low in years when winter precipitation is low. Production will likely range from 30 to 55 aMW per month.

Exchange with Northern California Power Agency (NCPA). An exchange agreement with NCPA provides for City Light to deliver 60 MW of capacity and 90,580 MWh of energy to NCPA in the summer. In return, NCPA delivers 46 MW of capacity and 108,696 MWh of energy to City Light in the winter. Deliveries to NCPA started in 1995 and will continue until the agreement is terminated. Either party has the right to terminate the agreement after May 31, 2014.

In summary, the resources City Light currently relies upon to meet electricity demand are primarily hydroelectric power (86%), conservation, wind (3%), natural gas (5%), nuclear (4%), and a small amount of other resources such as coal, biomass, and petroleum. Nearly half of City Light's generation comes from its own hydroelectric resources.

Table 2-1 shows the amount of power generated by the projects owned by Seattle City Light and power purchased by the utility over the years 1999 through 2005. The year 2001 was a very low water year, and 1999 was a good water year. The amount of power generated by the utility's own resources in 1999 was more than double the amount in 2001.

Table 2-1. Seattle City Light Generation and Contract Energy (aMW) Actual Output Years 1999-2005

POWER GENERATED ANNUALLY- aMW							
	1999	**2000**	**2001**	**2002**	**2003**	**2004**	**2005**
OWNED GENERATION:							
South Fork Tolt	8.0	5.0	4.6	8.9	5.6	6.9	5.1
Cedar Falls	8.1	5.7	7.4	9.1	7.3	7.0	4.2
Newhalem		0.4	1.1	1.1	0.9	1.4	0.7
Gorge	135.4	109.3	70.4	117.0	106.3	105.2	88.7
Diablo	116.7	92.7	54.5	102.8	84.9	88.5	74.8
Ross	109.9	84.4	44.9	95.6	83.1	77.6	64.3
Boundary	508.1	431.7	267.1	452.2	408.1	398.8	395.1
Centralia	78.7	31.5					
TOTAL OWNED GENERATION	965.1	760.8	449.9	786.7	696.2	685.3	633.0

(Table 2-1 continued)

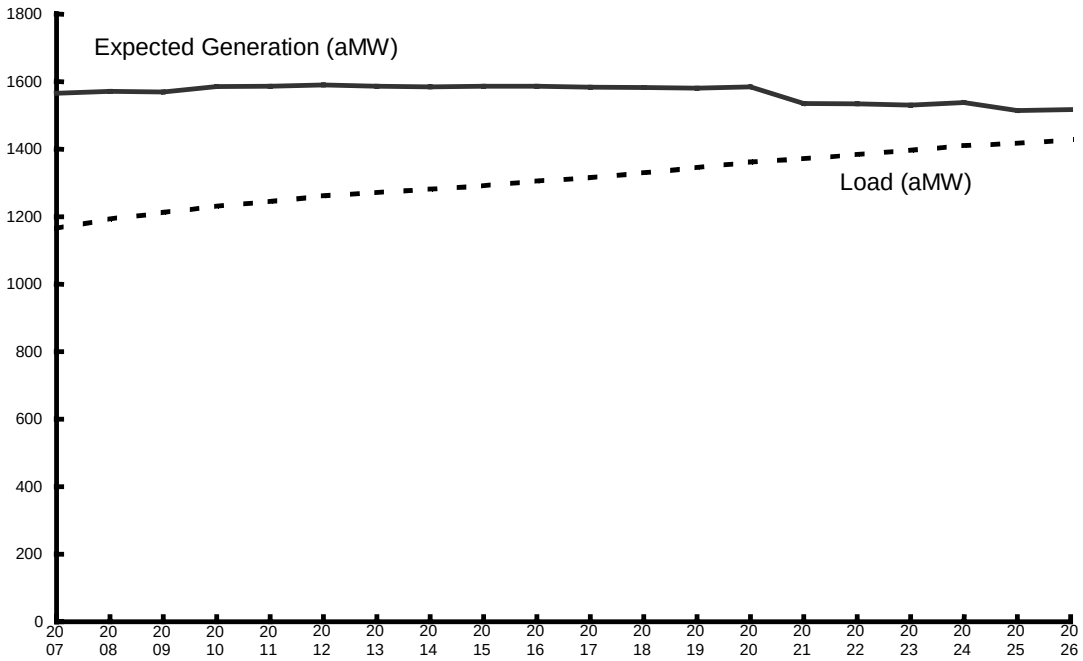
	1999	2000	2001	2002	2003	2004	2005
PURCHASE CONTRACTS:							
Bonneville Power Administration	180.6	193.7					
Bonneville Power Administration Block			200.7	152.3	147.1	137.8	109.4
Bonneville Power Administration Slice			71.5	322.4	390.9	392.8	385.1
Grant County PUD (Priest Rapids)	47.1	41.4	29.9	37.3	35.5	36.0	32.9
Pend Oreille PUD	8.1	6.6	4.9	5.0	5.4	6.7	3.0
Grand Coulee Project Hydroelectric Authority	28.6	27.2	30.9	28.3	26.9	28.9	28.5
Lucky Peak	48.6	38.8	21.5	33.0	3.4	31.3	25.8
Columbia Storage Power Exchange	16.1	12.1	11.6	11.3	3.0		
Klamath Falls (contract expires in 2006)			37.2	81.0	74.7	81.8	66.4
Metro CoGeneration	0.9	0.8	1.4	1.7	1.6	0.7	
B.C. Hydro (High Ross)	35.2	33.8	5.1	33.9	36.0	34.8	35.4
B.C. Hydro (Boundary Encroachment)	1.7	2.0	0.9	1.2	1.6	1.5	1.7
Stateline Wind				12.2	24.7	39.7	37.4
TOTAL PURCHASE CONTRACTS	366.9	356.5	445.8	719.5	780.8	792.0	725.6

2.4.1.4 Resource Adequacy: Load Forecast vs. Existing Resources

In planning for new resources, the IRP compared the forecasted differences between future load and existing resources that City Light owns or has contracts for over the planning period 2007 to 2026. Figure 2-2 compares forecast annual energy load with expected annual energy generation from existing resources. Figure 2-2 shows that *expected* generation on an annual basis appears to be sufficient to meet forecast annual energy load throughout the 20-year planning period. However, two factors may cause *actual* generation from existing resources to be less than energy load.

First, actual generation can be much less than expected, depending on the amount of precipitation in the watersheds of the dams that City Light primarily relies upon, as well as other variables that affect generation. City Light's IRP analysis considered the degree of variation in precipitation, as well as other variables that affect generation, when assessing the suitability of possible additions to the utility's resource portfolio. This analytical process is described in more detail in Section 2.5, *Development of Alternatives*. Figure 2-3 compares the annual energy load forecast and annual generation under very low water conditions.

Figure 2- 2. Annual Energy Load Forecast and Expected Generation



Second, the monthly profiles for loads and generation are not the same. For example, energy loads reach their highest levels during the winter months, while power generation is usually highest in May and June. As a result, there is a risk that monthly generation from existing resources may not meet monthly energy loads in winter months beginning in 2007, under low water conditions.

If severe weather occurs in the winter of a drought year, the system is stressed from both the generation and consumption sides. The one-hour peak load could easily surpass the all-time peak of 2,055 MW that occurred in 1990. The joint probabilities of low water and low temperatures, as well as the effects of load growth and other factors, are taken into account by the model City Light is using to assess the performance of the existing and alternative resource portfolios.

2.4.2 Policy Context for the Integrated Resource Plan

The 2001 power crisis in the West underscored the dangers of relying on the short-term wholesale power market for new resource needs. The Seattle City Council has directed City Light to re-institute long-term resource planning, which is being implemented in the form of the 2006 IRP.

City Light's actions, including resource decisions, are determined within a policy framework. This framework includes both internal policies that are established by the utility and its policy makers (the Seattle Mayor and City Council) and state and federal laws. In addition, there are guidelines and best industry practices that are promulgated by industry organizations and agencies, such as Public Utility Commissions that can be helpful in developing an IRP. This section describes the policies, laws, and guidelines that have the most impact on City Light's IRP process.

2.4.2.1 Internal Policies

Cost

It is City Light's policy to spend ratepayers' funds prudently, and to make wise resource investment decisions to meet its customers' need for electricity at reasonable cost. Producing and delivering low cost power is part of the Utility's mission, as described in the Vision, Mission, and Values Statement (see Appendix B). Recent City Council resolutions help guide City Light's approach to resource acquisition. Resolution 30685, passed in 2004, gives direction to City Light to consider long-term costs and objectives, stabilize rates over time, and to set rates to encourage conservation (one resource type considered in the IRP). Further, the Resolution states "Electric utility rates should be sufficient to meet the City Light Department's revenue requirements, while charging the lowest possible cost to the ratepayer over the long run."

Purchasing and contracting for energy is more than half of the entire cost of serving customers, whether it is the cost of building, owning and operating a plant, or the cost of purchasing electricity through a contract. So keeping energy costs low is an important part of keeping overall costs to ratepayers low.

City Light is not regulated by the Washington State Utilities and Transportation Commission. Instead, the Seattle City Council sets rates and policy for City Light. On a periodic basis, the Mayor of Seattle proposes new City Light rates that reflect the anticipated future cost to operate the utility, including the cost of new sources of power. The Council reviews the proposal and has final approval authority.

In the context of the IRP, the term cost is not the same as cost as used for setting rates, although the two are closely linked. Cost as used in the IRP means only the cost that City Light will face to cover the fixed and variable cost of obtaining resources. Other costs that the utility may face to maintain its distribution system, pay taxes, or run the business are among the costs that go into rates, but are not considered here.

Calculation of costs of specific resources in the IRP does not include determining whether City Light should build and own a resource rather than contracting to buy the output of that resource. It is expected that the long run costs of ownership versus contracting will be similar. With some exceptions, the determination will be made at the time that City Light is ready to acquire a resource and has received cost information for both approaches through competitive bidding. The exceptions are those resources that

are by definition based on contracting for energy rather than building and owning the plant, such as Call Options, Exchanges, and Market (resources that will be described in detail in later sections).

Costs in the IRP will be evaluated over the entire resource portfolio. For example, a higher cost resource could be included in small amounts in a portfolio, and that small addition could help City Light avoid investment in a much larger resource, which may have lower per unit of energy costs, but higher overall costs. It is necessary to evaluate resources in an *integrated* way to identify these resource combinations.

Environment

The City of Seattle and Seattle City Light have environmental policies that guide the resource planning and acquisition process. These policies include specific and general direction about how to protect natural resources and minimize impacts in serving the electricity needs of Seattle. Seattle City Light's Environmental Policy Statement is attached in Appendix B. It specifically calls for City Light to avoid, minimize, or mitigate impacts to the ecosystems that it affects and to incorporate environmental costs, risks, and impacts when making decisions. City Light's Vision, Mission, and Values Statement reaffirms that minimizing environmental impacts and enhancing, protecting, and preserving the environment are key parts of City Light's goals. In addition, City Light has a policy to minimize impacts to fish and wildlife in operating resources, and to operate its hydroelectric facilities to meet or exceed applicable laws and license requirements. The potential for minimizing and mitigating impacts in operating resources is a consideration in evaluating specific energy resource opportunities.

Conservation and Renewable Energy. Through a variety of City resolutions and ordinances passed over three decades ago, conservation was established as the first choice resource to meet City Light's energy requirements. Since that time, City Light has acquired over 10 million megawatt-hours of energy savings through utility operation conservation programs. Energy savings from active conservation measures installed from those conservation programs currently serve 110 aMW of customer energy demands, over 10 percent of City Light's total load.

More recently, the City of Seattle passed the 2000 Earth Day Resolution, which directed City Light to meet load growth with conservation and renewable energy as a strategy to avoid greenhouse gas emissions (see Climate Change section below). Towards that goal, the utility continues to acquire conservation at an annual rate of 7 aMW, while also purchasing 175 MW of capacity from the Stateline Wind plant.

Climate Change. In 1992, the Seattle City Council identified climate change as an environmental priority for the City of Seattle. City Light has a long history of initiatives and programs that help to reduce or mitigate the emissions of greenhouse gases that cause global warming. The utility started operating a comprehensive conservation program in 1977. In 1995, City Light joined the Climate Challenge, a U.S. Department of Energy voluntary program. Through the latter program, City Light reports projects that reduce

or sequester greenhouse gas emissions, such as conservation, efficient electricity production, and tree planting.

The City of Seattle's Earth Day Resolution directed City Light to begin meeting load growth with cost-effective conservation and renewable resources, and to mitigate for greenhouse gas emissions from any fossil fuel use. It also set a long-term goal of "Net Zero" greenhouse gas emissions, which Seattle City Light achieved in 2005. This commitment is to be met every year. In July 2001, the Greenhouse Gas Mitigation Strategy Resolution was passed, setting standards for calculating greenhouse gas emissions and mitigation projects. Greenhouse gas emissions come from City Light facility operations, some purchasing contracts for generation, the operation of vehicles, natural gas used to heat facilities, and other sources.

The climate change policy does not prevent City Light from acquiring electricity from resources that produce greenhouse gas, but does require that the utility fully offset those emissions. City Light has a mitigation program in which utility emissions are estimated each year, and then offsets are purchased. The emission counts are trued up at the end of the year. Offsets are the result of actions that avoid, reduce, or sequester greenhouse gas. There are currently no federal or state laws regarding how offsets are defined, created, and sold. However, there are guidelines being developed by non-profit and state government organizations. City Light tracks developments in that area and has established, with the assistance of external stakeholders, guidelines for counting emissions and selecting offsets. More information about the criteria is available on Seattle City Light's web site at: www.cityofseattle.net/light/climatechange.

In the IRP analysis, the amount of greenhouse gas emissions of various resources and portfolios has been calculated. The cost of offsetting those emissions will be calculated based on a range of potential mitigation costs that City Light would pay under its Council mandate, or that might be imposed through greenhouse gas regulation/taxes.

In addition to City Light's commitment to greenhouse gas mitigation, the City of Seattle has committed to achieve reductions in greenhouse gas emissions based on the Kyoto Protocol goal for the United States: a 7 percent reduction in greenhouse gas emissions compared to 1990 levels, to be achieved by the year 2012. To develop guidelines for meeting the goal, the Mayor appointed the Green Ribbon Commission on Climate Protection. The Commission, which includes 18 leaders from Seattle's business, labor, non-profit, government, and academic communities, was specifically charged with developing local solutions to global climate disruption and a Climate Action Plan. The Climate Action Plan directs City Light to maintain its goal of meeting load growth with conservation and renewable resources, and to offset all greenhouse gas emissions. The Plan also identifies other actions, including efficient use of natural gas and coordination between the gas and electric utilities serving Seattle in delivering efficient services. See http://www.seattle.gov/climate/ for more information.

Risk

Current practices in integrated resource planning focus increased emphasis on identifying and analyzing sources of risk. There are many forms of risk evaluated in the IRP, some of which are evaluated quantitatively, and some of which are evaluated qualitatively. Risks that can be quantified include:

- Variations in demand for electricity (City Light's load) due to factors such as weather and economic conditions;
- Generation plant output, particularly hydropower, where output can vary widely from year-to-year and month-to-month, depending on precipitation and snowmelt patterns;
- Prices for electricity on the wholesale market;
- Cost of fuel such as natural gas; and
- Potential cost of complying with environmental regulations, particularly with respect to air emissions.

Evaluating these risks does not guarantee that they can be determined exactly. Instead, the evaluation defines a range of possible risk, and the range of associated cost.

Other types of risk can be more difficult, and sometimes impossible, to quantify. These include the potential for regulatory or policy changes that could affect the availability and cost of resources, policies related to transportation of fuels by pipeline or rail, and requirements related to resource and transmission adequacy.

One of the most significant types of risk that City Light deals with is the risk of purchasing and selling electricity in the wholesale power market. These transactions involve hundreds of millions of dollars annually, and the magnitude of wholesale revenues and purchases can swing by more than $100 million from year to year. City Light participates in the market to buy electricity when its own resources are not sufficient to meet demand, which occurs at some times of year under dry hydro conditions. In addition, City Light can use the energy storage capability at its hydro projects to purchase low priced energy on the market and store water for use later when prices are higher. Currently, City Light sells much more electricity into the market on an annual basis than it purchases, due to an existing surplus of energy.

The risk of buying and selling on the market has two important aspects. One is the risk that City Light will have to buy power when it is expensive, and that if it had made different decisions about resources to add to its portfolio, it might have been able to avoid that higher cost. The second is that City Light will have to sell surplus power at lower than expected prices, leading to lower than expected revenues. The likelihood of facing either of these risks are difficult to predict, since City Light's hydro output varies so dramatically from year to year, and there are so many factors that determine demand and market prices.

A strategy City Light has used in an attempt to avoid selling power at a low market price is to enter into agreements to sell energy for delivery at some future date (up to 18 months out) at a set price. This eliminates the uncertainty about the price City Light will receive, but it has its own set of risks. The largest risk is that, due to dry hydro conditions, City Light will not have enough power to deliver as agreed, and will have to purchase power to meet the obligation on the market. During times of low hydro production, often the entire region is short on energy and, subsequently, market prices are high. Therefore, City Light may have to buy power in the market at a price that is higher than it will receive for providing it under the contract.

Because of the risks of being short or long on resources, and of the strategies used to deal with surplus and deficit energy, City Light, the Mayor, and City Council have been working for several years to establish policies to manage that risk. One of the primary goals of the IRP is to illustrate the trade off between these risks and the other criteria, such as cost and reliability. The IRP will not provide "the answer", but will show how certain portfolios can result in more or less risk, and illustrate the options.

There are three stages in dealing with the risk of buying and selling electricity in the market. The first, planning a low risk portfolio of resources, is one of the primary goals of the IRP process. It is reached by evaluating the portfolios under a number of different combinations of future conditions, such as City Light's demand for electricity, the cost of market power, the cost of natural gas and other fuels, and environmental regulations. In effect, the IRP process attempts to test the portfolios against a range of conditions that might occur in the future, without knowing which set of conditions will actually happen.

The second stage involves implementing the long-term resource strategy developed in the IRP. This stage includes acquiring new resources. It may also involve entering into long-term transactions designed to improve the overall balance of loads and resources in the utility’s portfolio.

The third stage of dealing with risk in the portfolio is to minimize risk on an ongoing basis. Resource portfolios will change over the years, and their output and performance can change daily or even hourly. This presents a significant challenge to utility resource operators who must make sure that City Light has enough electricity to meet demand at all times.

Reliability

It is generally accepted that electricity is a necessary part of modern life, and is critical to health, safety, and economic security. Consequently, providing reliable service is a critical mission for City Light. Producing and delivering reliable power is one of City Light's missions, as defined in the Utility's Vision, Mission, and Values Statement. Failure to provide reliable power has serious, immediate consequences, and City Light has practices and procedures to ensure that it is able to provide power or resume providing power quickly in case of events beyond its control.

Reliability is generally assumed to mean that when customers want to use electricity, that the electricity is available. There are three principal requirements in making sure that power is available:

- There must be enough power being generated to meet the demand.
- There must be sufficient transmission infrastructure, and that infrastructure must be functioning properly, to bring the power to City Light's service territory.
- There must be sufficient distribution infrastructure, and it must be functioning properly, to bring the power from the transmission system to the customer's location.

City Light is part of a very large electrical system that spans north to Canada, south to Mexico, and west to the Rockies. There are a large number of generating plants and thousands of miles of transmission lines throughout this area, and hundreds of miles of distribution lines in City Light's service territory. It is a complex process for the various organizations and people to keep this infrastructure operating so that electricity is available to everyone at all times.

IRPs have traditionally focused on meeting a high standard of reliability for power supply and do not address reliability for transmission and distribution. The availability of electric transmission is considered an important aspect of power supply, and is therefore evaluated for any potential new resource. Issues such as transmission availability and the likelihood and cost of building new transmission are considered.

The distribution aspects of reliability are not considered quantitatively in the IRP, with one exception. Energy savings from conservation programs are assumed to have some benefit in deferring investment in new distribution infrastructure. For purposes of quantifying those benefits in the IRP, the cost of all energy efficiency measures assessed in the IRP was reduced.

The reliability of power supply depends on several factors:

- Adequacy of generating capacity to meet demand;
- Adequacy of fuel (natural gas, coal, water, etc.) to create the energy needed; and
- Operational capability of the generating facility.

The question of whether there is enough generating capacity was evaluated in the IRP through the Resource Adequacy analysis (see Section 2.4.2 *Development of Alternatives* for more discussion). The Resource Adequacy analysis is an important step in determining the types of resources, in what combinations, and at what point in time that would be needed to meet a reliability standard. In the Resource Adequacy evaluation, City Light compared energy demand to the energy available from its owned and contracted resources, and a limited amount of market electricity. Approximately 250 possible combinations of hydropower outputs (a critical issue given City Light's dependence

on hydropower) and load were considered, and each combination was evaluated by month over the 20-year planning period.

The first step in guaranteeing reliability is to ensure adequate generation of electricity. In addition to the price risk associated with selling or buying electricity in the wholesale market, there is also risk for any type of generating resource that its output will not be available or predictable.

Each type of resource has its own set of uncertainties:

- Hydropower is dependent upon precipitation, snowmelt, and even the variations in the timing of the migration and spawning cycles of fish in the river.
- Coal plants can have unexpected outages that can bring a several-hundred - megawatt plant down to zero output.
- Wind farms are able to produce electricity only when the wind blows.
- Natural gas plants also face fuel supply issues, particularly in high demand periods. These plants can also experience unplanned outages that bring their output to zero.

In summary, the IRP process must consider the City of Seattle and City Light's internal policies related to costs and cost standards, environmental obligations, risks associated with generating vs. buying/selling electricity and the market, and reliability of generating and conveying electricity to meet customers needs at all times.

2.4.2.2 State and Federal Laws and External Guidelines

Washington State Integrated Resource Planning Requirement

In 2006, the Washington State Legislature passed a law that requires all large consumer-owned utilities that are not full-requirements' customers of BPA to prepare a detailed IRP. Further, it encourages the governing body of a consumer-owned utility to promote public participation when developing the plan. Seattle City Light must comply with this law. An IRP must describe the mix of generating resources and conservation and efficiency resources that will meet current and projected needs at the lowest reasonable cost to the utility and its ratepayers. The plans must contain a number of elements, including:

- Demand forecasts for at least the next 10 years.
- Assessments of commercially available conservation and efficiency resources.
- Assessments of commercially available utility-scale renewable and nonrenewable generating technologies.
- Comparative evaluation of renewable and nonrenewable generating resources.
- Integration of the demand forecasts and resource evaluations into a long-range assessment describing the mix of supply-side generating resources and conservation and efficiency resources.

- A short-term plan identifying the specific actions to be taken by the utility consistent with the long-range integrated resource plan.

City Light must submit it's plans to the Department of Community, Trade and Economic Development (CTED) every two years after the initial reporting date of September 1, 2008.

Resource Adequacy Standards

The Northwest Power Planning and Conservation Council's (Council) 5th Power Plan directed the development of a regional standard to be used for guidance in long-term resource planning. The Council adopted this standard for its own planning process and recommended that other entities in the region incorporate it into their planning efforts. Further, the Council recommended that this regional standard fit within the geographically-wider resource adequacy criteria being developed by the Western Electric Coordinating Council (WECC) for inclusion in its development of West-wide adequacy standards. WECC's process is part of a broader effort by the North American Electric Reliability Council (NERC) to develop a resource adequacy assessment standard.

The Regional Adequacy Standard is not intended to be a mandatory standard but rather a gauge used to assess whether the Northwest power supply is adequate to meet load requirements under most circumstances, which is a minimum threshold for resource acquisition. However, the Council encourages utility planners to think beyond this minimum and consider strategies that also protect against potentially bad economic outcomes. As new information becomes available, underlying assumptions for this regional energy standard will be updated. The intent is for this process to be dynamic, and the Council recommends that an assessment of the region's resource adequacy be made at least once per year.

The Regional Adequacy Standard is intended to address the unique characteristics of the Pacific Northwest including the region's winter-peaking loads (compared to summer-peaking loads across most of the West) and the region's heavy dependence on hydroelectric generation. While there is currently no regional capacity standard, it is being worked on and is anticipated to be finished within the year.

Transmission Adequacy Standards

BPA owns over 75 percent of the transmission infrastructure in the Pacific Northwest. In late 2004, BPA initiated the development of transmission adequacy standards in order to determine how much transmission it needs, the solutions to be deployed, and the criteria to be applied to guide prudent investment decisions consistent with its obligations. Because of the interconnected nature of the electric grid, transmission adequacy standards would be most effective if the standards were applied across all transmission in the Northwest. If this cannot be achieved, a BPA standard must be developed with input from all stakeholders. Thus, BPA engaged regional stakeholders in its effort to develop those standards that would apply to the federal transmission system. Trans-

mission Adequacy Standards are proceeding through the auspices of the Transmission Adequacy Work Group of the Northwest Power Pool's Northwest Transmission Assessment Committee.

Bonneville Power Administration (BPA)

City Light purchases approximately 44 percent of its power supply from BPA, the power-marketing agency for electricity generated from the projects owned and operated by the Army Corp of Engineers and the Bureau of Reclamation. Decisions by the President, Congress, the Department of Energy (DOE), and others affecting the marketing of this power can have a significant impact on City Light's resource portfolio cost, risk, and reliability. For purposes of the IRP, City Light is assuming that BPA will continue to sell it the same amount of power it currently receives, at cost-based rates. City Light is a transmission-dependent utility that relies heavily on purchases of significant amounts of transmission from BPA to transfer power from City Light's remote generating resources to its load.

BPA will begin allocating the output of the Federal Columbia River Power System (FCRPS) to its Northwest customers and the rate will reflect the costs of the FCRPS. To the extent that publicly-owned utilities need more resources than are allocated to them from the FCRPS, they will have to either acquire additional new resources themselves, or contract with BPA to do that for them and then reimburse BPA for the costs of those additional resources. Policies on how the existing system output will be allocated among regional utilities, and how it will be priced, have not been established, which results in uncertainty for planning purposes

Washington State Renewable Portfolio Standard Initiative

In November 2006, an initiative will be placed on the Washington State ballot that, should it pass, would mandate certain utilities in Washington State, including City Light, to acquire renewable resources for meeting their load. It would also require that these utilities evaluate the potential for cost-effective conservation in their service territories, and establish and make public an acquisition target for conservation. The renewable resource portfolio requirements in the initiative would increase over time: at least 3 percent of a utility's load by January 1, 2012; 9 percent by 2016; and 15 percent by 2020. This requirement could also be met by using Renewable Energy Credits, often called green tags. There would be a financial penalty for failing to meet the requirement. Existing hydropower would not be counted toward the target. Stateline Wind, at approximately 3 percent of current load, and efficiency upgrades resulting in additional power output at City Light hydropower plants (completed after March 31, 1999), at just under 1 percent of current load, are eligible resources for meeting the target.

Environmental Regulations

At the federal level, recent EPA regulations (the Clean Air Interstate Rule and the Clean Air Mercury Rule) will set tighter limits for emissions of common air pollutants from

power plants: oxides of sulfur and nitrogen, and mercury. Other regulations will further limit emissions of particulate matter. These regulations may become more restrictive during the planning period, and states may set their own more restrictive standards as well. Meeting these limits can be a significant technical challenge, as well as a significant additional cost, for power plants that burn fossil fuel.

Greenhouse gas regulations have not been passed at the federal level. However, there have been many bills proposed that would limit such emissions, or would require payment for emissions. New legislation is under consideration at the federal level. Some states, including Washington, are evaluating the options for greenhouse gas emissions limits on a regional basis through the West Coast Governor's Global Warming Initiative. The Regional Greenhouse Gas Initiative resulted in a cap and trade program that will be imposed on power plants in northeastern states. Washington and Oregon have laws that require new power plants that burn fossil fuel to mitigate portions of their greenhouse gas emissions.

Federal Clean Water Act regulations are also becoming more stringent. Power plants that use water for cooling could be affected by these changing regulations, as restrictions increase on removing water from, and discharging cooling water into, surface and groundwater sources. These restrictions are often related to protecting habitat for fish and wildlife, as well as protection of human health.

The Endangered Species Act (ESA) can affect the potential to site new power plants and transmission facilities. Currently, hydropower operations are significantly regulated because of their potential impacts on ESA-listed fish species. As new species are listed, and as new information about hydropower operations' effects on those species becomes available, the operational rules may change. Consequently, this could possibly change both the amount and the timing of hydropower output. This issue is extremely important to City Light given its reliance on both its own hydropower facilities and on the Bonneville Power Administration's supply.

Energy Policy Act of 2005

In 2005, the first federal energy legislation in 13 years addressed a wide range of issues including energy efficiency, generating resources and fuel supply, the environment, and transmission.

There are several provisions related to energy efficiency that may be relevant to City Light's Conservation programs. The Act authorizes $50 million annually in funding over the period 2006-2010 for state-administered energy efficient rebate programs for "residential Energy Star products". This category includes appliances, heating and cooling, home electronics, lighting, and windows, doors and skylights. The legislation establishes financial grants for state-run programs to achieve at least 30-percent efficiency improvements in new and renovated public buildings.

The Act provides for a number of tax deductions or credits in 2006-2007 including the following:

- A $2,000 tax credit to contractors who build new homes that use 50 percent less energy for cooling and heating than a comparable home built to the 2003 International Energy Conservation Code.
- Tax credits of varying amounts to homeowners for energy efficiency improvements made to their primary residence. Qualifying improvements include efficient windows, doors, insulation, electric heat pumps, geothermal heat pumps, electric heat pump water heaters, central air conditioners, and natural gas, propane or oil water heaters.
- Varying tax credits to manufacturers of qualifying efficient appliances manufactured in the U.S. Eligible appliances include Energy Star dishwashers, clothes washers, and refrigerators.
- A tax deduction of $1.80 per square foot for commercial buildings that achieve a 50-percent reduction in annual energy cost subject to certain conditions.

The Production Tax Credit (PTC) for certain renewable generation was modified and extended through December 31, 2007, including facilities producing electricity from wind, closed- and open-loop biomass, geothermal, solar, small irrigation power, landfill gas, trash combustion, and certain hydropower facilities that meet certain placed-in-service deadlines. For most renewable resources, the PTC is currently equal to about 1.9¢/kWh for electricity produced over a 10-year period. The Act also created the Clean Renewable Energy Bond program, which can be issued to construct renewable generating resources by rural electric cooperatives, municipal governments, and tribes.

The Act authorizes $100 million for hydroelectric efficiency improvements at existing dams and modernizes the hydropower laws to allow increased production, revises the provisions of the Federal Power Act governing relicensing, and creates a 10-year tax credit that will apply to “qualified hydropower production” if placed in service prior to January 1, 2008.

It confirmed that FERC has exclusive authority over siting, construction, expansion, and operation of LNG import terminals located onshore or in state waters. In addition, it confirms FERC’s role as the lead agency for National Environmental Policy Act (NEPA) compliance and for purposes of coordinating all applicable Federal authorizations. The Act also confirms existing rights of states to review LNG terminals under the Coastal Zone Management Act (CZMA), Clean Water Act, and the Clean Air Act.

The Act authorized $200 million per year from 2006 to 2014 for a federal government cost share program administered to conduct demonstrations of commercial-scale advanced clean coal technologies. It also authorized $3 billion in the form of loans, cost sharing, or cooperative agreements to encourage new sources of advanced coal-based power generation and to upgrade existing sources of coal-based generation to improve air quality to meet current and future obligations of coal-fired generation units regulated under the Clean Air Act. The Act authorized a total of $1.095 billion over three years in

funding for the Department of Energy clean coal R&D program, and authorized $75 million over three years for a DOE program to develop carbon capture technologies that can be applied to the existing fleet of coal units.

The Act established a loan guarantee program to provide incentives for "innovative energy technologies" that avoid, reduce, or sequester air pollutants or greenhouse gases and use improved technologies in comparison to those in commercial use. Eligible projects include renewable systems, advanced fossil energy technologies (including coal gasification), hydrogen fuel cell technology, advanced nuclear energy facilities, and other projects. There is no cap on the amount of funds used for this program.

The Price-Anderson Act was re-authorized for commercial nuclear power plants and Department of Energy contractors for 20 years; it increases the indemnification for DOE contractors to $500 million. In addition, it authorizes the construction of a nuclear reactor at the DOE Idaho National Laboratory that will generate both electricity and hydrogen and creates a federal loan guarantee program to encourage the design and deployment of innovative technologies including advanced nuclear power plants.

To promote investment in electric transmission infrastructure, FERC is directed to do an incentive rate rulemaking and provide for participant funding. In addition, it provides for expedited siting processes on both federal and private lands and it provides for the use of advanced transmission technologies. The Act established an Electric Reliability Organization to develop and enforce reliability standards for the bulk transmission system. The Act also requires FERC to identify the steps that must be taken to establish a system to make available real-time information on the functional status of all transmission lines within each of the transmission interconnections, and to implement such a transmission information system.

DOE is directed to prepare a study of electric transmission congestion and the possible designation of "national interest electric transmission corridors." The designation of such corridors could have a significant impact on the development of new electric transmission facilities. Congress has given FERC "backstop" authority to grant permits for the construction or modification of electric transmission facilities within these corridors in certain situations, including where the State siting authority has withheld approval.

Climate Change actions directed by the Act include forming a Climate Change Technology Advisory Committee that is charged with integrating existing federal climate change reports and activities. The Committee is to submit a national strategy to promote the deployment and commercialization of greenhouse gas intensity reductions, and to identify barriers to these technologies and ways to remove those barriers. Best Management Practices are also to be developed for calculating, monitoring, and analyzing greenhouse gas intensity.

Western Governors' Association

In June 2004, Western Governors adopted a resolution in which they agreed to examine the feasibility of developing 30,000 MW of clean and diverse energy by 2015, to increase energy efficiency 20 percent by 2020, and to provide adequate transmission to meet the region's needs through 2030.

In 2005, they created the Clean and Diversified Energy Advisory Committee (CDEAC) to oversee the work of seven task forces that examined the feasibility of reaching those goals. The task forces prepared reports with recommendations in the following areas: energy efficiency, advanced coal, geothermal, wind, biomass, solar, and transmission.

At the June 2006 annual meeting, the Western Governors adopted a resolution where they agree to draw upon the full range of recommendations contained in the CDEAC report as a basis on which to advocate for energy policy changes at the federal and regional levels and their respective states, where appropriate. Further, they agreed to support, among other things, federal energy polices that:

- Provide for a long-term (10-year) extension of the production tax credit for all renewable energy technologies, with complementary policies for consumer-owned utilities and tribes.
- Provide tax credits for energy efficiency investments.
- Raise the cap on the residential investment tax credit to $10,000 for renewable energy or distributed generation systems.
- Support improvements in national appliance efficiency standards.
- Encourage adequate funding for state programs, including energy efficiency, clean generation and storage technology research, development, and demonstration programs.
- Encourage federal agencies to collaborate with Western states and regional organizations on facility siting and infrastructure planning, consistent with sound, sustainable environmental practices.
- Extend the federal Integrated Combined Cycle Combustion Turbine (IGCC) tax credit for five years and provide a tax credit program for carbon capture and sequestration for at least five years.
- Support increased federal support and tax incentives for the construction of multiple pilot facilities that demonstrate IGCC in the Western United States in high altitude areas using western coal.
- Encourage proactive, transparent, stakeholder-driven regional transmission expansion planning, defer to existing regional and sub-regional processes that meet such standards, and reform imbalance penalties to allow for greater use of the existing transmission system.

Northwest Power and Conservation Council 5th Power Plan

The Northwest Power and Conservation Council (NPCC) is a public agency created by the Pacific Northwest Electric Power Planning and Conservation Act of 1980.

The agency has responsibility to develop a regional power plan and to implement fish and wildlife programs. Its three major functions are:

1. Develop a 20-year electric power plan that will guarantee adequate and reliable energy at the lowest economic and environmental cost to the Northwest
2. Develop a program to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin
3. Educate and involve the public in the Council's decision-making processes.

The NPCC's Fifth Power Plan (December 2004) forecasts a surplus of power for the next few years and no generation resources will be needed until at least 2010. A power surplus resulted when loads declined due to the recession after the West Coast power crisis of 2000-2001 and the decline in consumption by the aluminum industry. Regional loads fell to their early 1990s levels while many new power plants were built to respond to the power shortages experienced in 2000-2001. The Plan recommends that the region begin an aggressive conservation program and lay the groundwork for building a large amount of wind generation (and relatively small amount of coal-fired generation) that will be needed later.

2.5 Development of Alternatives

This section summarizes the process used to develop alternatives. Alternatives were formulated by first determining resource needs during the planning period. Once needs were defined, City Light created a number of possible combinations of new resource additions that could meet that need. These combinations are called "portfolios". The portfolios were tested against a wide range of future business environments that reflected variability in fuel prices, supply and demand for electricity, and electricity prices. One of the business environments is a baseline forecast called the Reference Case. City Light employed a model, *EnerPrise Planning and Risk*, to evaluate each of the portfolios. The model optimized the performance of each of the portfolios, considering each of the variables, to dispatch the resources that would enable it to most efficiently meet the demand it faces. The portfolio results were then compared to City Light's key objectives, or criteria, for evaluating portfolios to create a portfolio scorecard. The key criteria are cost, environmental impact, risk, and reliability.

2.5.1 Determination of Resource Need During the 2007-2026 Planning Period

As discussed in Section *2.4.1.4 Resource Adequacy: Load Forecast vs. Existing Resources*, City Light considered a wide range of potential future conditions to determine its needs for new electricity supply. The evaluation was based on a standard of "Resource Adequacy", which requires that the utility provide sufficient resources to meet customer needs under a range of conditions that can affect both supply and demand for electricity.

Resource adequacy is comprised of *Energy* resource adequacy, and *Capacity* resource adequacy. Energy resource adequacy refers to the sufficiency of available electric re-

sources to meet customer needs across an extended period of time such as a month, a season or a year. Capacity resource adequacy refers to the sufficiency of available electric resources available to meet customer needs during a much shorter period of time such as a peak hour or day, including when temperatures are colder than normal. Power supplies and demand-side resources are included in both adequacy measures.

To address energy resource adequacy for its 2006 IRP, City Light evaluated the probability that all of the energy needs of its customers will be met. This approach identifies a threshold specifying the amounts and timing of new resources that must be added by City Light to meet all customer energy needs, and the probability that this threshold can be attained. Alternative portfolios that include the new resources were defined and then evaluated using computer-based modeling tools that quantify performance with respect to cost, risk, and environmental objectives. Further details about the process used for the first round of portfolio analysis for City Light's 2006 IRP are described in *Section 2.5.2 Formulation of Portfolios*

The specific energy resource adequacy standard that was selected for the first round portfolio analysis for the 2006 IRP is at the 95 percent probability level. With this standard, there would be "a 95-percent confidence of having no unserved energy (power outages) in a month" caused by insufficient generation. This level of reliability compares well with the recommended standard from the North American Electric Reliability Council (NERC). NERC, an industry organization established to address reliability issues, has adopted largely the same reliability standard in seven of ten reliability regions. These reliability regions span the United States, Canada, and part of northern Mexico. The common standard is that a utility should have adequate generating resources to ensure that no more than one day (24 hours) of outages occur over a ten-year period. This standard is specific to generating resources and does not address reliability issues caused by electric transmission or distribution infrastructure. City Light has found that the "95-percent standard" is slightly more stringent than the NERC "one-day-in-10-years" standard for its generating resources. The second round analysis may consider a resource adequacy standard that is higher or lower than 95 percent, and the results of the analysis will be used to determine the final resource adequacy standard for City Light's 2006 IRP.

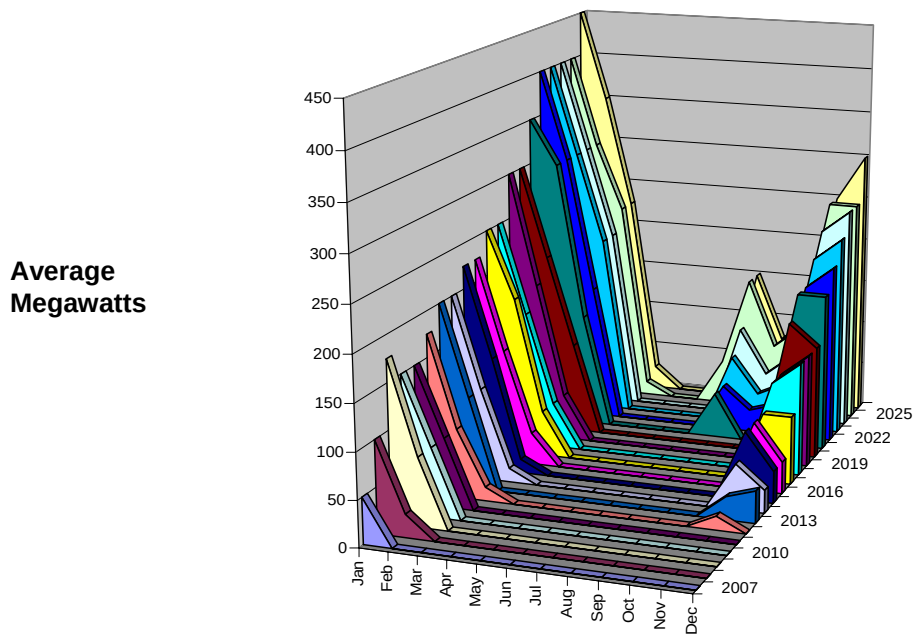
There is large variability in winter hydro generation and in winter peak demand, which can create power supply risk for Seattle. City Light uses an electric resource planning model to analyze Seattle's highly variable hydro generation and weather-driven demand. To meet demand under adverse hydro conditions, City Light assumes that it could obtain 100 average megawatts (aMW) from the wholesale market. The wholesale market provides a place to purchase power when the portfolio produces too little to meet demand, and a place to sell power when it produces more than needed. The high voltage transmission system defines the wholesale market for electricity in the West. Thus, City Light is affected by energy supply conditions throughout the 11-state western region. The Western Electricity Coordinating Council (WECC) estimates that the West as a whole could be tight in winter resources by 2008-2009 under adverse water condi-

tions and average demand. This suggests that a strategy of relying solely upon the market for reserves could be both risky and costly.

City Light used a sophisticated computer model (described in more detail below) to simulate over a thousand possible combinations of demand and hydro conditions, and to determine the resource requirements necessary to achieve a 95-percent confidence level of having not even one hour of unserved energy in a month. The result is depicted in Figure 2-3.

The analysis demonstrates City Light's resource needs are seasonal. Through 2020, City Light's resources are insufficient to meet a 95-percent confidence level during four winter months (November through February). The winter resource need grows from about 50 aMW in 2007 to 450 aMW in 2026. March through October does not require any additional resources before the year 2021. In 2021, the difference between forecast load and expected generation grows sufficiently to require additional summer resources to maintain a 95-percent confidence level.

Figure 2-3. Energy Resource Needs – 2007 to 2026



Without taking action to acquire additional resources to meet the 95-percent confidence level, it is unlikely that City Light would meet the one-day-in-ten year's standard adopted

in seven of ten electric reliability regions in North America. Failure to acquire resources increases the risk of having power outages if City Light experiences arctic express weather in combination with prolonged drought.

2.5.2 Formulation of Portfolios

Once the resource need was defined, City Light created a number of possible combinations of new resource additions to meet that need over the 2007-2026 planning period. These combinations are called "portfolios". The resources that City Light chose from are listed in Table 2-2. These resources and their environmental impacts are described in *Appendix C*. The portfolios are described in more detail in *Section 2.6, Description of Alternatives.*

Table 2-2. Resource Options

Conservation Plan 2	100% BPA Block
Hydro Contract	50% BPA Block
Hydro Efficiency Improvements	50% BPA Slice
Seasonal Exchange	Combined Cycle CT
Seasonal Call Option	Combined Heat and Power CT
Wind	Simple Cycle CT
Landfill Gas	Integrated Coal Gasification CC
Geothermal	Coal Plant
Biomass	The Wholesale Power Market

2.5.2.1 Reference Case and Futures -- Model Inputs and Assumptions

All forecasts of power prices and fuel prices over the 20-year planning period have been supplied by Global Energy Decisions, Inc. (GED). City Light used the baseline forecast, called the Reference Case, to plan for a future electric business environment in which the resource portfolios are most likely to operate. It also analyzed the resource portfolios using a broad range of potential alternate futures. These futures are used in the study in explicit recognition that the business environment for Seattle City Light could vary substantially over the next 20 years, depending upon future political, economic, regulatory, and environmental trends. Each future has an associated set of forecasts of energy supply, demand, and prices for the Pacific Northwest. Specifically, the forecasts include natural gas and coal, regional supplies of power resources by generation type, load-resource balance, expected demand growth in the Pacific Northwest, and spot market prices at key market hubs for wholesale power transactions in the West.

While the focus of City Light's resource planning is the Pacific Northwest, price forecasts for power are driven by the western wholesale power market in which City Light conducts power transactions. This westwide power market is commonly influenced by such diverse factors as hot temperatures in Southern California, transmission constraints at Palo Verde in the Desert Southwest, precipitation levels in the Pacific Northwest, coal plant outages in Montana and Utah, and power exports from British Columbia, Canada.

Forecasts used in the Reference Case are described in the sections that follow.

Fuel Prices

The following provides an overview of the forecasts being used in the IRP with respect to fuel prices:

Natural Gas. The market for natural gas in the Pacific Northwest is heavily influenced by national market trends because of the national, interconnected network of natural gas pipelines. Natural gas-fired generation plays a key role in the West because it is usually the last generating unit to be dispatched (known as the "marginal unit"). The cost of dispatching the marginal unit often sets the short-term power price in the western wholesale power market. Thus, even though City Light does not own or have natural gas-fired generation, the price of natural gas will continue to be an important factor in determining City Light's wholesale power costs and revenues.

In the Reference Case, future natural gas prices are forecast to fall considerably between 2006 and 2009, then range from an annual average of $4.31 per mmBtu in 2009 to $4.94 per mmBtu in 2026 (2006 dollars). The forecasted decline of natural gas prices would result in continued growth in the use of natural gas-fired turbines in the reference forecast. Natural gas-fired turbines also have a strong impact on the emissions rates of the Western wholesale spot market.

Coal. While a limited resource in the Pacific Northwest, coal is a very important factor in the broader western power market. Coal is forecast to remain the single most important resource in the western United States with respect to energy supplied for the next 20 years. Today it makes up nearly 40 percent of all electricity generation in the West. It is forecasted by GED to continue to be a large and stable source of base-load generation. Coal prices are forecast to grow at an average annual rate of 0.56 percent in real terms over the 20-year forecast period. At approximately $1.79 per ton today, it is expected to average $2.00 per ton by 2025 (2006 dollars).

Northwest Supply and Demand for Electricity

The interconnected, high-voltage electric transmission system physically defines the wholesale market for electricity in the West (generally the 11 western states, two Canadian provinces, and Baja, Mexico). In 2006, most parts of the West have surplus generating capacity, including the Pacific Northwest. Demand in the Pacific Northwest is forecast by GED to grow at an average of 2.3 percent annually, a faster rate than forecast for the City of Seattle. The Reference Case forecast estimates that the Pacific Northwest will have more than adequate reserves to meet a 12 percent recommended reserve margin for the next decade under normal conditions.

The Reference Case forecast for the Pacific Northwest indicates that most growth in power resources will come from natural gas-fired generation (Figure 2-4). Hydro, nuclear, and coal-fired resources are forecast to remain relatively constant, while natural gas will grow from 14,126 GWh in 2006 to 40, 581 GWh in 2026, an average annual

rate of 5.4 percent per year. Renewables also see significant growth, from 4,821 GWh in 2006 to 10,551 GWh in 2026, an average annual rate of 4.0 percent per year.

Electricity Prices

Electricity price forecasts are used in the IRP to evaluate the costs of buying power and the revenues from selling power in the spot market, and to determine when to make sales or to make purchases. Electricity prices have a direct impact on the emissions rates of potential future portfolios of power resources.

Figure 2-4. Resource Mix for the Reference Case Forecast

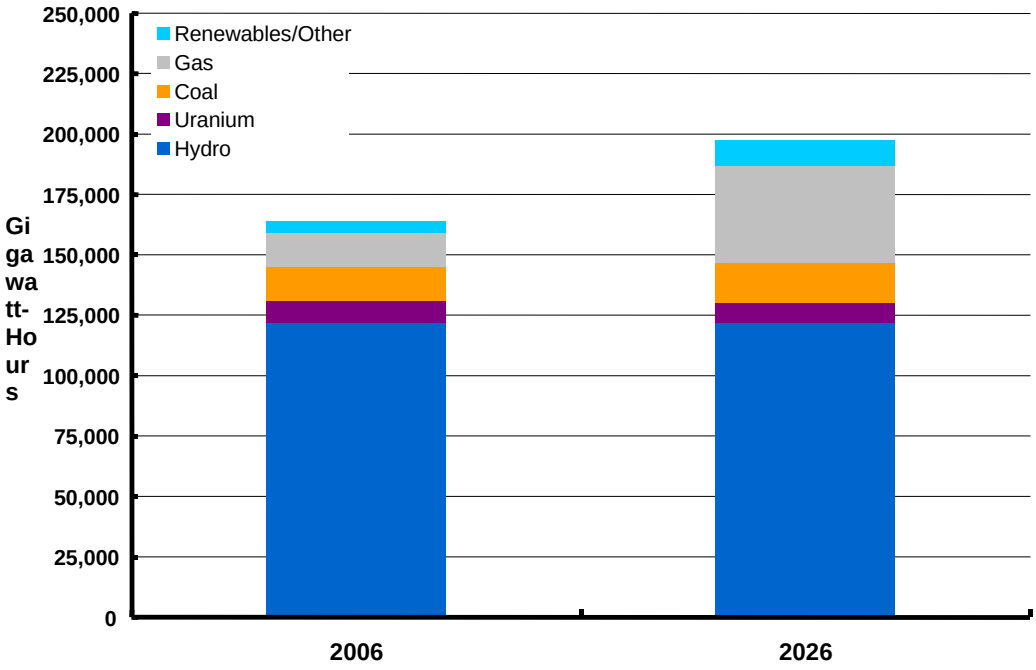
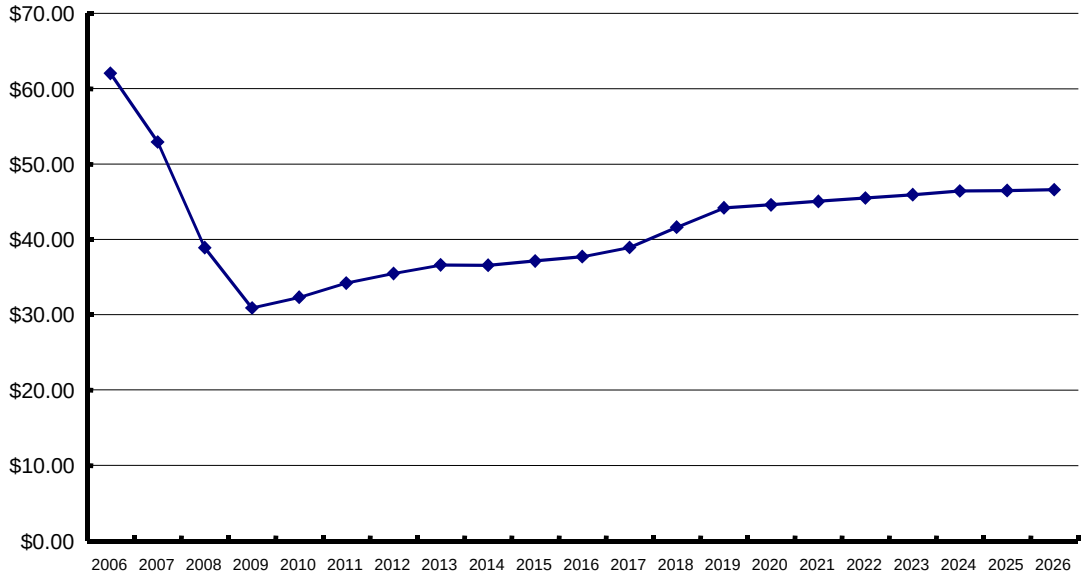


Figure 2-5 displays Reference Case annual average price forecast (all hours), showing general trends. Corresponding with a natural gas price decrease from 2006 to 2009, the forecasted price of on-peak power declines to $31, then increases to average $47/MWh (real 2005 dollars) by 2026.

Figure 2-5. Pacific Northwest Average Wholesale Power Prices – All Hours (Real Dollars per Megawatt Hour)



2.5.2.2 Scenarios -- Model Inputs and Assumptions

The Reference Case is identified as the most probable outlook by Global Energy Decisions, Inc.; it provides the basis for Draft EIS electricity market assumptions. Since it is impossible to know with certainty what the cost of fuel and the cost of buying and the price received for selling power in the wholesale market will be over the 20-year planning period, City Light evaluated the portfolios over a wide range of potential sets of future conditions, called "scenarios". These scenarios are meant to encompass major trends that have the potential to drive the development of the energy industry, which result in different patterns of fossil fuel prices and power prices. Because the focus of the alternative future analysis was changes in costs of the portfolios, the Draft EIS is focused on the Reference Case.

For each scenario, there is a set of assumptions about fuel availability and pricing, energy pricing, demand for energy, and environmental regulation. Over the next 20 years, such factors will determine the mix of available resources and the price of electric power in the Northwest.

Each scenario has a theme that is taken to its logical conclusion, mainly concerning government environmental and energy policy, market forces, and geopolitics. Each scenario has a shorthand name -- Green World, Nuclear Resurgence, Return to Reliability, and Terrorism & Turmoil. The summary below lists some of the features of each scenario and describes the fuel mix for the Pacific Northwest by 2026.

Green World	
Theme	Environmentally responsible; substantial voluntary conservation.
Regulation	Tight restrictions on nitrogen oxides (NO_X), sulfur dioxide (SO_2), mercury (Hg), particulate matter (PM2.5), and carbon dioxide (CO_2) are legislated.
Power prices	Highest of the four futures, growing to about $135/MWh (nominal) by 2026, due to CO_2 tax of $100/ton.
Hydro	Remains dominant.
Coal	Coal-fired steam plants eliminated, but replaced by integrated gasification combined cycle (IGCC) plants; coal generation grows to nearly 45,000 GWh.
Renewables	Account for more than 7,000 GWh by 2026, but still less than 1% of mix; primarily wind.
Natural gas	Gas generation grows to 3,000 GWh by 2026.
Uranium	No change.

Nuclear Resurgence	
Theme	Environmental responsibility coupled with acceptance of nuclear generation in other parts of the nation; strong economy.
Regulation	Tight restrictions on nitrogen oxides (NO_X), sulfur dioxide (SO_2), mercury (Hg), particulate matter (PM2.5), and carbon dioxide (CO_2) are legislated.
Power prices	Second highest of the four futures, growing to about $95/MWh (nominal) by 2026; cost of emissions reduction compliance offset somewhat by high percentage of LNG in fuel mix.
Hydro	Remains dominant.
Coal	Small reduction in coal-fired steam plant generation; more IGCC than in Green World.
Renewables	Account for nearly 13,000 GWh by 2026, but still less than 1% of mix; primarily wind; twice as much as in Green World, which features substantial conservation.
Natural gas	Increased gas generation; more than in other scenarios.
Uranium	No change for Pacific Northwest; plants are built elsewhere.

Return to Reliability	
Theme	High reserve margins and coal generation retained, in order to avoid brown-outs.
Regulation	No federal CO_2 regulations; existing NO_X and SO_2 regulations enforced.
Power prices	Lowest of the four futures, growing to about $65/MWh (nominal) by 2026, due to high proportion of coal and gas, and no carbon tax.
Hydro	Remains dominant.
Coal	About the same amount of coal generation as Nuclear Resurgence.
Renewables	Same amount as Green World, but less than 1% of mix; primarily wind.
Natural gas	Nearly 1,000 GWh by 2026.
Uranium	No change.

Terrorism & Turmoil	
Theme	Political instability and weak economy; LNG and oil supply constrained; reliance on coal generation.
Regulation	No federal CO_2 regulations.
Power prices	Third lowest of the four futures, growing to about $75/MWh (nominal) by 2026.
Hydro	Remains dominant.
Coal	About the same amount of coal generation as in Green World.
Renewables	Same amount as Green World, but less than 1% of mix; primarily wind.
Natural gas	Nearly 1,000 GWh by 2026.
Uranium	No change.

Applying assumptions for each scenario over the next 20 years, the analysis derived four different fuel mixes for the Northwest. Figure 2-6 shows the electric generation capacity and fuel mix for each future in 2026, compared to 2006. Even though there is substantial *capacity* in renewable resources, the amount of actual *output* is not discernable because the capacity factor for renewable resources such as wind is low. Wind in the northwest, for example, produces power only about 27 percent of the time.

For all scenarios, natural gas is the fuel source that changes by the greatest amount. Coal remains at about the same amount (though a smaller portion of the total) in the Return to Reliability and Terrorism & Turmoil scenarios. Green World looks least like the other scenarios by 2026. In Green World, coal has been eliminated primarily through emissions regulation and national Renewable Portfolio Standards. The cost of meeting regulations makes power costs for Green World very much higher than for the other three scenarios. Figure 2-8 shows the change in power price in the WECC Northwest over the period from 2006 to 2026.

Figure 2- 6. Electric Generation (GWh) by Fuel Source in WECC NW

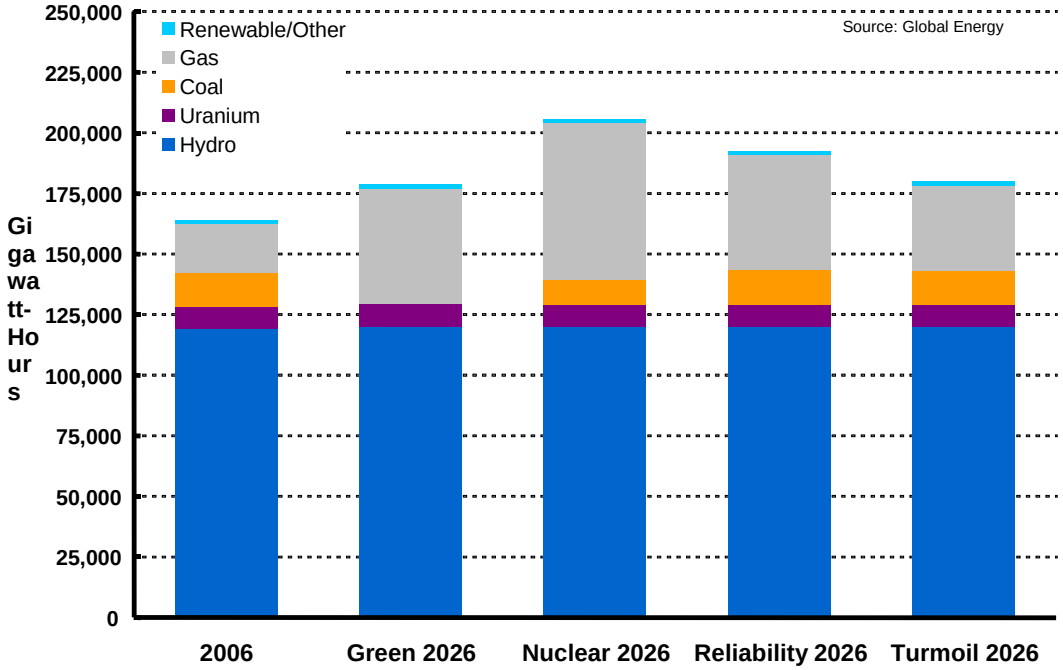
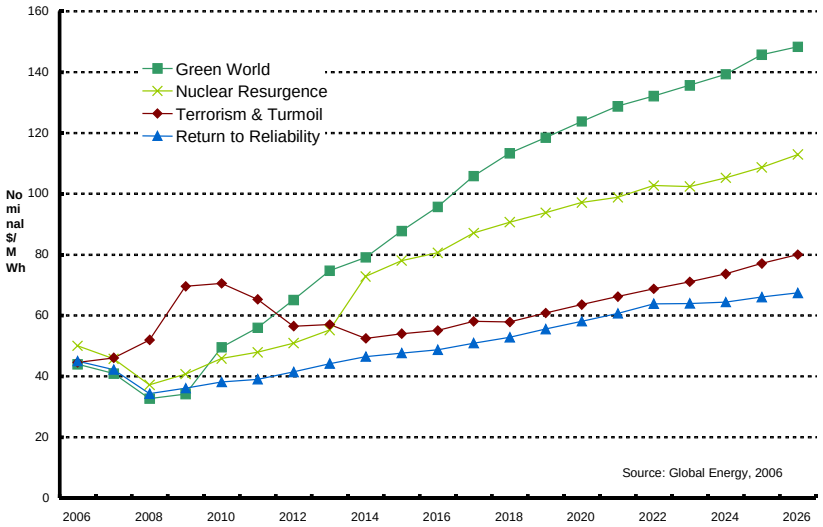


Figure 2-7. WECC NW All-Hour Average Wholesale Electricity Price



2.5.2.3 The Model

The model, *EnerPrise Planning and Risk*, incorporates a complete description of the resources available, the prices of fuel and power, and the load. It simulates the dispatch (operation) of the resources available to it to meet the demand it faces each hour of the year at the lowest possible cost. If it runs out of resources before meeting demand, or if wholesale market power is cheaper than the cost of dispatching resources in the portfolio, then it will purchase from the market. The model also dispatches resources to sell into the wholesale market when it is profitable. This use of a resource helps to reduce the overall cost of having it in the portfolio. Note that the costs associated with air emissions are not included in the dispatch decision.

As the model dispatches resources, it keeps track of the cost of operating the resources, quantifies a variety of air emissions, the hours of load not served, among a host of other data. These data are used for the evaluation criteria noted earlier. The model also considers uncertainty about the future such as uncertainty about future prices for fuel and power, customer demand, and the availability and variability of water for hydro generation.

The model produces random draws (or selections from all possible values) of fuel and power prices, generation, and load wherein it is constrained in several ways. First, there are relationships that exist between power prices and fuel prices. For example, higher fuel prices will lead to higher power prices, and fuel prices themselves often move in tandem. Second, because of the size of the hydro system in the Northwest, during the runoff period (April to June) wholesale market prices for power are often depressed as the hydro system displaces fossil fuel generation in the region. The effect is relatively short-lived, but it is important.

These correlations among the variables in the model must be accounted for when making a random draw of the price of market power. That random draw from the market price distribution cannot be entirely free and unconstrained, but must reflect the random draws made for natural gas, hydro generation, and other variables.

The final constraint on the random process is important when drawing values from the price distribution in particular. The draws must not only respect the correlations noted above, but must also mirror the pattern of prices actually observed in the markets for fuels and power.

For each hour in the analysis, the model generates a draw of correlated values for the prices, load, and generation, and dispatches the resources as described earlier. It repeats the random draw-dispatch process 250 times before moving to the next hour, and produces a distribution for each output. Those distributions reflect the underlying distributions and correlations for prices and other variables.

2.6 Description of Alternatives

Integrated resource planning commonly involves examining a wide range of alternative resources. Washington State law requires that City Light "perform a detailed and consistent analysis of a wide range of commercially available resources."

The Proposed Action covered in this EIS is adoption of an Integrated Resource Plan containing City Light's long-term strategy (types of resources, amounts, and timing) for meeting electrical load over a 20-year period. Once electricity needs were defined, City Light developed a number of possible combinations of new resource additions that could meet the need. These combinations are called "portfolios". City Light has not yet identified a Preferred Alternative.

2.6.1 Objectives

Three key objectives were considered in constructing the resource portfolios:

1. Develop a wide range of resource portfolios, including those containing predominantly renewable resources, those containing predominantly non-renewable resources, and those with a mixture of renewable and non-renewable resources.
2. Ensure sufficient supplies of generation each month during the 20-year period to avoid unserved energy needs with a 95-percent degree of confidence.
3. Utilize a mix of resources believed to be commercially available to Seattle City Light and resources specifically recommended for inclusion in the portfolios through the public input process.

Nine alternative resource portfolios that would satisfy City Light's future energy needs were formulated. Each portfolio, consisting of different combinations of individual resources, represents an alternative "theme". Evaluation criteria covering cost minimization, risk management, reliability, and minimization of environmental impacts were established for the portfolios, and each was subjected to analysis to determine how well they would perform under different future conditions. City Light used a computer model, EnerPrise Planning and Risk, to evaluate the performance of each portfolio. Assumptions about fuel and electricity prices, electricity supply and demand, and environmental regulations were varied. The Draft EIS uses the baseline assumptions about these variables (compiled as the Reference Case). The nine alternative portfolios are listed below and depicted in Table 2-3:

1. No Action – Rely on the Market
2. Renewables
3. Gas, 100% Block
4. Gas, Wind, 50% Block
5. Gas, Wind, Hydro
6. Gas, Biomass, Wind
7. Gas
8. Gas and Coal (Pulverized)
9. Wind and Coal (IGCC)

Table 2-3 depicts the new resources acquired in each of the resource portfolios between 2007 and 2026[2]. Common to all resource portfolios are 140 megawatts of conservation and 100 megawatts of exchange. Conservation and seasonal exchanges with utilities in other regions are seen as cost-effective approaches to meeting seasonal resource needs.

Five of eight portfolios contain a call option, with the amounts varying by portfolio. Call options (a 'reservation' on generating capacity that can be called on to produce electricity when needed, for a fee), help to improve the seasonal load-resource balance and can be a very effective tool for addressing seasonal resource needs. Hydro resources occur in two forms: a 10-megawatt efficiency upgrade to existing SCL hydro capacity and a 50-megawatt contract for existing hydro capacity from another utility. Wind resources are found in five portfolios, with the largest amount (750 megawatts) occurring in the Renewables portfolio.

Table 2-3. Total New Resources by Portfolio (Megawatts of Capacity in 2026)

Resource	Resource Portfolio								
	1 Rely on Market	**2 Renewables**	**3 Gas, 100% Block**	**4 Gas, Wind, 50% Block**	**5 Gas, Wind, Hydro**	**6 Gas, Biomass, Wind**	**7 Gas**	**8 Gas, Coal**	**9 Wind, IGCC**
Conservation		140	140	140	140	140	140	140	140
Exchange*		100	100	100	100	*100*	100	100	100
Call Option*		*70*	*100*		*50*	*50*			*70*
Hydro (Efficiency and Contract)		60			60				
Wind		750		150	150	150			450
Geothermal		25							
Landfill Gas		25			25	25			
Biomass		25				50			
CHP (co-gen.)					25				
CC Turbine			350	350	150	100	300	225	
SC Turbine			50		50	50	50		
IGCC - Coal									300
PV Coal								150	
2026 Total	**0**	**1,125**	**990**	**640**	**750**	**615**	**590**	**615**	**990**

*Call options and exchanges are temporary resources and may no longer be in the portfolio by 2026.

Geothermal occurs in one portfolio, landfill gas in three portfolios, biomass in two portfolios, and Combined Heat and Power (CHP, also called cogeneration) in one portfolio. All four of these resources are comparatively small, at 25 megawatts per unit.

[2] The totals in Table 1-2 are for the year 2026. Please note that the totals may vary among portfolios because they represent generation capacity vs. energy actually produced. For example, because of the lesser reliability of wind energy, a greater generation capacity is required to produce an amount of electricity equal to that produced by another resource with higher reliability.

Simple cycle and combined-cycle natural gas turbines are included in five portfolios. In three of the five portfolios, natural gas turbines make up more than one-half of the total resources added. Conversion of the BPA slice product to block in the 100-percent Block portfolio results in less BPA generation being available for the existing resources portion of the portfolio (see Section 1.3.2) because the potentially higher amounts of electricity available under the slice product would be foregone. Additional new resources must be added to make up for the loss to existing hydro resources. The 100-percent Block portfolio contains the most natural gas turbines (400 megawatts) of any portfolio.

City Light has not yet identified a Preferred Alternative. These portfolios will be refined base on the results of a second round of analysis and comments received. A Preferred Alternative may be identified through this process and will be described on the Final EIS.

2.6.2. Portfolio Descriptions and New Resource Capacity

The range of environmental impacts seen in Round 1 portfolios are expected to encompass the range of impacts of Round 2 portfolios and, thus, the portfolio ultimately to be recommended as the "preferred" portfolio. A brief description of each of the nine portfolios follows.

2.6.2.1 Portfolio 1: No Action - Rely on the Market

In the No Action Case, no new resources (generation or conservation) are acquired. Instead, all new power requirements are met with short-term purchases in the western wholesale power market. Short-term (spot) market purchases are made at the forecasted market price, set by the marginal generating unit in the West. From an environmental perspective, it means that at any given time, air emissions will be driven by whatever generating unit is on the margin in the spot market at that point in time. Presently in the West, natural gas-fired generation is on the margin more than 90 percent of the time.

2.6.2.2 Portfolio 2: Renewables

As its name implies, the Renewables portfolio contains many renewable resources. In addition to the renewable resources, there is a seasonal exchange and a call option. Emissions in the portfolio are assumed to occur from four of the nine resources: biomass, landfill gas, the call option, and the exchange. The biomass and landfill gas resources are treated as greenhouse gas neutral, but have other emissions such as sulfur dioxide and nitrogen oxide. While the generating resources supplying the exchange would operate seasonally each year, the generating resources backing up the call option would seldom operate – and only if called upon. Under normal weather and hydro conditions, many years could pass without exercising the call option. Table 2-4 depicts new resources to be acquired for Portfolio 1 between 2007 and 2026.

Table 2-4. Renewables Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Hydro Contract	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Call Option	Mid-C	70	70																		
Exchange	Mid-C		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hydro Efficiency	W. WA		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Wind	E. WA		150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Landfill Gas	W. WA							25	25	25	25	25	25	25	25	25	25	25	25	25	25
Geothermal	W. WA									25	25	25	25	25	25	25	25	25	25	25	25
Wind	E. WA													150	150	150	150	150	150	150	150
Biomass	W. WA													25	25	25	25	25	25	25	25
Wind	E. WA															300	300	300	300	300	300
Wind	E. WA																				150
Total		127	394	331	338	345	352	384	391	423	430	437	444	626	633	940	947	954	961	968	1125

2.6.2.3 Portfolio 3: Gas, 100% Block

The 100% Block portfolio eliminates BPA's slice product from the mix, instead taking all block and reshaping it on a monthly basis to take more in the winter. The advantage of a larger proportion of the block product is that it allows City Light to match more closely its BPA power purchase to its needs. However, City Light would receive considerably less power from BPA in total because the block product is based upon a 1937-38 water year. In trading slice for block, on average, City Light would receive about a one-third less megawatt-hours than it would have received from a corresponding amount of slice. This means that more generation must be added sooner to the portfolio to offset the loss in BPA megawatt-hours. The additional generation comes in the form of combined-cycle combustion turbine capacity. In total, there is 600 MW of combined-cycle turbine capacity. Table 2-5 depicts new resources to be acquired for Portfolio 3 between 2007 and 2026.

Table 2-5. Gas and 100% Block Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026)

Resource (MW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservatiion	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Call Option	Mid-C	100	100	100	100	100															
SC Turbine	W. WA			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
CC Turbine	MT									150	150	150	150	150	150	150	150	150	150	150	150
CC Turbine	W. WA										150	150	150	150	150	150	150	150	150	150	150
CC Turbine	W. WA													150	150	150	150	150	150	150	150
CC Turbine	MT																150	150	150	150	150
Total		207	214	271	278	285	192	199	206	363	520	527	534	691	698	705	862	869	876	883	890

2.6.2.4 Portfolio 4: Gas, Wind, 50% Block

Seattle City Light purchases two products as part of its contract with the Bonneville Power Administration. One product is called "slice," because it mimics ownership of a slice of the hydroelectric generation capacity on the BPA system. In good water years, more megawatt-hours of generation are received by City Light than in bad water years. In buying the slice product, City Light shares in the annual hydro risk that comes from the BPA hydroelectric system. A second product is called "block," in reference to it being taken as blocks of power. It is a firm product, where a pre-determined amount of generation is delivered by the BPA irrespective of what kind of water year occurs. The block generation can be 'shaped," or taken in different amounts at different times of the year, but does not vary from the contracted amount. The 50% block: 50% slice portfolio allows analyzing a different mix of products than City Light currently purchases from BPA. In addition to the block and slice, the portfolio contains a call option, 50 MW of a simple-cycle turbine capacity, and 350 MW of combined-cycle turbine capacity. Table 2-6 depicts new resources to be acquired for Portfolio 4 between 2007 and 2026.

Table 2-6. Gas, Wind, 50% Block Portfolio - New Resources

(Megawatts of Capacity 2007 through 2026)

Resource (MW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservatiion	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100															
CC Turbine	E. WA			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Wind	MT						150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
CC Turbine	W. WA										100	100	100	100	100	100	100	100	100	100	100
CC Turbine	W. WA															100	100	100	100	100	100
Total		107	114	271	278	285	342	349	356	363	470	477	484	491	498	605	612	619	626	633	640

2.6.2.5 Portfolio 5: Gas, Wind, Hydro

Like the Renewables portfolio, the Gas, Wind, and Hydro portfolio contains many renewables. However, a significant difference is that the portfolio contains three additions of natural gas-fired turbine capacity (2011, 2019, and 2021), for a total of 200 MW by the year 2021. Emissions come from the operation of the simple-cycle and combined-cycle turbines, the exchange contract, landfill gas, combined heat and power (CHP), and the call option. As mentioned above, landfill gas is treated as greenhouse gas neutral (no CO_2 emissions). Table 2-7 depicts new resources to be acquired for Portfolio 5 between 2007 and 2026.

Table 2-7. Gas, Wind, Hydro Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026)

Resource (MW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Hydro Contract	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Exchange	Mid-C		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hydro Efficiency	W. WA		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Wind	E. WA		150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Landfill Gas	W. WA			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
CHP	W. WA			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
CCT	W. WA							50	50	50	50	50	50	50	50	50	50	50	50	50	50
CT	W. WA													50	50	50	50	50	50	50	50
CCT	W. WA															100	100	100	100	100	100
Call Option	Mid-C																			50	50
Total		57	324	381	388	395	402	459	466	473	480	487	494	551	558	665	672	679	686	743	750

2.6.2.6 Portfolio 6: Gas, Biomass, Wind

The Gas, Biomass, and Wind portfolio is similar to the hydro, wind, and gas portfolio, except it has no hydro. Emissions anticipated in this portfolio come from the combined-cycle and simple cycle (CCCT and SCCT) turbines, two biomass plants, and exchange. With the exception of the Renewables portfolio, it has more generation capacity than other portfolios. This is because the variability of wind resources causes them to generate, on average, at roughly 30 percent of their nameplate capacity (a 30-percent capacity factor). At this capacity factor, more wind plant resource must be added to get the same amount of generation as other resources with higher capacity factors. Table 2-8 depicts new resources to be acquired for Portfolio 6 between 2007 and 2026.

Table 2-8. Gas, Biomass, Wind Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026)

Resource (MW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Call Option	Mid-C	50	50	50																	
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Wind	E. WA			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
SCCT	E. WA					50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Landfill Gas	W. WA					25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Biomass	W. WA									25	25	25	25	25	25	25	25	25	25	25	25
Biomass	W. WA											25	25	25	25	25	25	25	25	25	25
Wind	W. WA													150	150	150	150	150	150	150	150
CCT	W. WA															100	100	100	100	100	100
Wind	W. WA																				150
Total		157	164	321	278	360	367	374	381	413	420	452	459	616	623	730	737	744	751	758	915

2.6.2.7 Portfolio 7: Gas

In addition to the conservation and exchange assumed in all portfolios, the Gas portfolio contains only natural gas-fired turbines. It is assumed that the natural gas-fired turbines would be sited in western Washington, helping to keep their transmission costs down. Emissions in the Gas portfolio come from the exchange, the two simple-cycle turbines, and the single combined-cycle turbine. Table 2-9 depicts new resources to be acquired for Portfolio 7 between 2007 and 2026.

Table 2-9. Gas Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
SCCT	W. WA			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
CCT	E. WA											150	150	150	150	150	150	150	150	150	150
SCCT	W. WA																50	50	50	50	50
Total		107	114	271	278	285	292	299	306	313	320	477	484	491	498	505	562	569	576	583	590

2.6.2.8 Portfolio 8: Gas, Coal

In addition to conservation and a long-term exchange, the Gas and Coal portfolio contains 225 MW of natural gas turbine capacity and 150 MW of coal-fired capacity. Although the coal-fired capacity is conventional pulverized coal technology, total carbon dioxide emissions are lower than in the IGCC portfolio. The IGCC portfolio has twice as much coal-fired capacity. Other resources with air emissions are the exchange, the simple cycle turbine, and the combined-cycle turbine. Table 2-10 depicts new resources to be acquired for Portfolio 8 between 2007 and 2026.

Table 2-10. Gas, Coal Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026))

Resource (MW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CC Turbine	W. WA			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Coal	MT						150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
CC Turbine	W. WA																75	75	75	75	75
Total	W. WA	107	114	271	278	285	442	449	456	463	470	477	484	491	498	505	587	594	601	608	615

2.6.2.9 Portfolio 9: Wind, Coal (IGCC)

The IGCC and Wind portfolio contains conservation, an exchange, a 70-MW call option that expires in 2011, three wind plant additions, and two additions of IGCC capacity. The IGCC capacity is assumed to be part of a future IGCC plant constructed in eastern Montana. Emissions from this portfolio are from the exchange, the call option, and the IGCC capacity additions. The IGCC technology has lower air emissions than convention pulverized coal technology. However, it is assumed that the carbon dioxide emissions would not be sequestered. Therefore, the IGCC capacity would require the purchase of carbon dioxide emission offsets. Like the Renewables portfolio, this portfolio has a comparatively large amount of total generating capacity because of 450 MW of

wind capacity, in addition to the 300 MW of IGCC capacity. As described in the Gas, Biomass, and Wind portfolio, more wind capacity is required because of the low capacity factor. Table 2-11 depicts new resources to be acquired for this portfolio between 2007 and 2026.

Table 2-11. Wind, Coal (IGCC) Portfolio - New Resources
(Megawatts of Capacity 2007 through 2026)

Resource (MW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservatiion	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Call Option	Mid-C	70	70	70	70																
Wind	E. WA			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
IGCC	MT					150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Wind	E. WA						150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Wind	E. WA							150	150	150	150	150	150	150	150	150	150	150	150	150	150
IGCC	MT													150	150	150	150	150	150	150	150
Total		177	184	341	348	435	592	749	756	763	770	777	784	941	948	955	962	969	976	983	990

2.7 Portfolio Evaluation

2.7.1 Portfolio Evaluation Criteria

After each resource portfolio is modeled, the portfolios are evaluated in comparison to each other. A series of calculations are completed for measures of cost, environmental impact, risk, and reliability. These criteria were selected for evaluating the relative performance of the resource portfolios being studied. All costs and revenues are expressed in real dollars, as a net present value using a 3-percent discount rate. The portfolio evaluation criteria are shown in Table 2-12.

Table 2-12. Portfolio Evaluation Criteria

Portfolio Evaluation Criteria	Criteria Measures
Minimize Costs to Customers	20-Year Net Present Value of Portfolio Costs
Manage Risks	Volatility of Portfolio Costs
Provide Reliable Service	Occurrence of Unserved Customer Energy Need
Minimize Environmental Impacts	Level of Environmental Impacts including Monetized Values for Emissions of Pollutants including CO2, SO2, NOx, Mercury

Cost

Fixed costs are evaluated in the form of capital costs for generation plants and electric transmission expansions or upgrades. Variable costs include fuel, plant start-up costs, variable operations and maintenance (O&M), and carbon dioxide offset costs. Carbon dioxide offset costs are internalized in the analysis because of the City's policy on greenhouse gas emissions. Offset costs range from $5 per ton in the Reference Case, to $20 per ton in the near term and escalating to $100 per ton by 2026 in the Green World case. Offset costs are not included in dispatch decisions.

Environmental Impact

Air Emissions. Air emissions was the only environmental factor explicitly included in the modeling and analysis of portfolios because of its importance and because it can be quantified without specific siting information. For each generating resource portfolio, total emissions into the air of carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NOx), mercury (Hg), and particulates (PM) are estimated over the 20-year period. A monetary cost is applied to the emissions to facilitate evaluating the cost of complying with potential environmental regulations in the future. The compliance costs of each portfolio are tabulated by year and expressed as a net present value. These costs are varied in the alternative futures to gain a sense of the how well the portfolios perform

under different regulatory scenarios. These costs are included in the cost evaluations described above.

There are several methods to determine the societal costs of environmental impacts such as air emissions. In addition to the internalized cost comparisons described above, the net emissions for each resource portfolio (emissions generated minus emissions reductions from sales into the market that result in turning off of less efficient resources) are calculated. In this case, control costs are used as a proxy for the net environmental damage from air pollutants of each portfolio.

Other Environmental Impacts. For other environmental elements including land use, surface and groundwater, soils and geology, plants and animals, employment, aesthetics and recreation, environmental health, and cultural and history, each portfolio was assessed for the level of impact in each element and ranked high, moderate or low.

Risk

Risk is measured for the variable costs of the resource portfolios and for net market purchases and sales. Varying fuel prices and the extent and frequency of plant operations affect variable costs. Net revenues from market purchases and sales are influenced by the extent of surplus generation and the spot market price. For both the variable cost and net revenue risk, the measure applied is the coefficient of variation, which measures the degree of variance from the mean, or average. The greater the variance from average, the larger the coefficient of variation and the larger the implied risk associated with the portfolio. This measure is useful for evaluating the relative volatility of variable costs and net revenues across portfolios.

Reliability

Reliability is factored into the analysis early in the process. Each portfolio is constructed to meet all loads and water conditions with 95-percent confidence on a monthly basis. As constructed, the portfolios produce little or no unserved energy and produce no meaningful differences among the portfolios that by definition provide a high degree of reliability. Another, less direct measure of reliability is the net market purchases and sales. Portfolios that rely more heavily on market purchases may be less reliable. However, in all resource portfolios, Seattle City Light would be a large net seller.

2.7.2 Portfolio Evaluation Results

The measures for the four evaluation criteria (cost, environment, risk, and reliability) are useful for comparing portfolios relative to each other. In keeping with the IRP stakeholders' recommendation, portfolios are depicted in relation to each other, without a weighting of the relative importance of measures. Because the impacts in the elements of the environment cannot be combined into a single measure of environmental impact, this table shows the Direct Generation air emissions as a measure of environmental impact. The results of the portfolio comparison are shown in Table 2-13.

Table 2-13. Portfolio Comparison

	Total Cost	Environ-mental Impacts	Cost Risk	Market Risk	Revenue Less Cost ($5/ton for CO2)	Revenue Less Cost ($25/ton for CO2)
1. Rely on Market-No						
2. Renewables						
3. Gas, 100% Block						
4. Gas, Wind, 50% Block						
5. Gas, Wind, Hydro						
6. Gas, Biomass, Wind						
7. Gas						
8. Gas, Coal						
9. Wind, IGCC						

	Best Performing
	Mid Performing
	Worst Performing

The portfolios performing among the top third of portfolios across all six measures are:

- Renewables
- Gas, Wind, Hydro
- Gas

The top three portfolios in terms of net present value of net power costs (revenues net of costs) assuming a $5 per ton costs for CO2 emissions, are:

- Renewables
- Gas, Wind, Hydro
- Gas, Coal

If a $25 per ton cost for CO2 emissions is used, then the top three portfolios are:

- Renewables
- Gas, Wind, Hydro
- Gas, Biomass, Wind

The top three performing portfolios with respect to the lowest environmental impact, as measured by residual air emissions (carbon dioxide, sulfur dioxide, nitrogen oxide, particulates, and mercury) from generation, are:

- Renewables
- Gas, Wind, Hydro
- Gas, Biomass, Wind

CHAPTER 3

Affected Environment, Impacts of the Alternatives, Mitigating Measures, and Significant Unavoidable Adverse Impacts

3.1 Introduction

Chapter 2 includes a description of Seattle City Light's load projections, existing resources, and the adequacy of these resources to fulfill the load. With the conclusion that additional resources are needed, Chapter 2 then provides the policy context for resource planning and outlines the process SCL undertook to develop alternatives. This process involved formulating nine alternative resource portfolios, any of which would satisfy SCL energy needs during the planning period. Each portfolio consists of different combinations of individual resources, and represents a different "strategy" or "theme". Evaluation criteria covering cost minimization, risk management, reliability, and minimization of environmental impacts were applied to the portfolios, and each was subjected to rigorous analysis to determine how well they would perform.

This analysis covered several scenarios about the future in which assumptions about fuel prices, electricity supply and demand, and electricity prices were varied. The alternative portfolios evaluated in this Draft EIS use the baseline forecast (Reference Case) assumptions about future conditions. This chapter describes the environmental impacts of implementing each of the nine alternative portfolios. The portfolios are:

1. No Action – Rely on the Market
2. Renewables
3. Gas, 100% Block
4. Gas, Wind, 50% Block
5. Gas, Wind, Hydro
6. Gas, Biomass, Wind
7. Gas
8. Gas, Coal (Pulverized)
9. Wind, Coal (Integrated Gasification Combined Cycle-IGCC)

A detailed description of the portfolios is in Chapter 2. The individual resources that comprise these portfolios are shown below:

Portfolio	Resource Additions
1 - No Action - Rely on Market	Market Purchase and Sales Only
2 - Renewables	Conservation, Geothermal, Gorge Tunnel (hydro efficiency), Wind, Call Option, Exchange, Hydro Contract, Market Purchases and Sales, Biomass, Landfill Gas
3 - Gas, 100% Block	Conservation, Wind, Change in BPA, Call Option, Exchange, Market Purchases and Sales, Natural Gas(CCCT)

Portfolio	Resource Additions
4 - Gas, Wind, 50% Block	Conservation, Wind, Change in BPA, Exchange, Market Purchases and Sales, Natural Gas (CCCT)
5 - Gas, Wind, Hydro	Conservation, Gorge Tunnel, Wind, Call Option, Exchange, Hydro Contract, Market Purchases and Sales, Landfill Gas, Natural Gas (CCCT, SCCT, CHP)
6 - Gas, Biomass, Wind	Conservation, Wind, Call Option, Exchange, Market Purchases and Sales, Biomass, Landfill Gas, Natural Gas (CCCT, SCCT)
7 - Gas	Conservation, Exchange, Market Purchases and Sales, Natural Gas (CCCT, SCCT)
8 - Gas, Coal (Pulverized)	Conservation, Exchange, Market Purchases and Sales, Natural Gas (CCCT, SCCT), Coal (PV)
9 - Wind, Coal (IGCC)	Conservation, Wind, Change in BPA, Call Option, Exchange, Market Purchases and Sales, Coal (IGCC)

The various combinations of resources in the nine portfolios are shown in Table 3-1. This table depicts the aggregate resources that would be used over a 20-year period to fulfill SCL's electricity needs, by portfolio. For example, Portfolio 4 (Gas, Wind, 50% Block) would be comprised of 1,719 aMW of new conservation measures, 773 aMW of new wind resources, 12,181 aMW of energy acquired from BPA, 1 aMW exchanged to other utilities, 241 aMW purchased from other utilities, 8,714 aMW sold to other utilities, and 2,032 aMW of new CCCT.

The impact evaluations in this chapter draw upon assessments of individual resources (including transmission) presented in Appendix C. Appendix C is organized by energy resource, with impact conclusions then presented for each of the elements of the environment. The evaluations assign impact according to four levels: none, low, moderate, high. Each level reflects a subjective judgment about the "severity" of an impact, with the level of severity determined by considering the magnitude, extent, duration, and probability of an impact. Impacts shown with a "+" reflect positive impacts; "+L" indicates that the positive impacts are low and "+M" indicates they are moderately positive. Further, impacts are shown for construction and operation separately. Generally, construction impacts tend to be relatively short term and operational impacts of longer-term duration and greater magnitude. The impact evaluations for the individual resources are summarized in Table 3-2.

Rather than repeat information that may be common to more than one portfolio, this chapter uses an abbreviated approach to summarize impacts that are discussed more fully in *Appendix C*. The chapter is organized around elements of the environment, with impact conclusions presented for each portfolio. The impact evaluations for the alternative portfolios combine the results for the individual resources and vary according to the composition and amount of resources in each portfolio. Further, this environmental assessment is programmatic in that specific sites or projects are not known or proposed. As a result, much of the analysis is presented in relative terms in a manner that seeks to distinguish the alternative portfolios.

Table 3-1. Alternative Energy Portfolios and their Composition – Reference Case
(aMW of Energy, 2007 – 2026)

Resource	Portfolios								
	1	2	3	4	5	6	7	8	9
	Rely on Market	Renew-ables	Gas, 100% Block	Gas, Wind, 50% Block	Gas, Wind, Hydro	Gas, Biomass, Wind	Gas	Gas, Coal	Wind, IGCC
Conservation	0	1,719	1,719	1,719	1,719	1,719	1,719	1,719	1,719
Geothermal	0	153	0	0	0	0	0	0	0
Gorge Tunnel	0	84	0	0	84	0	0	0	0
Wind	0	2,064	980	773	929	929	0	0	2,392
BPA	13,830	13,830	11,495	12,181	13,830	13,830	13,830	13,830	12,341
Call Option	0	50	50	0	42	25	0	0	50
Exchange	0	-1	-1	-1	-1	-1	-1	-1	-1
Hydro Contract	0	1,000	0	0	1,000	0	0	0	0
COB Sales	-1,452	-1,452	-1,451	-1,452	-1,452	-1,452	-1,452	-1,452	-1,452
MID C Purchase	835	38	180	241	61	135	196	55	67
MID C Sales	-4,986	-9,510	-7,403	-7,262	-8,945	-7,926	-8,107	-9,540	-9,639
Biomass	0	54	0	0	0	105	0	0	0
Landfill	0	198	0	0	255	228	0	0	0
CCCT	0	0	2,837	2,032	271	429	1,972	1,247	0
SCCT	0	0	0	0	388	206	70	113	0
CHP	0	0	0	0	48	0	0	0	0
IGCC	0	0	0	0	0	0	0	0	2,752
PV Coal	0	0	0	0	0	0	0	2,255	0

Table 3-2. Resource Impact Matrix

Elements of the Environment	Landfill Gas	Wind	Gas - SCCT	Gas - CCCT	Coal - Pulverized	Coal - IGCC	Transmission	Geothermal	Biomass	Hydro Gorge Tunnel	Conservation	Market Transactions
	Resources											
Soils and Geology												
Construction	L	M	M	M	H	H	M	H	L	M	N/A	0
Operation	0	L	M	M	H	H	L	H	M	0	0	M
Air Quality												
Construction	L	L	L	L	L	L	L	L	L	L	N/A	0
Operation	L	L	M	M	H	H	L	L	M	L	L	H
Surface and Groundwater												
Construction	L	L	L	L	L	L	M	L	L	L	N/A	0
Operation	L	L	M	M	H	H	M	M	M	0	0	M
Plants and Animals												
Construction	L	M	M	M	H	H	M	H	M	L	N/A	0
Operation	L	M	L	L	H	H	M	M	M	0	0	M
Energy and Natural Resources												
Construction	L	L	L	L	M	M	M	L	L	L	N/A	0
Operation	+	0	H	H	H	H	M	L	L	+	+	H
Environmental Health												
Construction	0	L	L	L	M	M	H	M	M	L	N/A	0
Operation	+	M	M	M	H	H	L	M	M	0	L	M
Land Use												
Construction	L	M	M	M	H	H	H	M	M	L	N/A	0
Operation	L	M	M	M	H	H	H	H	H	L	0	M
Aesthetics and Recreation												
Construction	L	M	M	M	M	M	M	H	M	M	N/A	0
Operation	L	H	M	M	H	H	H	H	H	L	0	M
Cultural Resources												
Construction	0	M	M	M	M	M	L	M	M	L	N/A	0
Operation	0	M	M	M	H	H	M	L	L	0	L	M
Economy												
Construction	+L	+L	+M	+M	+M	+M	+L	+L	+L	+L	+H	0
Operation	+L	+L	+L	+L	+M	+M	+L	+L	+L	+L	+L	+L
	L	Low impact		M	Moderate impact		H	High impact		+, +L, +M	Positive impact	
	0	No impact		N/A	Not applicable							

The evaluation does not weigh the relative importance of impacts among elements of the environment. However, the cumulative impacts are reflected in the impact ratings for resource portfolios (Sections 3.3 through 3.12). That is, the impact ratings for resource portfolios reflect the highest rating of the individual resources in the portfolio for each element of the environment. For example, Land Use impacts during operation for Portfolio 8 (Gas/Coal) would be “moderate” for Gas and “high” for Coal. The Land Use impact rating for the portfolio is “high”. In addition, even if the relative amounts of resources vary between portfolios, the highest rating of the individual resources in the portfolio is applied.

3.2 Regulatory Setting

The principal laws and regulations enacted all or in part to protect the environment are summarized in Table 3-3. These regulations provide a framework for looking at mitigation of environmental impacts associated with construction and operation of energy resources; it is assumed these regulations would be followed. (For policy and regulations pertaining more specifically to resource planning and priorities see Section 2.4.1.5.)

Table 3-3. Regulations Related to Mitigating Environmental Impacts

Element of the Environment	Regulations	Jurisdiction
Soils and Geology	Zoning and Grading Regulations	Generally set at the local level (county or city)
	Surface Mining Control and Reclamation Act	Federal (Office of Surface Mining)
	The Surface Mining Law created two major programs: a **regulatory program** to establish standards and procedures for approving permits and inspecting *active* coal mining and reclamation operations, both surface and underground; and a **reclamation program** for *abandoned mine lands*, funded by fees that operators pay on each ton of coal mined, to reclaim land and water resources adversely affected by pre-1977 coal mining. Although Surface Mining Control and Reclamation Act is a federal law, Congress structured the program in such a way that states would be the primary authorities responsible for enforcing the law, establishing regulations and performance standards, and issuing surface mining permits.	

	Use of Best Management Practices (BMPs) to reduce soil erosion and control storm water runoff. These standards are employed based on specifics of site and weather conditions, and are often required by local jurisdictions. The required BMPs may include the use of straw, silt fences, and water detention ponds. Clearing and Grading Permits are often required by local jurisdictions for soil and vegetation disturbance and may also contain requirements for BMPs.	
Air Quality	New Source Review (Air Operating Permit, Prevention of Significant Deterioration)	Generally the State and regional air authorities, with authority delegated by the U.S. Environmental Protection Agency
SOx	Clean Air Act, National Ambient Air Quality Standards, Clean Air Interstate Rule	Federal, often delegated to states
NOx	Clean Air Act, National Ambient Air Quality Standards, Clean Air Interstate Rule	Federal, often delegated to states
Mercury	Clean Air Mercury Rule	Federal, often delegated to states
Particulates	Clean Air Act	Federal, often delegated to states
Other	Clean Air Act	Federal, often delegated to states
Greenhouse Gas	Oregon and Washington state energy facility siting standards -- requirement for mitigation	State level currently; federal regulations proposed
	Seattle Greenhouse Gas Mitigation Policy	City of Seattle
Surface and Groundwater	Clean Water Act	Federal; often delegated to states
Cooling Water Intake Structures	In December 2001, EPA published final regulations to establish location, design, construction, and capacity standards for cooling water intake structures at new facilities under section 316(b) of the Clean Water Act. Section 316(b) of the Clean Water Act requires EPA to ensure that the location, design, construction, and capacity of cooling water intake structures reflect the best technology available for minimizing adverse environmental impact.	

Surface Water Discharge	National Pollutant Discharge Elimination System (NPDES) permit program controls water pollution by regulating point sources that discharge pollutants into waters of the United States. Point sources are discrete conveyances such as pipes or man-made ditches. Industrial, municipal, and other facilities must obtain permits if their discharges go directly to surface waters. In most cases, the NPDES permit program is administered by authorized states.	
Plants and Animals	Endangered Species Act, Migratory Bird Treaty Act, Clean Water Act, Coastal Zone Management Act, Tribal treaties	Federal (US Fish and Wildlife, NOAA Fisheries, U.S. Army Corps of Engineers), State and local government, Tribes
	Northwest Power Act	Northwest Power and Conservation Council and NOAA National Marine Fisheries Service
Energy Resources	Limited regulation; some states have Renewable Portfolio Standards (RPS) requiring that electric utilities supply a percentage of energy from renewable sources -- types and amounts vary	State level; proposals have been made for federal legislation; an RPS initiative is on the November 2006 ballot in Washington
Environmental Health	Noise Regulations	State and Local
	Mine Safety and Health Administration,	Federal
Land Use	Growth Management Act (GMA): Zoning and land use regulations vary widely by jurisdiction	Generally set at the local level (county or city) subject to the requirements of GMA
Aesthetics and Recreation	Vary widely by jurisdiction; related to land use and zoning regulations	Generally set at the local level (county or city)
Cultural and Historical	National Historic Preservation Act	Federal and State
Economy/Employment	Minimum wage and safety regulations apply and may have modest impact on number of employees and conditions of employment	Federal and State

It is important to note that there are some impacts that can be mitigated with proper siting (such as wind impacts on birds), and some that cannot at this time (such as residual emissions from CCCTs and coal-fired generation).

3.3 Soils and Geology

3.3.1 Affected Environment

The Pacific Northwest, the study area for this IRP, 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/Olympic, Cascade, and Rocky Mountain ranges. 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. These physiographic 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).

There is wide variability in geologic structure, topography, slope, erosion potential, and geologic hazards within this region. The specific conditions at an energy resource site would determine a project's level of impact.

3.3.2 Impacts of the Alternatives

A variety of land-disturbing activities could occur depending upon the type of energy project and the location of the site. During construction, clearing and grading to build access roads, construction pads for plant facilities, waste disposal areas, and other plant components; excavations for utilities and foundations; and blasting to achieve desired grades could trigger erosion, soil compaction, fugitive dust, and geologic hazards such as landslides. Similar risks would be involved during operation in some cases. Some biomass plants would require clearing of logging residues or dedicated crops. Natural gas and coal extraction involve digging and drilling, operating heavy equipment, and other activities that could adversely affect soils and geologic features.

The levels of impact on Geology and Soils attributable to the alternative portfolios for both construction and operation are summarized in Table 3-4[1]. Overall, during construction potential impacts would range from none for Portfolio 1 (No Action-Rely on Market portfolio) to high for Portfolios 2, 8, and 9 (portfolios using coal and geothermal energy facilities). The latter evaluations reflect the greater ground-disturbing activities that would occur and, in the case of geothermal, the risk of greater geologic impacts such as landslides or subsidence. Thus, while one would expect the Renewables

[1] Note that resource impact evaluations for Conservation is not included in the portfolio evaluation summaries because it is common to all portfolio alternatives.

Portfolio (Portfolio 2) to result in lower levels of impact, the inclusion of geothermal resources in this portfolio raises the impact level to high. All of the other portfolios (3-7) would result in moderate construction impacts. However, there are differences among them. For example, portfolios with a greater proportion of wind resources (Portfolio 3) vs. landfill gas resources (Portfolios 5 and 6) would be expected to have somewhat higher levels of impact (see Tables 3-1 and 3-2 to discern these differences).

Table 3-4. Impacts on Geology and Soils

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Biomass, Wind**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Soils and Geology									
Construction	0	H	M	M	M	M	M	H	H
Operation	M	H	M	M	M	M	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

Operational impacts generally parallel those for construction for all the portfolios. Efficiency improvements at the Gorge Tunnel and landfill gas, by themselves, would result in negligible impacts. However, the inclusion of geothermal facilities in portfolio 2 (Renewables) raises its level of impact rating to high. Thus, even though the Renewables Portfolio would have low operational impacts in most respects, inclusion of geothermal energy in this portfolio (and its attendant geologic risks) bumps it into the high rating. Likewise, Portfolios 8 and 9 (Gas/Coal, and Wind/IGCC portfolios) with coal-fired facilities would be expected to result in impacts at a high level.

3.3.3 Mitigation

Potential mitigating measures for Soils and Geology include the following:

- Minimize the extent of ground disturbance required, such as by using existing roads to the extent possible. Locate new access roads to follow the local topography, and minimize sidehill cuts.
- Cover and stabilize exposed areas consistent with applicable standards, salvage removed topsoils and reclaim disturbed areas as soon as possible.
- Identify and avoid unstable slopes and other geologic hazards, and avoid creating excessive slopes during construction; use special construction techniques where applicable.
- Develop and implement a temporary storm water management system to control runoff, erosion, and sedimentation during construction.

- Implement a Spill Prevention Control and Countermeasure (SPCC) Plan.
- Employ Best Management Practices (BMPs) such as using straw, silt fences, and water detention ponds to reduce soil erosion and control storm water runoff.
- Implement a permanent storm water pollution prevention plan (SWPPP).

3.4 Air Quality

3.4.1 Affected Environment

Concern over air quality is greatest in air basins where ambient concentrations of criteria pollutants (including sulfur oxides, nitrogen oxides, particulates, and mercury) exceed the federal National Ambient Air Quality Standards (NAAQS) and around certain generating plants in the affected region (BPA, 1993). Areas where background concentrations are greater than the NAAQS are referred to as non-attainment areas. Greenhouse gases are also considered to be a harmful air emission because of their effect on climate.

The following sections describe some of the principal air pollutants of concern for the various energy resources.

Sulfur Oxides (SOx) - The combustion of fuels that contain sulfur results in the emission of oxides of sulfur (SOx). Coal contains relatively high levels of sulfur compared to other fuels. The amount of sulfur in coal varies with the location of the mine, and can even vary widely within a mining area. Other fuels, including natural gas, can also contain sulfur that is converted in to SOx during combustion, but at much lower levels. SOx affects air quality both directly and indirectly. The direct effect of breathing SOx, is irritation of lungs which can lead to coughing, lung damage, and difficulty breathing in both animals and humans. Sensitive populations such as the elderly, children, and people with existing health problems related to lung and heart function are particularly at risk, as are people who are outdoors for extended periods or during exercise. According to the US Environmental Protection Agency (EPA), secondary pollution from particles formed from sulfur dioxide can build up in the lungs and are associated with premature death. In addition, SOx combines with precipitation to form an acid solution, causing damage to plants and acidifying water bodies, resulting in damage to aquatic life.

Nitrogen Oxides (NOx) - In power plants, oxides of nitrogen (NOx) are produced as a result of combustion of fuel. Some of the NOx is from the nitrogen contained in the fuel itself, and some is from the reaction of nitrogen in the air during the combustion process. The NOx emissions affect air quality both directly and indirectly. The direct effect of breathing NOx is irritation of lungs which can lead to coughing, lung damage, and difficulty breathing in both animals and humans. Indirectly, NOx combines with precipitation to form an acid solution, causing damage to plants and acidifying water bodies, resulting in damage to aquatic life. NOx can form particles, which can be breathed into the lungs, and, according to the EPA, they are associated with premature death. NOx combines with other chemicals in the air to form ground level ozone (smog) which

causes breathing difficulty and impairs visibility. Ozone is a serious health hazard, and can damage lung tissue and reduce lung function. NOx also combines with other chemicals to form toxic pollutants, which may cause biological mutations.

Mercury - A very hazardous heavy metal that is gasified in the combustion process of some fuels, particularly coal. According to the EPA, mercury exposure at high levels can harm the brain, heart, kidneys, lungs, and immune system of people of all ages. It is a known neurotoxin. It has been identified as a significant hazard to brain development in babies, both before birth and during infancy and childhood. Mercury is also a potent toxin in ecological food chains, and through bioaccumulation affects those animals on the top of the food chain. The severity and types of health impacts are determined by a number of factors, including the form of the mercury (methylmercury, elemental mercury, or other compounds of mercury), the level of exposure (amount and duration), age, and health of the person exposed.

Particulate Matter (PM) – Power plants that combust solid fuels, such as coal and some forms of biomass, emit the largest amounts of particulates per unit of electricity. Particulates can be either liquid or solids. Particles smaller than 2.5 micrometers in diameter are considered to be especially damaging to the lung and heart functions because they can be breathed in and lodged deep in the lungs. According to the EPA, breathing particulates can result in damage to human health, such as breathing difficulty, bronchitis, asthma, and damage to heart and lung functions, irregular heartbeat, nonfatal heart attacks, and premature death in people with heart or lung disease. While sensitive populations such as the elderly, children, and people with lung and heart disease are most at risk from particulate pollution, otherwise healthy people can experience health impacts from high particulate pollution levels. The pollutants in the particulates can often cause damage when they are deposited on soils or in water. Particulates also reduce visibility, which can be a safety concern in some situations, as well as an aesthetic problem.

Greenhouse Gas - There is widespread agreement among climate scientists worldwide that human activity is increasing the greenhouse gases in the earth's atmosphere and accelerating global warming. Heat trapping of "greenhouse gases" in the Earth's atmosphere -- primarily water vapor (H_2O), carbon dioxide (CO_2), and methane (CH_4) -- serves as a "blanket" for keeping the Earth's climate habitable. With industrialization and population growth, greenhouse gas emissions from human activities (like the burning of coal and oil) have significantly increased. As CO_2 and other greenhouse gases increase in the atmosphere, so do their insulating effect, causing the Earth to get warmer.

Climate scientists generally agree that releasing CO_2 into the atmosphere will cause increased global and our climate to change, resulting in serious disruptions. Climate models predict an increase in violent weather - severe storms, floods, forest fires, and drought - with potentially devastating impacts on plant and animal populations, and adverse effects on human health and survival.

The University of Washington's Climate Impacts Group has reported on possible impacts to the Northwest region. The most likely scenario would be disruption to normal hydrological cycles resulting in less snowpack and more flooding, which affect hydropower generation, salmon survival and water resources in general (Seattle City Light, 2006).

3.4.2 Impacts of the Alternatives

The evaluation of air quality impacts is more extensive than for the other elements of the environment. This is because of its importance in evaluating the portfolios in the planning process, and because emissions can be quantified without having site-specific information about a resource.

In order to understand the environmental impacts of the alternatives (portfolios), it is necessary to consider the two basic aspects of each resource in the portfolio: (1) the capacity of the resource that is available to the computer model to serve City Light demand for electricity over the 20-year planning period, and (2) the actual energy output of the resource resulting from how the model used each resource to meet the demand. Impacts associated with capacity are related to the construction of the plants, and occur whether the plant is operated or not. Air impacts of capacity tend to be low, and are primarily due to construction activity that disturbs soil and creates dust, and to construction vehicle emissions. Air impacts associated with operation of power plants are much higher, especially for fossil fuel generation or plants that burn fuel such as coal, landfill gas and biomass. The emission rates have been quantified for five pollutants: carbon dioxide (CO_2), oxides of nitrogen (NO_X), oxides of sulfur (SO_X), mercury (HG), and particulates (PM).

Table 3-5 is a summary of the air quality impacts. The impacts are discussed in more detail in the sections following the table. Impacts shown in the table are the direct impacts from the Construction and Operation/Fuel Extraction phases of the new Generation resources, impacts from market purchases, and indirect impacts resulting from purchases of existing resources. When SCL purchases more of an existing hydro resource, it reduces the available supply of hydro for other utilities. The net effect is to bring about the purchase of another resource. For the purposes of this analysis, this resource is considered to be the spot market. The model used in this IRP assumes that the spot market is a mixture of natural gas combustion turbines and small amounts of other resources such as coal. Increasing use of the spot market will increase emissions associated with these fossil fuel resources. If the Air Quality impact in any of the categories is High, the overall impact rating is High. The overall Air Quality impact ratings for the portfolios are shown in Table 3-16 at the end of this section.

Table 3-5. Summary of Air Quality Impact Levels, Extent, and Duration in Each Portfolio

	Construction	Direct-Generation/Fuel Extraction	Indirect-Contract/Market Purchase Impacts
1 - Rely on the Market - No Action	No Impacts - no New Generation	No Impacts - no New Generation	High Impact, Long Duration, Potential for regional extent
2 - Renewables	Low Impact, Short Duration, limited area/extent impact	Low Impact, Long Duration, Potential for regional extent	Moderate Impact, Long Duration, Potential for regional extent
3 - Gas, 100% Block	Low Impact, Short Duration, limited area/extent impact	High Impact, Long Duration, Potential for regional extent	Low Impact, Long Duration, Potential for regional extent
4 - Gas, Wind, 50% Block	Low Impact, Short Duration, limited area/extent impact	Moderate Impact, Long Duration, Potential for regional extent	Low Impact, Long Duration, Potential for regional extent
5 - Gas, Wind, Hydro	Low Impact, Short Duration, limited area/extent impact	Low Impact, Long Duration, Potential for regional extent	High Impact, Long Duration, Potential for regional extent
6 - Gas, Biomass, Wind,	Low Impact, Short Duration, limited area/extent impact	Low Impact, Long Duration, Potential for regional extent	Low Impact, Long Duration, Potential for regional extent
7 - Gas	Low Impact, Short Duration, limited area/extent impact	Moderate Impact, Long Duration, Potential for regional extent	High Impact, Long Duration, Potential for regional extent
8 - Gas, Coal	Low Impact, Short Duration, limited area/extent impact	High Impact, Long Duration, Potential for regional extent	High Impact, Long Duration, Potential for regional extent
9 - Wind, IGCC	Low Impact, Short Duration, limited area/extent impact	High Impact, Long Duration, Potential for regional extent	Low Impact, Long Duration, Potential for regional extent

3.4.2.1 Emission Rates

Emission rates are the amount of pollutant emitted per unit of fuel used or per unit of electricity produced. Air emissions impacts resulting from electricity production will vary widely among the resource types. Table 3-6 shows categories of resources that are used in the portfolios.

Table 3-6. Emission Rate Assumptions for Air Impact Calculations

Category	Description	Resources	Emission Rate
Generating Resources	These are new generating plants that SCL would build or from which it would purchase energy. See the Portfolio descriptions, Chapter 2, for information about locations assumed for types of plants.	Biomass (wood) Natural Gas – Combined Cycle and Simple Cycle Coal - Pulverized and Integrated Gasification	Rates are specific to each resource - See Table 3-8
Contract Purchases of Existing Resources	Energy that SCL would receive through contract	Call Option Exchange Hydro Contract	Market Emission rate - See Table 3-8 and 3-9
BPA Change	In some portfolios, SCL would change its BPA contract, resulting in a reduction in expected energy	BPA	Market Emission rate - See Table 3-8 and 3-9

Once the emission rate for each resource is established, it is multiplied by the amount of energy produced by that resource in each portfolio to determine the total emissions. This is done for each of the five emission categories (CO_2, NO_X, SO_X, HG and PM) in each portfolio. The general calculation is:

Emissions[2] (pounds) = Emission Rate (pounds/MWh[3]) x Electricity Produced (MWh)

[2] Generally, pounds have been converted into tons (1 ton = 2,000 pounds).
[3] MWh = megawatt hour

Generating resources are new power plants that are built to meet load. The emission rates of generating resources are based on best knowledge about technology available today. It does not reflect potential changes in efficiency or control technology.

Contract purchases of existing resources provide a specified amount of energy for a specified time period at a specified price. For analysis purposes, the important characteristic of these contracts is that they would be supplied by existing power plants. By acquiring some of the energy output of these existing resources, City Light precludes other utilities from using it to meet their loads, forcing them to acquire the energy somewhere else. For the purposes of understanding the net air impact of using these resources, it is assumed that the emissions are from the marginal resource, a market mix. See Appendix C for additional information about these resources and the assumption that they are served by market resources.

3.4.2.2 Emission Control Equipment - Assumptions for Each Resource

The developer of any proposed new power plant is required under the federal Clean Air Act to evaluate the plant's potential to emit air pollutants during operation. Plants that could emit quantities of air pollutants above an amount set by law, or that could increase air pollution in the vicinity of the plant above the National Ambient Air Quality Standard (NAQQS - levels considered safe for public health), will be required to install pollution control equipment or limit operation.

The processes for evaluating the potential emissions and their impact on air quality are extremely complex, and are very specific to the geographic and climatic conditions at the plant site as well as the plant design and operation patterns. Therefore, it is impossible to know precisely how a generalized power plant would affect air quality, and this EIS does not attempt to estimate the specific impacts of specific plants. However, it is possible to make some general assumptions about major types of generating plants and the type of control equipment that would likely be required. For coal plants, for example, the pollution controls include equipment to remove particulates from the exhaust combustion gas, to remove oxides of nitrogen, and to remove oxides of sulfur. Some power plants that do not emit pollutants, such as wind power, or plants that are small and use low amounts of fuel, would not be required to install air pollution controls or limit operations to reduce air emissions.

No controls were assumed for capturing carbon dioxide (CO_2). While CO_2 capture has been proposed for plants using coal with IGCC, at this time the technology is still in the research and development stage, and was not included in the assumptions for IGCC.

Table 3-7 shows the pollution control equipment that was assumed to be included in the new generating resources included in the portfolios. Each of the control technologies listed in Table 3-7 has costs for both the equipment capital and its operation and maintenance. Pollution controls can reduce the efficiency of plants somewhat, and often require the use of a small amount of the plant's power output to operate.

Table 3-7. Assumed Emission Control Equipment for Resources

Coal -(Pulverized)	Low NOx burners (control oxides of nitrogen) Limestone Scrubber (control oxides of sulfur) Selective Catalytic Reduction (control oxides of nitrogen) Electrostatic Precipitator (control particulates)
Coal - (IGCC)	Low NOx burners (control oxides of nitrogen)
CCCT	Selective Catalytic Reduction (control oxides of nitrogen)
SCCT	Selective Catalytic Reduction (control oxides of nitrogen)
Wind	None - no emissions
Biomass (wood)	None - generally emissions are below regulatory threshold
Landfill Gas	None - generally emissions are below regulatory threshold
Geothermal (binary)	None - no emissions
Hydro Efficiency (Gorge Tunnel)	None - no emissions

The emissions rates for the resources listed in Tables 3-8 and 3-9 represent the emissions that would still occur, even though emission control equipment is assumed to be used. Even though many pollution control devices can control up to 90 percent or more of a pollutant in the combustion exhaust, there will be residual emissions.

Table 3-8. Air Emission Rates by Resource Type

	SOx lbs/mm Btu	**NOx lbs/mm Btu**	**Mercury lbs/1000 mmBtu**	**Particu-lates lbs/mm Btu**	**CO_2 Lbs/mm Btu**
CCCT	0.0006	0.03	0	0.0007	117
SCCT	0.0006	0.03	0	0.0007	117
Coal (Pulverized)	0.154	0.15	4.6	0.014	208
Coal (IGCC)	0.077	0.07	0.23	0.01	208
Wind	0	0	0	0	0
Biomass (wood)	0	0.03	0	0.0097	0
Landfill Gas	0	0.06	0	0.0097	0
Geothermal - Binary	0	0	0	0	0
Conservation	0	0	0	0	0
Hydro Efficiency	0	0	0	0	0

Table 3-9. Air Emissions per Unit of Electricity, by Generation Type

	SOx lbs/MWh	**NOx** lbs/MWh	**Mercury** lbs/MWh	**Particulates** lbs/MWh	**CO_2** lbs/MWh
CCCT	0.00432	0.216	0	0.00504	857
SCCT	0.00581	0.2906	0	0.00678	1153
CHP	0.0028	0.0144	0	0.00336	571
Coal (Pulverized)	1.47	1.43	4.38x10^-5	0.133	1979
Coal (IGCC)	0.68	0.62	2.03x10^-6	0.0882	1979
Wind	0	0	0	0	0
Biomass (wood)	0	0.80	0	0.259	0 (closed loop carbon cycle)
Landfill Gas	0	0	0	0	0 (closed loop carbon cycle)
Geothermal - Binary	0	0	0	0	0
Conservation	0	0	0	0	0
Hydro Efficiency	0	0	0	0	0

3.4.2.3 Energy Output In the Portfolios

Table 3-10 shows the 20-year total energy produced by each resource type in each portfolio, in units of average megawatts (aMW). Each portfolio has a different combination of resources, and not all resources were available in all portfolios. The amount a resource was actually operated in the computer model over the 20-year planning period was determined by a number of factors, including fuel prices, market prices, demand for electricity, and the output of SCL's hydropower plants and BPA contract. As shown, the conservation levels are the same for every portfolio, reflecting a continuation of the current level of conservation acquisition. The plan for future conservation levels will be evaluated in more detail in the Round 2 IRP analysis and in specific conservation program planning efforts.

The energy output from new Generation resources varies widely across the portfolios. Some resources, such as Biomass (wood), Combined Heat and Power (CHP), Geothermal, and the Gorge Tunnel Efficiency Improvement project, contribute only small amounts of energy to the overall 20-year total. Landfill gas contributes about 10 percent of the generation in three of the portfolios, and Simple-Cycle Combustion Turbines (SCCTs) are included in four of the portfolios, ranging from between 5 percent to almost 20 percent of the generation. The resources that provide the most energy in the portfo-

lios in which they are included are wind, Combined Cycle Combustion Turbines (CCCTs), pulverized coal, and Integrated Gasification Combined Cycle (IGCC) coal. In the Renewable portfolio, wind contributes almost 80 percent and in the IGCC portfolio, wind contributes almost 50 percent to the generation resource energy.

The Contracts for Existing Resources also show a range of energy outputs in the portfolios. While the Call Option does not contribute a large amount of energy, it does contribute energy during the winter to meet high demand, and does not add surplus energy in the months when it is not needed. An Exchange contract, which is included in all

Table 3-10. 20-Year Total Energy in Each Portfolio (aMW)

Portfolio	1	2	3	4	5	6	7	8	9
Conservation	0	196	196	196	196	196	196	196	196
Generation									
Biomass	0	6	0	0	0	12	0	0	0
CCCT	0	0	324	232	31	49	225	142	0
CHP	0	0	0	0	5	0	0	0	0
Geothermal	0	17	0	0	0	0	0	0	0
Gorge Tunnel	0	10	0	0	10	0	0	0	0
IGCC	0	0	0	0	0	0	0	0	314
Landfill	0	23	0	0	29	26	0	0	0
PV Coal	0	0	0	0	0	0	0	257	0
SCCT	0	0	0	0	44	23	8	13	0
Wind	0	236	112	88	106	106	0	0	273
Contracts for Existing Re-sources									
Call Option	0	6	6	0	5	3	0	0	6
Exchange	0	0	0	0	0	0	0	0	0
Hydro Con-tract	0	114	0	0	114	0	0	0	0
BPA	1,579	1,579	1,312	1,391	1,579	1,579	1,579	1,579	1,409
Market									
COB Sales	-166	-166	-166	-166	-166	-166	-166	-166	-166
MidC Pur-chase	95	4	20	27	7	15	22	6	8
MidC Sales	-569	-1,086	-845	-829	-1,021	-905	-925	-1,089	-1,100
TOTAL	939	939	959	940	939	939	939	939	939

Key to Portfolios:

1	**Rely on the Market - No Action**	**6**	**Gas, Biomass, Wind**
2	**Renewables**	**7**	**Gas**
3	**Gas, 100% Block**	**8**	**Gas, Coal**
4	**Gas, Wind, 50% Block**	**9**	**Wind, IGCC**
5	**Gas, Wind, Hydro**		

portfolios, is shown as very close to zero energy output. However, that is a result of the structure of the contract and, actually, exchanges could have an important role in meeting demand. The reason that it appears to be zero is that the Exchange provides energy during high demand winter months, and then in months where SCL has surplus energy, it is 'returned' to the other party in the contract -- so the net energy is close to zero. This works well in helping utilities with opposite load patterns. From an impact perspective, though, it is simply a contractual agreement for trading existing resources. The Hydro contract provides a significant amount of energy in two of the portfolios: (1) Renewables and (2) Hydro, Gas, and Wind. It is assumed to be an existing resource, and therefore is assigned the market emission rates.

Energy received from BPA remains the same as it is currently under all of the portfolios except three. In portfolios 3, 4, and 9 (Gas/100% Block, Gas/Wind/50% Block, and Wind/IGCC) portfolios the amount of expected energy that City Light would receive decreases. The impact of reducing the amount of energy from BPA is that another utility can use that energy, thus reducing their use of market energy, or it reduces the amount of market energy that BPA purchases to meet its obligation to serve its utility customers. This will reduce air emissions. See the Development of Alternatives section (2.4.2), description of portfolios (Section 2.4.3), and Appendix C for more details about the BPA resource.

Market Sales and Purchases accounted for a significant amount of energy in each portfolio. Purchases were actually much smaller than sales because the need to acquire resources to meet winter demand (see section on resource adequacy in Chapter 2) causes City Light to be surplus the rest of the year. The model used in the IRP is designed to operate resources not needed to meet load for sale in the market when it is profitable to do so; that is, when price received for the energy is greater than the run cost of the resource in question. The results indicate that this was almost always the case and City Light's new portfolios were generally able to displace the marginal resource in the market. The environmental implications of this are important because the new resources are assumed produce lower emissions than the marginal resource, resulting in a net environmental gain from their operation.

This result is, of course, only valid if the resources acquired by City Light can profitably be operated for sale into the market and produce lower emissions than the marginal resource in the market. If the market evolves a marginal resource that is closer to the efficiency of those in City Light's portfolio, then resources in the portfolios would be operated less, with a consequent reduction in the environmental benefit accruing to the portfolios. Similarly, if the market evolves a marginal resource with emissions closer to those produced by resources in the portfolios, then again the environmental benefit would be reduced, even if the portfolio resources can be profitably operated. The results upon which this analysis is based reflect the assumptions about the evolution of the market inherent in the GED forecasts of prices and upon the assumptions about the characteristics of the resources used in the portfolios. Small variations in either or both of these could significantly alter the results. This effect should be significantly reduced,

as the portfolios are revised to more closely match SCL's resource needs. It is not SCL's intent to build resources for the purpose of wholesale sales.

3.4.2.4 Air Emissions from the Portfolios

Air emissions from electricity produced in each portfolio are listed in Tables 3-11 through 3-15. The numbers are the 20-year totals, in tons, for the Reference Case. The emissions are broken out into four tables, one for each of the categories described above (Generation, Contracts for Existing Generation, Change in BPA contract, and Net Market Sales/Purchases). Table 3-16 shows the sum of the contributions from all four categories.

Referring back to Table 3-10 (20-Year Total Energy in Each Portfolio), and the table of emission rates for each of the resource categories within the portfolios (Table 3-8), is useful in understanding the emission data. The actual energy produced (or displaced in the case of existing resources), multiplied by the emission rates, is what determines the actual 20-year emissions. While the capacity of each resource in the portfolios does contribute to the air impacts, due to impacts from construction for example, these are much smaller in magnitude and shorter in duration than operational impacts.

Table 3-11. 20-Year Air Emissions for Each Portfolio – New Generation Resources Only

Portfolio	CO_2 (tons)	NO_X (tons)	SO_X (tons)	HG (tons)	PM (tons)
1	0	0	0	0	0
2	0	763	0	0.000	154
3	10,646,391	2,684	54	0.000	63
4	7,625,694	1,922	38	0.000	45
5	2,177,106	1,285	11	0.000	132
6	2,646,438	1,696	13	0.000	242
7	7,754,426	1,955	39	0.000	46
8	24,803,847	15,423	14,501	0.432	1,347
9	22,121,842	7,445	8,189	0.024	1,064

Direct emissions from New Generation Resources (Table 3-11) are zero in the 'Rely on the Market - No Action' portfolio, since in that portfolio City Light assumes that it does not acquire any new resources, but instead relies entirely on its existing resources and contracts, and buys any additional electricity needed to meet load on the wholesale power market. Portfolio 1 (Renewables) emits zero CO_2, and its NO_x and particulate (PM) emissions are very low; these emissions are due to the biomass wood and landfill gas plants in the portfolio. In the low-range category for emissions from new Generating resources are the portfolios that combine relatively small amounts of natural gas, wind, and other small renewable sources: portfolios 5 and 6 (Gas/Wind/Hydro, and Gas/ Biomass/ Wind). Portfolios that contain larger amounts of natural gas, 4 and 7 (Gas/Wind/50% Block; and Gas) are in the mid-range of emissions. The portfolios that

contain large amounts of gas, portfolio 3 (Gas, 100% Block) and coal, 8 and 9 (Gas/Coal and Wind/IGCC)), have much higher emissions of all pollutants, and are the only portfolios with emissions of mercury from new Generation resources.

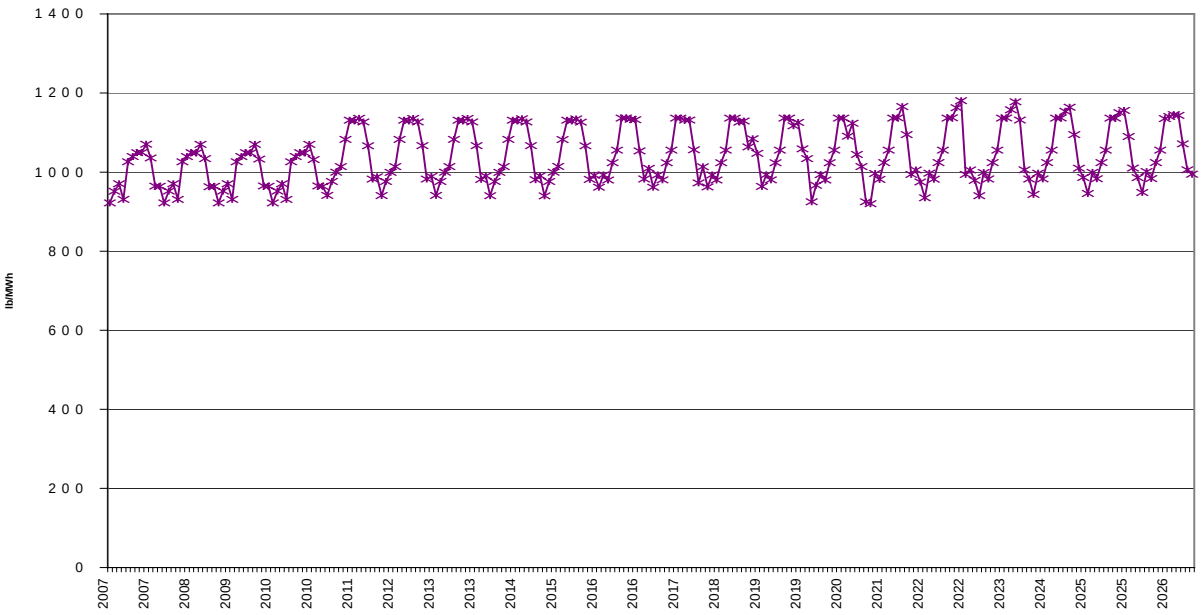
Table 3-12. 20-Year Air Emissions for Each Portfolio – Contracts for Existing Resources Only (Call Options, Exchange, Hydro Contract)

Portfolio	CO_2 (tons)	NO_X (tons)	SO_X (tons)	HG (tons)	PM (tons)
1	0	0	0	0	0
2	8,868,922	2,239	223	0.00	1,083
3	-242,200	-1,197	-198	0.00	-587
4	-653,107	-1,281	-205	0.00	-651
5	8,850,916	2,315	232	0.00	1,034
6	-447,654	-1,239	-202	0.00	-619
7	-653,107	-1,281	-205	0.00	-651
8	-653,107	-1,281	-205	0.00	-651
9	-242,200	-1,197	-198	0.00	-587

Emissions due to Contracts for Existing Generation (Call Options, Exchanges, and the Hydropower contract) are shown in Table 3-12 and illustrate that the Market emission rates are different for seasons within a year. Consider the 100% Block portfolio (Portfolio 3). While that portfolio has a net positive amount of energy from Contract resources in the 20-year planning period, it shows a decrease (negative) in emissions. This is due to the differences in seasonal market emission rates. The Call Option and Exchange energy is being brought into SCL's system at a time when emission rates are lower, on a per MWh basis. Figure 3-1 shows this for carbon dioxide (CO_2) emissions, where the 'peak and valley' pattern across the years 2007 to 2026 is a result of the seasonal pattern of the market emission rate. According to the Global Energy Decision market evaluation, emissions will be lower in the winter than in the summer when SCL would be returning energy under the Exchange in periods of higher market emission rates. Higher market emission rates occur in the summer as an increasing number of power plants are dispatched that are less efficient and have more emissions. These less efficient power plants with higher emissions are needed in order to meet higher levels of western wholesale market demand. The only portfolios in which there is not a decrease in total emissions are 2 and 5 (Renewables and Hydro/Gas/Wind). This is due to the large amount of Hydro Contract electricity compared to the amount of the Exchange.

Emission reductions from Changes in Energy Received from BPA (Table 3-13) occur in three of the portfolios: 3, 4, an 9 (Gas/100% Block, Gas/Wind/50% Block, and Wind/IGCC). In these portfolios, SCL receives less energy from BPA relative to the amount that would be anticipated under the existing contract. This energy is considered to be used by another BPA customer, who can therefore avoid market purchases, or it reduces the amount of market electricity that BPA might otherwise have to purchase to

Figure 3-1. CO_2 Emission Rate for Market Transactions – 2007 to 2026 - by Month



serve its utility customers. Therefore, that electricity is given a *negative* emission value, to reflect displacement of market emissions. Since the amount of electricity reduction from a change in the BPA contract is so large, and the market emission rates are relatively high compared to the Generating resources, the resulting reductions are very high. In fact, in the 100% Block portfolio, the amount of emissions displaced by changing the BPA contract is more than twice the magnitude of the emissions from Generation resources.

Table 3-13. 20-Year Air Emissions for Each Portfolio – Change in Energy Received from BPA Only

Portfolio	CO_2 (tons)	NO_X (tons)	SO_X (tons)	HG (tons)	PM (tons)
1					
2	0	0	0	0	0
3	-22,443,870	-11,289	-1,747	0	-4,919
4	-16,106,889	-8,267	-1,234	0	-3,509
5	0	0	0	0	0
6	0	0	0	0	0
7	0	0	0	0	0
8	0	0	0	0	0
9	-14,248,563	-6,316	-754	0	-2,272

For all portfolios, the Net Market Sales and Purchases category (Table 3-14) shows decreases in emissions for the 20-year period, and the values are very large. These are compared against the 'Rely on Market-No Action' Alternative (emissions from these market transactions are a measure of the surplus of SCL's existing resources) set as the base for the analysis. The decreases are a result of the way that the resources were operated by the model, and the fact that SCL is, on average, going to have much more electricity on *an annual basis*, than it needs to meet load (due to the nature of SCL's owned hydropower resources, which produce electricity most in the spring when demand is lower). The model can choose to run new generating resources above what is needed to meet SCL customer demand for electricity, if the excess energy can be sold at a profit. As a result, in most portfolios Generation resources are used for market sales, creating a very large net sales number. Consequently, a large amount of market electricity, with high emission rates, displaced, resulting in large negative emission number.

Table 3-14. 20-Year Air Emissions in Portfolios - Net Market Sales/Purchases ONLY (Difference from 'Rely on Market')

Portfolio	CO2 (tons)	NOX (tons)	SOX (tons)	HG (tons)	PM (tons)
1	0	0	0	0	0
2	-24,164,978	-8,952	-1,020	0	-2,775
3	-13,406,142	-3,482	-128	0	84
4	-12,433,773	-3,295	-201	0	-391
5	-21,411,641	-7,747	-878	0	-2,691
6	-16,418,240	-5,840	-642	0	-1,760
7	-16,926,325	-5,905	-622	0	-1,569
8	-24,111,422	-8,616	-966	0	-3,121
9	-24,431,673	-8,769	-1,008	0	-2,748

The 'Rely on the Market - No Action' portfolio is a reasonable representation of the amount of Market Sales and Purchases that City Light would have due to its existing resources. By looking at the difference between those numbers and each of the other portfolios, it is possible to get a sense of the magnitude of the effect of the new resources. Table 3-14 shows that the magnitude of the impacts of sales is very large. Therefore, the assumption about how new resources would be operated, and what is assumed about market emission rates, is very important in the overall emission numbers for the portfolios, as described above.

3.4.2.5 Summary of Air Quality Impacts

Table 3-15 shows the sum of all four of the resource categories. In every portfolio, the numbers are negative, meaning that because of displacing generating resources in the market that would have higher emissions, the generating resource would cause a net reduction in overall emissions in the West.

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Table 3-15. 20-Year Air Emissions for Each Portfolio – Sum of Generation, Contracts, BPA Change, Market Net Sales and Purchases

Portfolio	CO_2 (tons)	NO_X (tons)	SO_X (tons)	HG (tons)	PM (tons)
1	0	0	0	0	0
2	-15,296,055	-5,950	-797	0	-1,538
3	-25,445,821	-13,284	-2,018	0	-5,359
4	-21,568,076	-10,920	-1,602	0	-4,506
5	-10,383,619	-4,147	-635	0	-1,525
6	-14,219,456	-5,383	-830	0	-2,137
7	-9,825,006	-5,231	-788	0	-2,174
8	39,318	5,526	13,329	0	-2,425
9	-16,800,594	-8,836	6,230	0	-4,543

Table 3-15 shows that the net air impacts are worst for Portfolio 1 (Rely on Market - which uses less efficient, higher emission market resources) and 8 (Gas/Coal). The next highest are portfolios 5 and 7 (Gas/Wind/Hydro and Gas). The relative ratings of the other portfolios for net emissions is mainly a function of the quantity of their net sales into the market. In summary the air quality impacts of each portfolio (Table 3-16), portfolios that had either high direct emissions or high indirect emissions were rated as having high impact.

Table 3-16. Impacts on Air Quality - Summary

	Portfolios								
	1	2	3	4	5	6	7	8	9
Elements of the Environ-ment	Rely on Market - No Action	Green	Gas, 100% Block	Gas, Wind, 50% Block	Gas, Wind, Hydro	Gas, Biomass, Wind	Gas	Gas, Coal	Wind, IGCC
Air Quality									
Construction	0	L	L	L	L	L	L	L	L
Operation	H	M	H	M	H	M	H	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

3.4.3 Mitigation

3.4.3.1 Emissions Control Mitigation

Air emissions from new and existing power plants are regulated under the federal Clean Air Act. For individual plants, these regulations are often implemented by state air agencies, to whom authority has been delegated by the US Environmental Protection Agency. The state agencies translate the Clean Air Act regulations into specific permit requirements and emission standards for power plants. These regulations serve to reduce some air emissions, and are subject to change, usually towards more restrictive regulations on emissions, as new information about human and environmental health impacts of the emissions becomes available, and as new control technologies are developed.

There are two general categories of air pollutant regulations: those that apply to specific generation facilities and those that apply to the entire power generation industry.

The regulations that apply to specific power plants include requirements for Best Available Control Technology (BACT) on new plants, which mean that any new plant is required to install air pollution control equipment that is commercially available and economically feasible. The technologies that are considered to be BACT change as technology changes and through federal legislation and agency rulemaking. Power plants are also required to show that they will not exceed the National Ambient Air Quality Standards (NAAQS) for any air pollutant. These standards are usually defined in parts per unit of volume of air of the pollutant, and are measured on varying time periods, such as hourly, daily, and annual. Before a new plant can receive an operating permit from the local air quality agency, it must do computer modeling to show that the NAAQS will not be exceeded. Factors that are site specific, such as the presence of other sources of air pollutants, climate, meteorology, topology, and proximity to population centers and protected natural areas can have a significant impact on whether a plant can show that it will be in compliance with NAAQS. Plants are also required to monitor emissions during operation to show they remain in compliance.

Regulations that apply to the power generation industry as a whole include the Acid Rain Reduction program and EPA regulations released in spring of 2005. The Acid Rain program is commonly called the SOx trading program, and was designed as a cap and trade system. Emissions from the entire industry were capped, and then reduced over time. Power plants were given allowances; if they exceeded their emission allowances they were able to purchase allowances from other plants that have been able to emit less than they were permitted. The new EPA regulations, the Clean Air Interstate Rule and the Clean Air Mercury Rule, limit overall emission rates of oxides of sulfur (SOx) and nitrogen (NOx), and mercury. These limits are reduced over the next 10 to 15 years. It is proposed that these regulations will also be implemented through a cap and trade process, though details are still to be worked out. Other federal legislation has been proposed, and it is possible that caps and deadlines for meeting those caps will change, as technologies change and studies provide new information.

Some mitigating measures reduce air emissions, but may have their own negative environmental impacts. NOx controls with selective catalytic reduction (SCR) uses ammonia. There are risks associated with ammonia include harm to human, animal, and environmental health if it is released during transportation and storage. Also some ammonia is released from control equipment, but these releases are often limited by permit requirements. SOx controls using limestone can change the chemical properties of the coal fly ash, making it more difficult to re-use and more likely to be put in a landfill. Mercury controls can increase the amount of mercury in the fly ash, also making it more difficult to dispose of. Electricity is also required to operate the emission control equipment, reducing the net amount the plant can produce for end use consumption elsewhere.

3.4.3.2 Greenhouse Gas Mitigation Requirements

Seattle City Light has a specific obligation to evaluate the greenhouse gas (GHG) (primarily CO_2 emissions) impacts of its operations, including electricity resource decisions, and to mitigate those impacts. The policy, established by the Seattle City Council and Mayor, is described in the Internal Policy section of Chapter 2. Specifically, City Light is to avoid emissions of greenhouse gas to the extent possible, through energy conservation and renewable resource acquisition, then to purchase greenhouse gas offsets to cover any emissions that result from energy purchased from resources that emit CO_2. Current cost estimates for high quality, verifiable greenhouse gas offsets ranges widely depending on a number of factors, but has been on average about $5 per metric ton CO_2 equivalent. Over time, the costs of offsets could change. In the scenarios used to evaluate potential economic conditions over the 20-year planning period (see Chapter 2), these offset costs ranged from $ 5 per metric ton CO_2 to almost $100 per metric ton CO_2 by the end of the planning period.

A greenhouse gas offset directly avoids, displaces, or sequesters GHG emissions. Offset projects must be evaluated carefully to determine that they will actually produce the intended results, and that they will be monitored, and the offsets verified by a third party. Examples of offset projects include converting to fuels, such as biodiesel, with lower overall greenhouse gas emissions, or capturing and destroying potent greenhouse gases in industrial processes. There are many types of potential offset projects, and many organizations are attempting to create standards for the definition, accounting, and certification of offsets. In considering offset projects, City Light will continue to seek high quality offsets at the lowest available price.

3.5 Surface and Groundwater

3.5.1 Affected Environment

In general, the Pacific Northwest enjoys excellent water quality, but stringent protection is necessary. 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).

The two major Northwest rivers, the Columbia and the Snake, are very different now compared to when the region was first settled by non-Native Americans. Over the last 60 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). In addition, groundwater has been tapped as a cooling water source for some energy projects, particularly combustion turbine facilities.

3.5.2 Impacts of the Alternatives

Construction of energy facilities can affect surface and groundwater quantity and quality in several ways. Construction can affect water resources through alteration of surface and groundwater flow patterns, discharges to existing water sources, and consumption of water during the construction process. Surface disturbance of a project area for construction of roads, building sites, and other facilities can alter the surface drainage patterns and create areas of impervious surfaces, leading to greater levels of runoff. If uncontrolled, runoff from disturbed areas can produce temporary increases in soil erosion, resulting in elevated turbidity in runoff water and sedimentation in stream channels. Grading and excavation activities and extraction of geologic materials for use in construction can also change groundwater flow patterns, and result in discharges to groundwater. National Pollution Discharge Elimination System (NPDES) permit conditions would include the required development and implementation of a surface water pollution prevention plan (SWPPP), which will in turn require a variety of best management practices (BMPs) to minimize erosion and control runoff and sedimentation. Construction also typically involves water consumption for several activities, including dust suppression, vehicle washdown, concrete, and potable water supply for the construction crew.

During operation, electricity generation can affect surface and groundwater in many phases of its life cycle. Extraction of fuels such as natural gas and coal can affect both ground and surface water due to drilling and mining the fuel and from waste products from fuel processing. In coal extraction and processing, water is used to suppress coal dust around the mine and power plant, and water is used to clean the coal before it

goes into the plant. If the generation source is based on fuel combustion, water is often used as both a carrier of combustion energy to a turbine for conversion into electricity, and for cooling the plant. Ground or surface water sources are needed for these functions. Water use per MWh for the various energy resources considered in the IRP analysis is depicted in Table 3-17.

Table 3-17. Water Use for Energy Resources
(Gallons/MWh)

Energy Resource	NWPCC 5th Plan (Withdrawal)	California Energy Commission (2005) (Consumption)
CCCT (once-through)	7,500 - 20,000	250
CCCT (re-circulate)	~230	
CCCT (dry)	~40	
SCCT (probably once)		500
Coal (once-through)	20,000 - 50,000	
Coal (re-circulate)	300 - 800	
Coal (dry)	40	
Wind	~1	0
Geothermal	107,000 - 130,000	250
Biomass Steam (once-through	23,000 - 55,000	500
Biomass Steam (re-circulate)	350 - 900	
Biomass Steam (dry)	50	
Biogas (Landfill)		250

Thermal resources are the most water-intensive. Re-circulating water rather than using the water only once considerably reduces the amount of water that has to be withdrawn from a surface or ground source. There is a cost, however. More water is 'lost' to evaporation in re-circulation systems compared to once-through systems, resulting in less water being returned to the source. In addition, more chemicals such as chlorine and biocides are used in re-circulation systems and these chemicals eventually leave the cooling system and have to be disposed of.

In addition, wastewater is often produced, sometimes containing chemicals added at the generation facility and with a higher temperature that the intake water. If the wastewater is discharged into surface or ground water bodies, this chemical and thermal pollution can be transferred to those water bodies. Hydropower generation can also affect surface water during generation, particularly if there is a storage reservoir associated with the facility. Changing a river's flow can have significant impacts on water quality, including turbidity and temperature. Sections of rivers may be dewatered, and new surface water bodies (storage reservoirs) would be formed.

Construction and operation impacts on surface and groundwater attributable to the alternative portfolios are shown in Table 3-18. Although considerable potential exists for impacts during construction, the requirements for mitigation are likely to minimize those impacts. As a result, construction impacts are anticipated to be low for all portfolios.

Table 3-18. Impacts on Surface and Groundwater

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Wind, Biomass**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Surface and Groundwater									
Construction	0	L	L	L	L	L	L	L	L
Operation	M	M	M	M	M	M	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

Operational impacts of the resource portfolios are high for portfolios 8 and 9 (Gas/Coal and Wind/IGCC), due to impacts of coal-fired generation – during mining, transport, handling, and water use for steam generation and cooling. All the other portfolios have moderate operational impacts on water resources. Extraction of fuel, including natural gas, water for geothermal, and in biomass the potential for erosion due to crop production and harvest, cause the moderate impacts.

3.5.3 Mitigation

Potential mitigating measures for Surface and Groundwater include the following:

- Use a recirculating system for cooling to reduce water requirements.
- Use treated wastewater where applicable.
- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.
- Characterize the surface and groundwater hydrology prior to construction, develop an understanding of discharge and recharge relationships, and avoid creating new hydrologic connections through grading and related activities.
- Monitor water quantity and quality conditions if construction activity is to occur near aquifer recharge areas.
- Implement BMPs for use, handling, and storage of fuels, pesticides and other hazardous materials during both construction and operation.
- Dispose of ash at approved sites.

3.6 Plants and Animals

3.6.1 Affected Environment

The Pacific Northwest 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 ecosystems and, consequently, habitats are quite diverse. Accordingly, diverse fish, wildlife, and plant 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 ecologically important but some are of special concern due to dwindling populations, ecological function, or cultural or recreational value. Some species are listed for protection by state and/or federal governmental agencies. The following section is focused primarily on species that have received such designations.

3.6.1.1 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). Over the last 10 to 15 years, several stocks of chinook, chum, coho, and sockeye salmon and steelhead were listed as threatened or endangered under the federal Endangered Species Act (Table 3-19). Puget Sound steelhead trout are in the process of being listed as threatened.

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. 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 three species of chubs and suckers, pallid sturgeon and Kootenai River white sturgeon, bull trout in all four Pacific Northwest states, and Lahontan cutthroat trout.

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)(1)(A)].

Table 3-19. Status of Federally-Listed Animal and Plant Species in the Pacific Northwest

Status	Listed Species in the Pacific Northwest Including Those That May Not Occur in the Region
	Animals
E	Albatross, short-tailed (*Phoebastria (=Diomedea) albatrus*)
T	Bear, grizzly lower 48 States, except where listed as an experimental population or the Yellowstone population (*Ursus arctos horribilis*)
E	Butterfly, Fender's blue (*Icaricia icarioides fenderi*)
T	Butterfly, Oregon silverspot (*Speyeria zerene hippolyta*)
E	Caribou, woodland ID, WA, B.C. (*Rangifer tarandus caribou*)
E	Chub, Borax Lake (*Gila boraxobius*)
T	Chub, Hutton tui Hutton (*Gila bicolor ssp.*)
E	Chub, Oregon (*Oregonichthys crameri*)
E	Condor, California U.S.A. only (*Gymnogyps californianus*)
E	Crane, whooping except where XN (*Grus americana*)
E	Curlew, Eskimo (*Numenius borealis*)
T	Dace, Foskett speckled Foskett (*Rhinichthys osculus ssp.*)
E	Deer, Columbian white-tailed Columbia River DPS (*Odocoileus virginianus leucurus*)
T	Eagle, bald lower 48 States (*Haliaeetus leucocephalus*)
T	Fairy shrimp, vernal pool (*Branchinecta lynchi*)
E	Ferret, black-footed except where XN (*Mustela nigripes*)
E	Limpet, Banbury Springs (*Lanx sp.*)
T	Lynx, Canada lower 48 States DPS (*Lynx canadensis*)
T	Murrelet, marbled CA, OR, WA (*Brachyramphus marmoratus marmoratus*)
T	Otter, southern sea except where XN (*Enhydra lutris nereis*)
T	Owl, northern spotted (*Strix occidentalis caurina*)
E	Pelican, brown except U.S. Atlantic coast, FL, AL (*Pelecanus occidentalis*)
T	Plover, piping except Great Lakes watershed (*Charadrius melodus*)

E = Endangered
T = Threatened

T	Plover, western snowy Pacific coastal pop. (*Charadrius alexandrinus nivosus*)
E	Rabbit, pygmy Columbia Basin DPS (*Brachylagus idahoensis*)
T	Salmon, chinook Puget Sound (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook fall Snake R. (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook lower Columbia R. (*Oncorhynchus (=Salmo) tshawytscha*)
E	Salmon, chinook spring upper Columbia R. (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook spring/summer Snake R. (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chinook upper Willamette R. (*Oncorhynchus (=Salmo) tshawytscha*)
T	Salmon, chum Columbia R. (*Oncorhynchus (=Salmo) keta*)
T	Salmon, chum summer-run Hood Canal (*Oncorhynchus (=Salmo) keta*)
T	Salmon, coho Lower Columbia River (*Oncorhynchus (=Salmo) kisutch*)
T	Salmon, coho OR, CA pop. (*Oncorhynchus (=Salmo) kisutch*)
T	Salmon, sockeye U.S.A. (Ozette Lake, WA) (*Oncorhynchus (=Salmo) nerka*)
E	Salmon, sockeye U.S.A. (Snake River, ID stock wherever found.) (*Oncorhynchus (=Salmo) nerka*)
T	Sea turtle, green except where endangered (*Chelonia mydas*)
E	Sea turtle, leatherback (*Dermochelys coriacea*)
T	Sea turtle, loggerhead (*Caretta caretta*)
T	Sea-lion, Steller eastern pop. (*Eumetopias jubatus*)
E	Sea-lion, Steller western pop. (*Eumetopias jubatus*)
T	Snail, Bliss Rapids (*Taylorconcha serpenticola*)
E	Snail, Snake River physa (*Physa natricina*)
E	Snail, Utah valvata (*Valvata utahensis*)
E	Springsnail, Bruneau Hot (*Pyrgulopsis bruneauensis*)
E	Springsnail, Idaho (*Pyrgulopsis idahoensis*)
T	Squirrel, northern Idaho ground (*Spermophilus brunneus brunneus*)
T	Steelhead Snake R. Basin (*Oncorhynchus (=Salmo) mykiss*)
T	Steelhead lower Columbia R. (*Oncorhynchus (=Salmo) mykiss*)
T	Steelhead middle Columbia R. (*Oncorhynchus (=Salmo) mykiss*)
E	Steelhead upper Columbia R. Basin (*Oncorhynchus (=Salmo) mykiss*)
T	Steelhead upper Willamette R. (*Oncorhynchus (=Salmo) mykiss*)
E	Sturgeon, pallid (*Scaphirhynchus albus*)
E	Sturgeon, white U.S.A. (ID, MT), Canada (B.C.), Kootenai R. system (*Acipenser transmontanus*)
E	Sucker, Lost River (*Deltistes luxatus*)
E	Sucker, shortnose (*Chasmistes brevirostris*)
T	Sucker, Warner (*Catostomus warnerensis*)
E	Tern, least interior pop. (*Sterna antillarum*)
T	Trout, bull U.S.A., conterminous, lower 48 states (*Salvelinus confluentus*)
T	Trout, Lahontan cutthroat (*Oncorhynchus clarki henshawi*)
E	Whale, humpback (*Megaptera novaeangliae*)
E	Wolf, gray lower 48 States, except MN and where XN; Mexico (*Canis lupus*)

	Plants
T	Catchfly, Spalding's (*Silene spaldingii*)
T	Checker-mallow, Nelson's (*Sidalcea nelsoniana*)
E	Checkermallow, Wenatchee Mountains (*Sidalcea oregana var. calva*)
E	Daisy, Willamette (*Erigeron decumbens var. decumbens*)
E	Desert-parsley, Bradshaw's (*Lomatium bradshawii*)
T	Four-o'clock, MacFarlane's (*Mirabilis macfarlanei*)
E	Fritillary, Gentner's (*Fritillaria gentneri*)
T	Howellia, water (*Howellia aquatilis*)
T	Ladies'-tresses, Ute (*Spiranthes diluvialis*)
E	Lily, Western (*Lilium occidentale*)
E	Lomatium, Cook's (*Lomatium cookii*)
T	Lupine, Kincaid's (*Lupinus sulphureus (=oreganus) ssp. kincaidii (=var. kincaidii)*)
E	Meadowfoam, large-flowered woolly (*Limnanthes floccosa ssp. grandi-flora*)
E	Milk-vetch, Applegate's (*Astragalus applegatei*)
T	Paintbrush, golden (*Castilleja levisecta*)
E	Popcornflower, rough (*Plagiobothrys hirtus*)
E	Rock-cress, McDonald's (*Arabis mcdonaldiana*)
E	Stickseed, showy (*Hackelia venusta*)
T	Thelypody, Howell's spectacular (*Thelypodium howellii spectabilis*)
E	Wire-lettuce, Malheur (*Stephanomeria malheurensis*)

Source: U.S. Fish and Wildlife Service web site.

3.6.1.2 Plants and Animals

Vegetation within the region is a diverse mix of species found in varying complexes of topography, climate, and soils. The vegetation may be broadly classified as (BPA, 2000):

- Grasslands -- naturally-growing grasses found in the southern Puget Lowlands, Willamette Valley, and the extensive rangelands of eastern Washington, Oregon, southern Idaho, and the intermountain valleys of Montana.

- Shrublands – shrubby areas located on mountains and in low-lying areas, rangeland, and shrub-steppe vegetation that typically have few trees and where herbaceous vegetation ranges from none to densely abundant.

- Forested areas – extensive areas of coniferous, deciduous, and mixed tree species that occur generally where precipitation is highest: Coast Range, Willamette and Puget Sound valleys, Cascade Mountains, Blue Mountains of northeastern Oregon, and Rocky Mountains of Idaho and western Montana.

In addition, riparian areas, where vegetation may be taller and lusher than surrounding vegetation because more water is available, occur within these major vegetation zones.

Likewise, wetlands are special plant communities influenced by the presence of water. Wetlands also occur throughout these vegetation zones and provide water quality and hydrologic benefits; they are important habitats for a wide variety of plant and animal species. Wetlands are accorded special protection at the federal, state, and local levels with restrictions on land use related to the quality, function, and location of the wetlands.

There are fewer federally-listed plant species than fish species (Table 3-19), but the threatened and/or endangered status is widespread in the region for several of the species. For example, Spalding's catchfly, water howellia, and ute ladies'-tresses are listed species in all four states.

Wildlife in the region is also diverse, ranging from large mammals to birds, insects, and reptiles (BPA, 2000). The presence of wildlife species is determined by the type and amount of food, cover, water, and other habitat conditions. Some species are of special interest due to economic or recreational value, or are protected by state or federal government regulations. Some well-known species that are either threatened or endangered include the grizzly bear, gray wolf, bald eagle, spotted owl, and marbled murrelet (Table 3-19).

3.6.2 Impacts of the Alternatives

A broad range of impacts on plants and animals could occur during construction and/or operation of energy facilities; the type and severity of impact would depend upon the nature of the energy resource and location. Direct effects during construction commonly include removal of vegetation and the habitat it provides for wildlife, and mortality or injury to animal species that inhabit a site at the time of construction. Impacts can be substantial for facilities that occupy large sites, such as a pulverized coal-fired plant. Construction requires clearing of existing vegetation around areas to be occupied by roads, plant facilities, fuel storage, substations, and other project facilities. These areas represent a permanent loss of vegetation and habitat on a previously undeveloped site. Mobile species present on a project site are likely to be displaced during construction, while those that are less mobile can be killed or injured because of construction activity within the area of disturbance.

Indirect effects during construction can stem from a number of disturbance mechanisms that can interfere with normal animal behaviors or introduce adverse changes to their habitat. Remaining vegetation and habitat quality for wildlife can be diminished indirectly through dust generated by construction, erosion and runoff, and increased opportunities for invasive species. Similarly, aquatic habitat can be degraded by runoff, dust, and exposure to contaminants through spills. Noise, the presence of humans and vehicles, and similar aspects of construction activity can modify the behavior of wildlife remaining on the site and in adjacent areas.

Impacts during operation would generally be non-existent or low at the locations of plant facilities because there would be little additional ground-disturbing activity. Exceptions are for energy resources where fuel extraction would require additional disturbance of

habitats (e.g., coal mines, natural gas extraction, clearing of forest residues or dedicated crops for biomass facilities), and potential impacts on birds and bats from operation of wind turbines.

Impact levels for Plants and Animals are depicted in Table 3-20. Portfolios 2, 8, and 9 (Renewables, Gas/Coal, and Wind/IGCC) could experience high impacts during construction:. This level of impact is due to the inclusion of geothermal, and/or coal resources in the portfolios, which would have potentially greater land disturbing activities. With the exception of the Rely on the Market - No Action, the other portfolios would result in moderate impacts during construction.

Table 3-20. Impacts on Plants and Animals

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Biomass, Wind**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Plants and Animals									
Construction	0	H	M	M	M	M	M	H	H
Operation	M	M	M	M	M	M	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

During operation, only the portfolios that include coal as a fuel resource are expected to result in high impacts – Portfolios 8 and 9 (Gas/Coal, and Wind/IGCC). This is due to the continuing potential disturbance of habitats and species during coal-mining operations. The other portfolios would have moderate impacts.

3.6.3 Mitigation

Potential mitigating measures for Plants and Animals include the following:

- Conduct adequate surveys of plant and animal resources.
- Avoid siting facilities in areas that support unique or sensitive plants or important wildlife habitat.
- Where possible, use existing roads and disturbed areas for project development, and minimize the area disturbed for project construction.
- Design necessary stream crossings to minimize disturbance and maintain aquatic habitat conditions.
- Develop and implement a restoration plan to restore disturbed plant and animal habitat.

- Purchase or preserve areas to replace habitat values lost through project development.
- Implement measures to minimize establishment of invasive species.
- Landscape site buffer areas with native plant species.
- Establish a monitoring program to assess impacts on the area's plants and animal species.

3.7 Energy and Natural Resources

3.7.1 Affected Environment

Fossil fuel resources are consumed in the generation of electricity by coal-fired power plants, combustion turbines, many cogeneration facilities, and fuel cells. Approximately 40 percent of electricity in the Northwest region is generated by fossil fuels (including coal, gas and some fuel oil), under average hydro conditions (Northwest Power Planning and Conservation Council, 2006a). 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, wind power, and geothermal energy) would have less potential adverse impacts to fossil fuel resources.

3.7.1.1 Natural Gas

Natural gas accounts for about 20 percent of the Pacific Northwest's electricity production (Northwest Power Planning and Conservation Council, 2006b). The proven reserves of natural gas in the United States are estimated at 192 trillion cubic feet (U.S. Department of Energy, 2004) and those in North America are estimated at 263 trillion cubic feet (U.S. Department of Energy, 2006a). In 2000, North American consumption was about 27 trillion cubic feet per year (U.S. Department of Energy, 2006b). In North America, the Gulf Coast of Texas and Louisiana, with 60 percent of U.S. production, is the dominant gas-producing region. In addition, Canada has vast reserves of natural gas. Liquid natural gas (LNG) imports are predicted to increase. In 2001, the U.S. imported 238 billion cubic feet equivalent of LNG, and the U.S. Department of Energy, EIA, forecasts that by 2030 the U.S. net imports of LNG will be 4.4 trillion cubic feet (U.S. Department of Energy, 2006c).

The Northwest Power and Conservation Council (NWPCC) states in its Fifth Power Plan (May 2005) that "the estimated ultimate potential of gas supply areas serving the Northwest is about 22 years at current production rates." This supply is not located in the Northwest, but is available because it can be transported through pipelines from other areas. The NWPCC also notes that imported LNG could be another source of natural gas supply, and that LNG facilities have been proposed 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. If new LNG terminals are built along the Pa-

cific coast, new gas pipelines would be built to transport the fuel, creating new potential locations for gas-fired power plants.

3.7.1.2 Coal

Coal provides 20 percent of the Pacific Northwest's electricity under average hydro conditions. NWPCC (2005) forecasts that “Sufficient coal is available to the region to support all electric power needs for the 20-year planning horizon of this plan." The Council also states that there are abundant supplies of coal in western North America to serve coal-fired power plants, and that coal can be shipped from other regions economically.

The existing 1,343-megawatt Centralia plant in southwestern Washington is operated by TransAlta 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.

3.7.1.3 Fuel Oil

Fuel oil in the Northwest region is exclusively used as backup fuel for natural gas-fired generating plants, with the exception of one 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 during the planning period.

To summarize, natural gas and coal are estimated to be available to the Northwest region, and the existing reserves in the western United States and Canada would be sufficient to meet the forecast demand in the region for the next 20 years. Fuel oil, for backup generation, is widely available and is easily transported via trucks to power generating facilities in the northwest region. However, supply of these fuels, and their costs, have been volatile in the past, and it is difficult to forecast precisely what their availability will be in the future.

3.7.2 Impacts of the Alternatives

The impact on energy resources varies widely with generation technology. Generation that uses fossil fuels such as natural gas and coal deplete those non-renewable fuel resources. Electricity generation using renewable fuels, such as wind and solar power, are generally considered to have negligible to no impact on energy resources. Some fuels, such as biomass, are sometimes considered renewable if they come from sources that are easily and quickly replaced (such as wood waste or fast-growing crops). However, biomass might not be considered renewable if the source is not readily replaceable (such as wood or forest residues from a mature forest). Within those generation types there are a variety of plant designs with different efficiencies in fuel use. Fuel use rates for resources considered in the IRP are shown in Table 3-21.

Table 3-22 summarizes the level of impacts on Energy and Natural Resources that are expected to occur for the alternative portfolios. During construction, Portfolios 8 and 9 (Gas/Coal and Wind/IGCC portfolios) are anticipated to have to moderate impacts, with the moderate rating attributable to coal-fired resources and the greater consumption of energy and natural resources that would occur with their development. All other portfolios would likely have a low level of impacts during construction.

Table 3-21. Fuel Use Rate By Resource

Resource	Fuel	Heat Rate (Btu/kWh)
Conservation	None	N/A
SCL Owned Hydro	Water	N/A
Contracts for existing resources/ Exchanges	Primarily natural gas, with some coal and other resources	7,000 to 11,600
Natural Gas	Natural Gas	Combined Cycle – 7,200 Simple Cycle -- 9,688
IGCC Coal	Coal	8,824
Conventional Pulverized Coal	Coal	9,516
Wind	Wind	N/A
Geothermal	Water	N/A
Biomass (wood)	Wood	26,686
Biogas (landfill gas)	Methane (landfill gas)	11,000
Market Purchases	Primarily natural gas, with coal and other resources	7,000 to 11,600

Table 3-22. Impacts on Energy and Natural Resources

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Wind, Biomass**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Energy and Natural Resources									
Construction	0	L	L	L	L	L	L	M	M
Operation	H	L	H	H	H	H	H	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

Portfolios 1, 8, and 9 would have the highest level of impacts during operation. Again, for portfolios 8 and 9, this is attributable to coal-fired resources and their use of a non-renewable resource. In addition, any portfolios with gas-fired combustion turbines (Portfolios 3 through 7) are expected to have high impacts due to the use of non-renewable natural gas fuel, which, while expected to be available over the planning period, is predicted to be in short supply at various times in the near term, and in the longer term. However, four of the portfolios using gas resources (Portfolios 3 through 6) would also use renewable resources (wind) or hydro efficiency improvements and landfill gas. These resources would have positive impacts on the use of fossil fuel, but are not considered to 'cancel out' the impacts from the use of non-renewable fuels.

3.7.3 Mitigation

Mitigation of energy resource use can be achieved by using high efficiency technologies, regardless of fuel, which reduce the impacts to the energy resource. This can occur either directly by avoiding use of that resource in the plant, or by producing more electricity from a renewable source, which avoids the use of a non-renewable source. In addition, some states have Renewable Portfolio Standards requiring that electric utilities supply a percentage of energy from renewable sources.

3.8 Environmental Health

3.8.1 Affected Environment

In addition to possible air quality health impacts, other health issues associated with energy facilities are electric and magnetic field effects and noise.

Electric and magnetic fields: Power lines, appliances, and wiring – and anything else that generates, transmits or uses electricity – all produce electric and magnetic fields (EMF). Electric and magnetic fields are properties of the space near their electrical source and describe the forces that would be experienced by an object that is capable of interacting with these fields. *Electric fields* are the result of voltages applied to electrical conductors and equipment, and *magnetic fields* are produced by the flow of electric currents. The strength of both electric and magnetic fields decreases as you get farther away from the source of the field.

Since electricity is being used pretty much on a constant basis, EMF can be found in nearly all locations people spend time – homes, workplaces, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there. In most homes, background magnetic field levels average about 1 milligauss (mG), resulting from wiring within the home, electrical appliances, and power lines outside the home (Zaffanella, 1993). The intensity of magnetic fields diminishes quickly with distance from the source.

Questions have been raised as to whether exposure to electric or magnetic fields causes adverse health effects. Hundreds of studies have been conducted over the past 30 years to address this question. These studies have looked for relationships between EMF exposures in our homes and workplaces and cancer or other adverse health outcomes. Some of the epidemiology[4] studies have reported associations[5] between EMF exposure and adverse health outcomes, while others have not. Most of the attention has focused on the possible association between childhood leukemia and magnetic field exposure, because of some early epidemiology studies that suggested a possible association.

Numerous multidisciplinary international and national scientific agencies have assembled scientific panels to conduct weight-of-evidence reviews of the research literature on EMF and possible adverse health effects. These scientific panels include the National Radiological Protection Board of Great Britain (NRPB, 2002), International Commission for Non-Ionizing Radiation Protection (ICNIRP, 2003), International Agency for Re-

[4] Epidemiology is the study of the frequency and distribution of disease and health in human populations, and the factors that contribute to disease and health events.

[5] Epidemiology studies estimate associations, which are quantitative measures of how often an exposure and a disease occur together. If a study reports a statistical association between an exposure and a disease, it means that the disease and the exposure occur together more often than one would expect just as a result of chance. A statistical association between an exposure and a disease does not mean that the exposure causes the disease.

search on Cancer (IARC, 2002), and National Institute for Environmental Health Sciences (NIEHS, 1998).

The conclusions from organizations including the NRPB, ICNIRP, IARC and NIEHS are generally consistent[6]. The assessments agree that there is little evidence suggesting that EMF is the cause of adverse health effects, including adult and childhood cancer, Alzheimer's disease, amyotrophic lateral sclerosis, and reproductive effects.

The only studies that can be said to confirm a relationship between electric and magnetic fields and an adverse biological or health effect are those in which very high levels of exposure to these fields produce currents and fields in the body, a shock-like effect. The levels at which these short-term effects occur are very high and several organizations have recommended exposure guidelines to protect against their occurrence (see following). Fields at these high intensities are not found in residential environments or other areas where the general public may be near transmission lines.

No scientific organization has recommended limiting exposure to the levels of EMF that people typically encounter on a daily basis. Several international scientific organizations have published guidelines for exposure to EMF based on *acute* (short-term) health effects (e.g., the stimulation of nerves and muscles, a shock-like effect) that can occur at very high field levels. The ICNIRP recommends a residential exposure limit of 833 mG and an occupational exposure limit of 4200 mG (ICNIRP, 1998). The International Committee on Electromagnetic Safety (ICES) also recommends limiting exposures at high levels because of the risk of acute health effects, although their guidelines are even higher than ICNIRP's guidelines (ICES, 2002). These levels of magnetic fields are rarely encountered by the general public, and not from electric transmission lines.

In addition to scientific organizations, government bodies can also issue standards or guidelines, although these recommendations are not always based on health effects. For example, six states have standards or guidelines for electric fields on or at the edge of the right-of-way (ROW) that to minimize the perception of shocks. Two states, Florida and New York, have enacted standards to limit magnetic fields at the edge of transmission line ROWs (150 mG and 200 mG, respectively). However, the basis for limiting magnetic fields from transmission lines in these two states was to maintain the "status

[6] Both the IARC and the NIEHS have an established method for classifying the possible carcinogenicity of exposures. Categories include (from highest to lowest risk): carcinogenic to humans, probably carcinogenic to humans, possibly carcinogenic to humans, unclassifiable, and probably not carcinogenic to humans. Since some epidemiology studies reported an association between higher average magnetic field levels and childhood leukemia and the influence of bias could not be ruled out, magnetic fields were categorized as a "possible carcinogen" under the IARC and NIEHS classification systems. It is important to remember that the categorization "possible carcinogen" does not mean that magnetic fields cause cancer, nor does it suggest that the possibility is likely. In both the IARC and NIEHS reviews, the scientific panels concluded that the evidence was insufficient to establish a causal relationship between magnetic fields and childhood leukemia. Three scientists from the California EMF program also conducted a review of the research on EMF and health effects in 2002. This review, although considered by the State of California, has not provided the basis for any change to the recommendations of the CA Department of Health Services, which state that magnetic fields are not a known cause of adverse health effects (http://www.dhs.ca.gov/ehib/emf/general.html).

quo" so that fields from new transmission lines would not be higher than those produced by existing transmission lines.

Noise: Audible noise occurs during the construction and operation of energy facilities, and may be present near high-voltage transmission lines. Noise impacts are evaluated with respect to adjacent and surrounding land uses, especially sensitive noise receptors like schools. Many governmental jurisdictions have regulations governing permissible noise levels at adjacent properties that vary with the type of land use that would apply to the operation of energy facilities. Construction activities are generally exempt from noise regulations except for provisions regarding permissible hours of construction activity.

3.8.2 Impacts of the Alternatives

The scientific agencies that have considered EMF have concluded that the extensive body of research that currently exists does not suggest that EMF from electrical sources causes any long-term adverse health effects. Recent research does not provide any evidence to alter this conclusion. The only studies that can be said to confirm a relationship between EMF and an adverse effect are those in which very high levels of exposure to these fields produce short-term, shock-like effects. The levels at which these short-term effects occur are very high and are rarely encountered by the general public. In summary, there is no scientific basis to indicate any adverse health effects to the public as a result of the electric and magnetic fields from transmission lines.

Construction-related noise impacts would occur that are audible beyond the boundaries of the construction site. Noise sources would include heavy equipment operation, construction of the structures and ancillary facilities, and truck traffic. As depicted in Table 3-24, it is not expected that any significant impacts would occur during construction for any of the portfolios. Resource Portfolios 2, 4, 8, and 9 (Renewables, Gas/Wind/ Biomass, Gas/Coal, and Wind/IGCC portfolios), comprised of coal-fired, geothermal, and biomass energy resources, may experience impacts as high as moderate. The remaining portfolios would result in low levels of impact or better.

Table 3-23. Impacts on Environmental Health

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Biomass, Wind**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Environmental Health									
Construction	0	M	L	L	L	M	L	M	M
Operation	M	M	M	M	M	M	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

Similar to several other elements of the environment, portfolios 8 and 9 (Gas/Coal and Wind/IGCC) that include coal-fired resources could result in high levels of impact during operation. This is mainly due to the greater scale of noise-generating activities associated with mining activities (as well as plant operations). All other portfolios would experience impacts reaching a moderate level.

3.8.3 Mitigation

Potential mitigating measures for Environmental Health include the following:

- Restrict construction activities to daylight hours.
- Lay out plant facilities so that noise standards are not exceeded at the site boundary.
- Ensure adherence to all applicable occupational safety regulations and standards and project health and safety plans in construction and operation.
- Establish safety zones and setbacks to prevent public exposure to potential safety hazards during both construction and operation.
- Plan and design projects to comply with FAA requirements for notification and marking of tall structures to ensure aviation safety.
- Analyze and evaluate operating noise conditions during project planning and design to ensure compliance with applicable community noise standards.
- Consider implementing a noise complaint and investigation program for the project operation period.
- Use up-to-date low field designs to minimize EMF near transmission lines.

3.9 Land Use

3.9.1 Affected Environment

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

The most intensively developed areas are in the Puget Trough and Willamette Lowlands areas of western Washington and Oregon, which is where the greatest demands for electricity are centered. Population in the Pacific Northwest centers on the Seattle metropolitan area, greater Portland, and smaller urban areas in Washington, Oregon, Idaho, and Montana. The population of these states in 2005 was 6.26 million, 3.58 million, 1.39 million, and 936,000, respectively.

Washington and Oregon have land use planning laws that regulate where various land uses may be developed. In Washington, each jurisdiction must have a process for administering the siting of essential public facilities, which includes energy facilities proposed by public utilities. Both states have siting councils that oversee the permitting of energy facilities above designated capacities.

3.9.2 Impacts of the Alternatives

Land use impacts vary widely with location, type of energy facility, and land requirements. Sites that are already used for commercial or industrial purposes, such as a co-located biomass energy facility, are less likely to experience significant additional impacts from the plant. Undeveloped sites would experience the largest incremental impact from new facilities construction. Usually, zoning regulations in the local area determine whether energy facilities are acceptable uses and, along with local, federal, and state regulations, the mitigation required to reduce adverse impacts. Some types of generation, such as coal, require extensive amounts of land for fuel extraction, particularly in surface mining, and make significant changes to the potential uses of land after decommissioning. In cases where mining occurs on public land, impacts may be greater if the land holds other resource values such as recreation. Other generation types can have less impact. For example, wind turbines are frequently located on agricultural land, and farming activities are able to continue around the generating facilities.

Land use impacts during construction include the possible displacement of existing uses (a long-term impact) and proximity impacts on nearby land uses as a result of noise, dust, traffic, and similar triggers (temporary impacts). The magnitude of these impacts would be greater for large facilities and if development were to occur in rural areas or affect lands designated as sensitive areas such as wetlands. Land use impacts for the alternative portfolios are shown in Table 3-25. Like many of the other elements of the environment, impacts can be high for the portfolios 8 and 9 that include coal (Gas/Coal

and Wind/IGCC). No impacts would occur with portfolio 1 (Rely on the Market - No Action), and all the rest of the portfolios would experience up to moderate impacts during construction.

Table 3-24. Impacts on Land Use

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Wind, Biomass**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Land Use									
Construction	0	M	M	M	M	M	M	H	H
Operation	M	H	M	M	M	H	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

High operational impacts could occur for portfolios 2, 6, 8, and 9, which include coal, geothermal, and biomass facilities (Renewables, Gas/Biomass/Wind/, Gas/Coal, and Wind/IGCC). This is because of the potentially long-term land-disturbing activities that could occur with coal mining and harvest/removal of biomass, and the possibility of land use conflicts where geothermal facilities are developed in pristine areas. The other portfolios would likely result in moderate impacts.

3.9.3 Mitigation

Potential mitigating measures for Land Use include the following:

- Locate the plant site to minimize land use impacts.
- Evaluate the project site before construction to make sure it conforms to local planning and zoning requirements and avoids compatibility issues with nearby uses.
- Locate new transmission facilities within or parallel to existing rights-of-way and avoid bisecting existing land uses such as farmland.
- Develop construction management plans that avoid or minimize disruptions to adjacent existing uses.

3.10 Aesthetics and Recreation

3.10.1 Affected Environment

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, water-skiing, rafting, boating, windsurfing, and swimming. Land-based activities such as picnicking, camping, hiking, and bird watching 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 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 diverse designated recreational areas and magnificent scenic vistas, the Pacific Northwest contains designated wilderness areas and scenic rivers. Some noteworthy 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. In addition, the deposition in alpine lakes of nitrates and sulfates from rainfall can have adverse effects on fisheries.

3.10.2 Impacts of the Alternatives

Except for energy facilities located in industrial areas, most energy resources and transmission lines would create visual contrasts with the surrounding areas in which they are located. Generally, generating facilities are industrial buildings and not designed based on aesthetic considerations. Fuel extraction sites are also often considered unattractive due to the disturbance to soils, heavy machinery, and potential for noise and dust. For most resources, there would be substantial changes in visual quality of the setting during construction that would carry on over the long term during operation. The level of impact would depend upon the nature of the site, visibility of the energy facility, and the number of potential viewers.

Similar impacts would occur for recreation. Energy facilities in more remote, pristine areas could affect recreation directly because of use conflicts and loss of habitat and wildlife and indirectly through compromising the recreation experience. Plant sites can be

located to avoid recreation sites but fuel extraction activities have less flexibility in this regard.

A summary of impacts on aesthetics and recreation is provided in Table 3-26. None of the portfolios would experience a high level of impacts during construction. At most, all the portfolios except portfolio 1(Rely on the Market - No Action) would likely cause moderate impacts during construction.

Table 3-25. Impacts on Aesthetics and Recreation

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Biomass, Wind**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Aesthetics and Recreation									
Construction	0	M	M	M	M	M	M	M	M
Operation	M	H	H	H	H	H	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

Most of the portfolios would have the potential to create high impacts during operation. The impact analysis concluded that portfolios that include wind, geothermal, and biomass resources (Portfolios 2 through 6) could result in impacts up to high depending upon location. Portfolios 1 and 7 (Rely on Market - No Action and Gas) would likely result in impacts no greater than moderate.

3.10.3 Mitigation

Potential mitigating measures for Aesthetics and Recreation include the following:

- If possible, locate facilities in areas with less viewer exposure and away from popular recreation areas.
- Integrate facility design and configuration of structures into the surrounding landscape or otherwise incorporate aesthetic objectives into design.
- Minimize surface disturbance for roads and other project features, particularly on steep slopes, and control erosion.
- If possible, provide vegetative screening to obstruct views of project facilities and fuel extraction sites from surrounding sensitive areas.
- Keep project facilities clean and well maintained throughout project operation.
- Compensate for impacts by aesthetic improvements in other areas such as reclamation of unneeded roads.

3.11 Cultural Resources

3.11.1 Affected Environment

Cultural resources exist throughout the Northwest and in areas where new energy facilities, including transmission, might be built. Cultural resources are the non-renewable evidence of human occupation or activity (BPA, 2002). 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).

3.11.2 Impacts of the Alternatives

Surface disturbance and excavation during the construction process could adversely affect cultural resources, although most cultural resources can be avoided during the siting process. If existing energy facilities that have historic value or status are removed or modified by new generation facilities, cultural resource impacts would occur. For example, increasing the output of existing generating facilities may require installation of new equipment and modification of existing equipment that displaces structures of historic value. In addition, construction activities visible from or air pollutants extending into areas of known cultural importance may be visually intrusive and could affect the spiritual or emotional value associated with the site. Improved access to remote locations where cultural resources are present could lead to greater human intrusion of the area and possible disturbance. These latter two types of impacts could extend into the period of operation. Otherwise, there would be no additional cultural resource impacts during operation except where fuel extraction activities (e.g., coal mining) are involved.

Impacts on cultural resources are summarized in Table 3-27. During construction, it is expected that impacts would be moderate for all portfolios (except Portfolio 1 -- Rely on the Market - No Action). Impacts would be similar during operation except for Portfolios 8 and 9 (Gas/Coal and Wind/IGCC portfolios), which could experience high impacts due to the ongoing ground disturbance during mining activities.

Table 3-26. Impacts on Cultural Resources

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Biomass, Wind**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Cultural Resources									
Construction	0	M	M	M	M	M	M	M	M
Operation	M	M	M	M	M	M	M	H	H

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

3.11.3 Mitigation

Potential mitigating measures for Cultural Resources include the following:

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and Native American tribes with interests in the project area to determine the likelihood of any cultural resources within or near the project area, including the proposed route for transmission facilities.
- Conduct records searches and field surveys, if necessary, to identify and assess resources that may be present.
- Modify the project configuration, to the extent possible, to avoid cultural resources identified through the inventory process.
- If cultural resources are present in development areas and impacts cannot be avoided, develop and implement a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO and any affected tribes, develop an appropriate mitigation program, and negotiate next steps.

3.12 Economy

3.12.1 Affected Environment

Although not required by SEPA, a general analysis of economic impacts, focusing on construction and operation employment, was conducted to identify potential differences among the portfolios. While the impacts are positive, the information may be helpful in discerning the differences among portfolios and the trade-offs between adverse and beneficial characteristics of the portfolios.

The pace and composition of economic growth in SCL's service area and the region are major determinants of future demands for electricity and the amount of new energy that is needed to satisfy the demand. The Seattle economy is more diverse than it was several decades ago, although it is still strongly influenced by the aerospace industry. The other, newer, dominant industry is software. A major factor in the recession of 2001-2003 was the dot.com bust. The recession hit the Pacific Northwest economy hard. The proportion of jobs lost in the Seattle area (Seattle-Bellevue-Everett) was greater than for the state. The state, in turn, was harder hit than the nation. For the years 2000-2004, Washington's unemployment rate exceeded the nation's rate. Oregon was also slower to recover from the recession than the rest of the country. Growth in the Seattle area has been strong over the past year. The regional economy continues to improve although it has yet to regain the employment level that preceded the 2001-2003 recession. As of March 2006, the number of payroll jobs in the Seattle was still 5,800 less than in December 2000, when the number peaked at 1,430,600.

Boeing had announced job cuts shortly before the attack on the World Trade Center on September 11, 2001. The subsequent blow to the commercial airline industry resulted in even more job cuts. Boeing employment has since rebounded, as has software industry employment. Even though most of the Boeing manufacturing jobs are not in the City Light service area and Microsoft is in Redmond, the multiplier effect of these two industries boosts employment and population growth in the service area. Washington State economic forecasters project continued job growth in the software industry, with a leveling off of aerospace job growth through 2009.

Much of the recent job growth has been in the construction industry. Statewide, the number of construction jobs has increased by more that 11 percent over the past year. Low mortgage rates and high housing prices have spurred residential construction in Seattle, as well as the rest of the country. Density is being encouraged in many parts of Seattle, driving the construction of high-rise apartments and condominiums. This trend is expected to continue because of recent lifting of height limits in downtown, Capitol Hill, and the Denny Triangle areas.

Commercial office vacancy rates have fallen somewhat, but they are still over 11 percent for downtown Seattle. Even so, office space is being built downtown, most notably the new Washington Mutual building. Some existing downtown space will fill as Safeco moves its operation from the University District. Office and laboratory space is being built in both the South Lake Union area and the Denny Triangle. Some developers have signed tenants, but others are building on speculation.

Sectors other than the construction industry that have been growing are aerospace manufacturing, machinery manufacturing, software publishing, computer-systems design, the health sector, the leisure and hospitality industries, the real estate sector of financial services, and professional and business services. The number of construction jobs will eventually decline as the construction cycle follows its usual boom-and-bust course.

Economic conditions in the vicinity of energy resources is likely to be quite variable, ranging from highly developed in the Seattle area to much less developed in rural areas. The structure of the local economies will influence their ability to provide the labor, goods, and services that are needed to build and operate energy facilities and, therefore, to benefit from the economic stimulus that such facilities provide.

3.12.2 Impacts of the Alternatives

Employment generally increases during all aspects of the life cycle of electricity generating plants; usually larger but shorter-term employment during construction and smaller but permanent employment during operation. This assumes that the generating plant is in addition to, and not replacing, existing generating plants. Different types of energy facilities have different levels of employment impacts. The most labor-intensive generating technology is coal-fired generation. The facilities are generally larger and have a longer construction period. The greater complexities of operations, as well as decommissioning a plant, also require a relatively larger work force compared to other energy resources. In addition, extracting, cleaning, and processing coal fuel requires a significant work force. Reclaiming and monitoring the mined land once the mine is closed, according to regulations, provides many long-term, all-season, relatively high-paying jobs. A similar amount of labor could be expected in an Integrated Gasification Combined Cycle (IGCC) plant, although the employment levels could be lower if a non-coal fuel source, such as petroleum coke that is a waste product of another refining process, is used instead. Wind generation generally requires less labor for operations, and clearly none for fuel extraction.

Along with employment, local economies accrue gains in personal income due to the wages and salaries paid to workers, spending for facility construction and operation, and the multiplier effects of these economic stimuli. Further, fiscal gains typically accrue to local governmental jurisdictions except in the cases where large-scale development occurs in rural areas without adequate infrastructure (e.g., the “boom-town” phenomenon associated with some past mining activities).

Table 3-28 summarizes the impacts of the alternative resource portfolios relative to the economy. Impacts would be positive during both construction and operation. Employment and other economic gains during construction would be zero to moderate, with portfolios that include coal-fired and gas turbine energy generation (Portfolios 3 through 9) posting the largest gains due to the larger scale of the facilities. The importance of these gains would vary with the size of the local economy in which the facilities are constructed. Relatively small work forces and personal income gains would occur during operation. The portfolios with coal-fired generation (Portfolios 8 and 9) would accrue moderate economic gains, which is partly due to economic activity associated with coal mining.

Table 3-27. Impacts on the Economy

	Portfolios								
	1	2	3	4	5	6	7	8	9
Element of the Environment	**Rely on the Market-No Action**	**Renew-ables**	**Gas, 100% Block**	**Gas, Wind, 50% Block**	**Gas, Wind, Hydro**	**Gas, Biomass, Wind**	**Gas**	**Gas, Coal**	**Wind, IGCC**
Economy									
Construction	0	+L	+M	+M	+M	+M	+M	+M	+M
Operation	+L	+L	+L	+L	+L	+L	+L	+M	+M

L	= Low impact	M	= Moderate impact	H	= High impact
+, +L, +M	= Positive impact	0	= No impact		

3.12.3 Mitigation

No mitigation would be needed, because the impacts are all zero or positive.

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Swinomish IndianTribal Community
Tulalip Tribes of Washington
Upper Skagit Indian Tribe
United Indians of All Tribes

ORGANIZATIONS

American Public Power Association
BOMA
Climate Solutions
Energy Northwest
League of Women Voters
Northwest Energy Coalition
Northwest Independent Power Producers
Renewables Northwest Project
Pacific Northwest Utilities Conference Committee
Pacific Northwest Generating Cooperative
Public Power Council
Seattle Chamber of Commerce
Washington Environmental Council

Washington Public Interest Research Group
Washington Public Utility Districts Association

UTILITIES

BC Hydro
Benton County PUD
Cascade Natural Gas
Chelan County PUD
Clark Public Utilities
Eugene Water & Electric Board
Franklin County PUD
Grant County PUD
Grays Harbor PUD
Idaho Power Company
Mason County PUD No. 3
Pend Orielle County PUD
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APPENDIX A

GLOSSARY

Integrated Resource Plan

Seattle City Light

September 2006

IRP GLOSSARY

Biomass
Plant material, vegetation, or agricultural waste used as a fuel or energy source.

Block
A power product offered by the BPA for a fixed amount of power, delivered at a constant rate through the month.

BPA -- Bonneville Power Administration
A power marketing and electric transmission agency of the United States government headquartered in Portland, Oregon.

Call Option
A contractual agreement with a power generator to reserve capacity to generate power only when requested, at a pre-arranged cost per megawatt-hour.

Capacity
The maximum amount of electrical load that a device can carry at one time. Capacity is also used synonymously with capability.

CCCT – Combined-Cycle Combustion Turbine
A simple cycle combustion turbine with a heat recovery unit added. The heat recovery system recovers waste heat from the combustion turbine and uses it to create steam for additional electricity generation. A combined-cycle turbine operates most efficiently when it is run for long periods of time without being
ramped up and down.

SCCT -- Simple Cycle Combustion Turbine
A natural gas-fired turbine (similar to a jet engine) used to drive an electric generator. Combustion turbines, because of their generally rapid firing time, are designed for meeting short-term peak demands placed on power distribution systems. They are frequently ramped up and down as needed.

EIS -- Environmental Impact Statement
A written analysis of the environmental impacts to be anticipated from a proposed activity (construction of a mine, power plant, or electric transmission). An EIS is required by the National Environmental Policy Act (NEPA) before construction can begin. The Washington State Environmental Policy Act (SEPA) also requires environmental review (which can include an EIS) for proposed activities including approval of plans by governmental agencies.

Electric System
The generation, transmission, distribution and other facilities operated as an electric utility or a portion thereof.

Energy
Electric energy is a measure of the amount of usage over time and is measured in kilowatt-hours or megawatt-hours.

Exchange
An agreement between two electricity suppliers to send each other electricity, each at a different time. These agreements work best between two suppliers whose peak demands occur in different seasons.

Geothermal
Power generated from heat energy derived from hot rock, hot water or steam below the earth's surface.

IRP -- Integrated Resource Plan
This planning approach provides a process for a utility to evaluate a wide range of power resource alternatives.

Renewables
A resource such as solar energy or wind that is inexhaustible without fear of it running out, like oil.

Scenario
A possible course of future events. In the IRP, scenarios are used to evaluate portfolios of energy resources under a range of circumstances other than the baseline forecast.

Shaping
Configuring a resource portfolio so that power generation capability and delivery of purchased power closely matches changes in demand over time. Shaping can help to avoid unnecessary costs and the need to sell surplus power.

Slice
A power product offered by the BPA for an amount of power that varies year to year according to the amount of water flowing through the BPA hydroelectric system. In a good water year (above average precipitation), more power is delivered to the same customer than in a poor water year (below average precipitation).

APPENDIX B

SEATTLE CITY LIGHT'S ENVIRONMENTAL POLICY STATEMENT

and

VISION, MISSION, AND VALUES STATEMENT

Integrated Resource Plan

Seattle City Light

September 2006

Seattle City Light Environmental Policy Statement

Environmental Policy *Our Policy:* Seattle City Light is committed to very high standards of environmental protection. We will operate in a manner that is compatible with the long-term sustainability of the ecosystems that we affect. We believe that sound environmental performance is a key component of sound business performance. Environmental stewardship is a responsibility of all Seattle City Light employees.	*To demonstrate our commitment, we will:* Comply: ● Meet or exceed the requirements of all applicable environmental laws, regulations, policies. ● Be a model for others in meeting our hydro license requirements. Conserve: ● Promote the efficient use of materials and resources, including water and electricity, in all phases of a facility's life. Protect Natural Resources: ● Manage our business activities to avoid, minimize, or mitigate impacts to the ecosystems we affect. ● Provide resource enhancements when opportunities arise. Prevent Pollution: ● Reduce the quantity and toxicity of materials used and waste generated from our facilities and operations through source reduction, reuse, or recycling. Continually Improve: ● Set high environmental standards and evaluate our performance against these standards. ● Incorporate environmental costs, risks, and impacts when making decisions. ● Train all employees on this environmental policy and the key environmental impacts and responsibilities of their work. Lead: ● Collaborate with customers, agencies, tribes and other organizations to promote sound science and achieve common objectives. ● Be proactive in identifying and addressing emerging environmental issues. ● Be a model for others by offsetting our greenhouse gas emissions.

Seattle City Light Vision, Mission, and Values Statement

Our Vision			
TO SET THE STANDARD **To deliver the best customer service experience of any utility in the nation**			
Our Mission			
Seattle City Light is a publicly owned utility dedicated to exceeding our customers' expectations in producing and delivering environmentally responsible, safe, low cost and reliable power			
Customer Service	**Employee Performance & Growth**	**Operational Excellence**	**Financial Strength**
• Being prompt and timely • Improve reliability • Provide solutions	• Reward exceptional performance • Invest in employee development and training • Provide career growth and learning opportunities	• Improve productivity and achieve cost effectiveness • Measure and improve performance • Minimize environmental impact	• Ensure long term financial stability • Preserve and enhance our assets for long term • Manage risks
Our Values			
Excellence	**Accountability**	**Trust**	**Stewardship**
• Safety is our number one concern. • Empowering our employees is essential to providing exceptional customer service. • We anticipate and meet customer needs. • We believe diversity makes us stronger. • We believe that continuous improvement strengthens us. • We are stronger working in teams made up of people from many parts of our business.	• We value ownership of decisions, actions and results. • We measure our success against expectations and accept responsibility. • We encourage sound delegation practices that promote a supportive decision making culture. • We are committed to the highest standards of ethical behavior.	• Our word is our bond. • We are honest, open and respectful in our communications with each other and with customers. • Our customers rely on us to keep our commitments.	• We are entrusted with an irreplaceable hydroelectric legacy. • We work to ensure the success and benefits of public power. • We must enhance, protect and preserve our assets and the environment.

APPENDIX C

ENVIRONMENTAL ANALYSIS OF RESOURCES

Integrated Resource Plan

Seattle City Light

September 2006

APPENDIX C
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APPENDIX C: ENVIRONMENTAL ANALYSIS OF RESOURCES

1.0 Landfill Gas

1.1 General Description

As organic materials in landfills decompose, high concentrations of combustible gases such as methane are produced. Others include CO2 and non-methane organic compounds. Typically, landfill gas is 50 to 60 percent methane and most of the rest is CO_2 (EPA and Power Scorecard). In most modern landfills, federal laws require that the gas be captured (usually with a series of collector pipes distributed throughout the landfill) and flared to reduce explosion hazard. In addition to reducing flammable methane, flaring destroys Hazardous Air Pollutants (HAPs) in the landfill gas. Flaring is assumed to destroy 98 percent of the HAPs, but the actual destruction level can be lower (NRDC).

Alternatively, the gas mixture can be burned to produce electricity using several generation technologies. Methane can be combusted to produce electricity in generators or it can be used in fuel cells to create electricity electrochemically. Landfill methane is used to produce electricity at 380 landfills in the U.S. (EPA). In this analysis, fuel cells are not considered as an electricity generation source, but instead it is likely that one or more small (approximately 5 MW) combustion turbines would be used.

This analysis assumes that the landfill energy project would be located at an existing landfill in the northwest, either west or east of the Cascade Mountains. Generally landfills are already served by the local electrical transmission and distribution network, but upgrades and new infrastructure may be required if the electricity generation exceeds the onsite needs of the landfill, which is likely in the project size category being evaluated. Additional infrastructure requirements may include transformers or a small substation, and new or larger transmission/distribution lines and poles/towers. The actual upgrade requirements and environmental impacts would be specific to the site.

1.2 Environmental Impacts and Mitigation

1.2.1 Soils and Geology

1.2.1.1 <u>Construction Impacts</u>

Since the landfill gas energy facility would be installed at an existing or permitted landfill, and the electricity generating facilities would not require substantial disturbance to soils or geology outside the existing landfill and gas collection footprint, impacts on soils and geology would be low. A temporary storm water sedimentation and detention system would be needed (if not already present) to control runoff, erosion, and sedimentation. Limited erosion could occur during development of any needed transmission facilities.

1.2.1.2 Operation Impacts

There would be no impacts during operation. Vibration associated with operating large combustion turbines could occur, although this is not likely to cause impacts at a previously disturbed landfill.

1.2.1.3 Mitigation

- Develop a temporary storm water sedimentation and detention system.

1.2.2 Air Quality

1.2.2.1 Construction Impacts

Equipment exhaust and fugitive dust would be the principal potential sources of pollutants during development of a landfill gas energy project. Emissions levels would likely be low and occur on an exposed site where emissions would be disbursed. Therefore, emissions from construction equipment are not likely to cause significant air quality impacts or have a measurable effect on ambient air quality near a site.

Exposed surfaces, including graded land, unpaved roads and driveways, and dirt tracked or deposited onto paved roads, can generate fugitive dust (Washington Department of Ecology, 2003). Emissions of wind-blown dust are directly related to the amount of exposed area. To the extent that exposed soils are not wetted or otherwise stabilized, they could generate windblown dust and that could be deposited in the surrounding area. Also, mobile heavy equipment (such as loaders) would generate fugitive dust during construction. Washington law requires owners or operators of fugitive dust sources to take reasonable precautions to prevent fugitive dust from becoming airborne, and to operate the source to minimize emissions.

Fugitive dust deposition is generally not considered to be a health issue; however, excess dust deposition is considered a nuisance as it can increase the soiling of surfaces. Washington does not have any quantitative standards pertaining to dust deposition; Ecology responds to and resolves dust-related complaints and provides technical guidance to prevent impacts from fugitive dust. Fugitive dust resulting from a landfill gas energy project is not anticipated to produce any measurable effect on the overall ambient air quality in the area surrounding a site. Overall, impacts would be low during operation.

1.2.2.2 Operation Impacts

Air pollutants of concern for a landfill gas combustion turbine include NOx, SOx, CO, particulates, ozone, mercury and other hazardous air pollutants. Several standards have been established to regulate emissions and pollutant concentrations. EPA has set new source performance standards to address emissions for several categories of air pollution sources including combustion turbines. Also, if the energy project were to emit

more than 100 tons of an air pollutant regulated under the Clean Air Act, it would be subject to Prevention of Significant Deterioration Standards (PSD). Finally, state and national ambient air quality standards prescribe an allowable concentration of a pollutant and an averaging time over which the concentration is to be measured. Some pollutants have more than one air quality standard to reflect both short term and long term effects.

Nitrogen Oxide (NOx)

NOx (as NO_2) is a product of combustion that can affect air quality both directly and indirectly. The direct effect of breathing NOx is irritation of lungs, which can lead to coughing, lung damage, and difficulty breathing in both animals and humans. Indirectly, NOx combines with precipitation to form an acid solution, which damages plants and acidifies water bodies, resulting in damage to aquatic life. NOx also combines with other chemicals in the air to form ground level ozone (smog), which causes breathing difficulty and impairs visibility. To protect health, state and national standards have been established (annual average of 100 $\mu g/m^3$). Emission rates for a combustion turbine burning landfill gas are typically 0.22 lbs/MWh. However, these emissions would be partially offset by the amount of emissions represented by a typical flare, which would be foregone. This offset is assumed to be 20 lbs per MMBtu of landfill gas **(**E.H. Pechan and Associates, Inc., 2003). Accordingly, it is expected that a landfill gas energy project would lead to small increases in concentrations of NO_2. It is not likely that ambient air quality standards of 100 $\mu g/m^3$ would be violated.

During operation, nitrogen emissions would be higher than natural background levels. Nitrogen deposition could have a fertilizer effect, especially for soils low in nitrogen, which could alter plant productivity, species composition, and nutrient retention. Plant resources in the vicinity of a landfill gas combustion turbine project would receive minimal deposition and extensive changes in species composition would be unlikely.

Sulfur Oxide (SOx)

Landfill gas contains sulfur, and energy generation could result in sulfur dioxide (SO_2) emissions. SO_2 is a criteria pollutant (standard of 80 $\mu g/m^3$ annual average concentration). Combustion turbines of the size used in landfills do not use SO_2 control equipment, but often the landfill gas is "cleaned" and sulfur removed to avoid damaging the generation equipment (NRDC). The amount of sulfur in landfill gas varies with landfill. The emission rate for this analysis is estimated to be 0.00432 lbs/MWh). However, SO_2 emissions are assumed to be the same as the emissions from flaring landfill gas and, therefore, no additional impact would occur with a landfill gas combustion turbine project **(**E.H. Pechan and Associates, Inc., 2003).

Mercury / Other Hazardous Air Pollutants

Emissions of mercury and other hazardous air pollutants from burning landfill methane will vary widely depending on the mercury contained in the landfill waste. The use of

landfill methane for electricity should not increase the amount of mercury released into the environment, and may result in a decrease in emissions (Power Scorecard). Burning landfill gas reduces most hazardous air pollutants in the gas, but produces small amounts of dioxins, another hazardous pollutant (NRDC). Overall, it is expected that impacts associated with hazardous air pollutants would be less than with flaring the landfill gas.

Particulates

Federal, state, and local regulations set limits on the concentrations of particles less than or equal to about 10 micrometers in diameter. This fraction of particulate matter, called PM_{10}, has potential human health impacts because particles this size can be inhaled deeply into lungs. PM_{10} is generated by industrial activities and operations, fuel combustion sources, motor vehicle engines and tires, and other sources. The annual average concentration standard for PM_{10} is 50 $\mu g/m^3$.

There is also a federal standard for particulate matter less than or equal to 2.5 micrometers (microns) in diameter. This fine fraction of particulate, called $PM_{2.5}$, is a subset of PM_{10}. Such small particles can be breathed deeply into the lungs, and are believed to represent the greatest risk to human health from all the varieties of particulate matter.

Emissions of particulate matter would vary widely depending on material in the landfill (Natural Resource Defense Council). Overall, emission offsets from flaring of landfill gas would result in little to no additional emissions of particulates; impacts would be low.

Greenhouse Gases

The combustion process within combustion turbines produces certain quantities of greenhouse gases, which are considered a major cause of global warming. However, like biomass fuel derived from organic matter such as wood and paper products and agricultural waste, methane from landfills is subject to the natural carbon cycle and therefore does not contribute additionally to global warming **(**E.H. Pechan and Associates, Inc., 2003). Generation from the combustion of all biomass is assigned zero emissions of CO_2 because these organic materials would otherwise release CO_2 (or other greenhouse gases) through decomposition.

Further, while large landfills are usually required to capture and flare landfill gas, smaller and older landfills are not. These may be significant sources of methane releases to the atmosphere. Since methane is 23 times more potent as a greenhouse gas than CO_2, capturing methane that would otherwise be released offers a significant benefit in reducing greenhouse gas emissions. Accordingly, electricity production at smaller landfills that captures the methane and reduces greenhouse gas emissions would result in positive environmental effects (Power Scorecard).

Overall, air quality impacts during operation would be expected to be low.

1.2.2.3 Mitigation

- Run generators in 'lean burn' mode (less oxygen than needed to combust fuel), which reduces NOx formation. However, it also results in more unburned fuel (Volatile Organic Compounds and Hazardous Air Pollutants). This effect can be mitigated by installing additional flares to combust these pollutants in the exhaust gas.

- Install additional flares, as described above, to destroy Volatile Organic Compounds and other Hazardous Air Pollutants that result from the operation of the generators. Although efforts are underway to reduce the amount of mercury in consumer products and the amount of mercury that goes into landfills, it is likely that there is mercury from decades of previously interred material that contains mercury that will gasify and be emitted.

1.2.3 Surface and Groundwater

1.2.3.1 Construction Impacts

Disturbance of the area developed for the landfill gas energy project may alter the surface drainage patterns and create areas of impervious surfaces, which would lead to greater levels of runoff. It is probable that most reclaimed landfills will have storm water runoff management systems in place that would accommodate runoff from the site with little or no modification. If not, a temporary storm water detention system would need to be developed. There is also the potential for release of hazardous fluids to ground water (fuel and hydraulic oils, etc.). Impacts on water resources during construction would likely be low.

1.2.3.2 Operation Impacts

Water needs will depend on the type of electrical generating equipment. Generally, the simple cycle gas turbines of the size used in landfill gas energy projects do not require water. Other types of generation, such as steam turbines or turbines with heat capture, would require a water source. The analysis for the IRP assumes a simple cycle combustion turbine, with no water use. Consequently, there would be no water resource impacts from a consumption perspective.

Similar to construction, a permanent storm water pollution prevention system that contains best management practices would need to be provided to accommodate a site's surface water runoff. Prevailing water quality standards would be met. Impacts on water quantity and quality are likely to be low.

1.2.3.3 Mitigation

- Develop temporary and permanent storm water pollution prevention systems.
- Develop a spill prevention control and countermeasure plan (SPCC).

1.2.4 Plants and Animals

1.2.4.1 Construction Impacts

Since the landfill gas energy facility would be installed at an existing or permitted landfill, and the electricity generating facilities would not require significant land outside the landfill footprint, little disturbance of habitat would occur. Construction of the facility would require removal of any plants within the facility's footprint that could serve as habitat for animal species. The quality of the habitat would likely be low and impacts on plants and animals would be correspondingly low. Threatened and endangered species would not likely be affected. Moderate impacts could occur during development of transmission facilities depending on the quality of habitat and species that are present.

1.2.4.2 Operation Impacts

There would be no direct impacts during operation because additional disturbance would not occur. Depending upon the location of the facility on the landfill site, additional noise from operations could disturb wildlife in adjacent areas. Overall, impacts would be low.

1.2.4.3 Mitigation

- Landscape site buffer areas with native plant species that could attract wildlife that would be compatible with the energy use.
- Maintain low-growing vegetation in transmission rights-of-way.
- Implementation of SPCC plan would lessen risks to any aquatic resources near or downstream from the facility.

1.2.5 Energy and Natural Resources

1.2.5.1 Construction Impacts

Small quantities of energy and natural resources would be consumed during construction; impacts would be low.

1.2.5.2 Operation Impacts

Using landfill methane gas to produce electricity avoids the use of other forms of energy such as fossil fuel. While there is debate as to whether landfill gas is renewable, due to the fact that it is based on waste material derived from consumed products, it is a source that is expected to be available well into the foreseeable future. In practice,

many states that have a Renewable Portfolio Standard requiring utilities to provide a certain percentage of electricity from renewable sources do consider landfill gas to be a renewable fuel. The amount of electricity generated per unit of landfill gas will vary with generator technology. The technology assumed in this analysis is roughly 35-percent efficient at converting landfill gas energy into electricity, and does not include heat recovery. Heat recovery is used in some landfill gas-to-energy applications, which does increase the overall efficiency of fuel use resulting in less use of other generating fuels. A simple cycle combustion turbine is assumed for this analysis, which requires no water. The overall impact would be beneficial.

1.2.5.3 Mitigation

No mitigation would be needed.

1.2.6 Environmental Health

1.2.6.1 Construction Impacts

There would be no impacts during construction.

1.2.6.2 Operation Impacts

A landfill gas energy project would have a positive impact with respect to environmental and human health. This is attributable to the potential reduction in air pollutants and greenhouse gas as a result of using landfill gas to produce electricity that otherwise would have been flared.

1.2.6.3 Mitigation

No mitigation would be needed.

1.2.7 Land Use

1.2.7.1 Construction Impacts

The landfill gas combustion turbine would likely be sited within the boundaries of an existing landfill site. Because a site would already be developed for landfill use, there would be no additional land use impacts from the installation of electricity production equipment – no displacement of other existing land uses would occur. Many landfills already have piping for capturing and flaring methane gas, and typically the electricity generating equipment (regardless of whether the technology is a gas turbine, internal combustion engine, or fuel cell) would easily be accommodated on the land used for the landfill. Some new structures may be required, such as foundations or buildings to house the generating equipment, but it should be possible to accommodate them within the existing landfill footprint. Depending on the existing electricity transmission infrastructure available at the site, new transmission and distribution facilities may be re-

quired, including poles/towers, conductors, transformers and substations. Some of these facilities would be located offsite and could result in the displacement of existing land uses. Overall, impacts would be low during construction.

1.2.7.2 Operation Impacts

Operation of a landfill gas combustion turbine project could result in some proximity-related impacts associated with noise, traffic, and the physical presence of the facilities. However, because the site would have been used for an industrial purpose, a precedent would have been established. It is likely, therefore, that land use compatibility impacts would be low. Likewise, the new use would need to be consistent with local comprehensive plan and zoning designations (or at least would be a use that would be generally compatible with allowed uses in the zone).

1.2.7.3 Mitigation

- To the extent possible, locate any new structures on existing landfill site, and minimize the size and number of new structures.

- Locate any new transmission facilities parallel to existing rights-of-way and avoid bisecting existing land uses.

1.2.8 Aesthetics and Recreation

1.2.8.1 Construction Impacts

There would be minor changes in visual quality of the setting during construction, attributable to the construction activities themselves. No recreational impacts would occur since the site would not have been available for recreational purposes; landfills are not generally located in or near recreational areas. Impacts would be low.

1.2.8.2 Operation Impacts

Landfills are often screened from public view or located far from population centers; therefore, the likelihood of long-term visual impacts is low. However, to the extent that new structures and activities contrast with the existing visual setting, and there is a viewing population, there could be low aesthetic impacts.

A landfill gas energy facility would be installed at an existing or permitted landfill that meets or is likely compatible with existing zoning requirements, and the electricity generating facilities would not require land outside the landfill footprint. Consequently, the facility is not likely to conflict with existing recreational activities in the area. Impacts would be low. The facility may beneficially reduce odors by collecting and combusting landfill gas. However, in landfills where gas is already captured and flared there may be little improvement attributable to the energy facility.

1.2.8.3 Mitigation

- If necessary and effective, provide vegetative screening to obstruct views of the facility from surrounding sensitive areas.

1.2.9 Cultural Resources

1.2.9.1 Construction Impacts

Cultural resources would not be adversely affected. It is assumed that the landfill gas energy facility would be installed at an existing or permitted landfill where major disturbance would have already occurred. A possible exception would be any new transmission facilities that would be required.

1.2.9.2 Operation Impacts

There would be no impacts during operation.

1.2.9.3 Mitigation

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and Native American tribes with interests in the project area to determine the likelihood of any cultural resources within or near the project area, including the proposed route for transmission facilities. If resources are discovered during construction, halt work and notify DAHP.

1.2.10 Economy

1.2.10.1 Construction Impacts

There would be a small, short-term increase in employment during construction and a corresponding increase in personal income in the area. Also, there would be a beneficial impact associated with spending for construction materials and plant facilities.

1.2.10.2 Operation Impacts

There would be a small permanent increase in employment and personal income associated with operation and maintenance of the energy facility; employment would probably not exceed one-full time employee equivalent.

1.2.10.3 Mitigation

No mitigation would be needed.

1.3 References

Washington Department of Ecology, 2003. *Techniques for Dust Prevention and Suppression.* Publication Number 96-433.

Natural Resource Defense Council
http://www.nrdc.org/air/energy/lfg/contents.asp; report pdf is at
http://www.nrdc.org/air/energy/lfg/lfg.pdf

EPA - Landfill Methane Outreach Program
http://www.epa.gov/lmop/

Power Scorecard
http://www.powerscorecard.org/tech_detail.cfm?resource_id=5

Landfill Gas - Solar Turbines
http://mysolar.cat.com/cda/layout?m=35442&x=7

E.H. Pechan and Associates, Inc. 2003. US EPA Office of Atmospheric Programs, eGRID Technical Support Document, (May 2003, page 9).

2.0 Wind

2.1 General Description

Wind was first harnessed for electricity generation first occurred approximately 100 years ago. Major advances in wind generation technology have occurred since then, particularly in the past two or three decades. The wind turbine technology research and development that followed the oil embargoes of the 1970s refined old ideas and introduced new ways of converting wind energy into useful power. Many of these approaches have been demonstrated in "wind farms" or utility-scale wind power plants (groups of turbines that feed electricity into the utility grid). Wind power is currently the world's fastest-growing source of electricity. Installed wind energy generating capacity in the United States totaled over 9,100 MW at the end of 2005 (AWEA, 2006). Wind power projects completed in the Pacific Northwest in 2005 included production capacity of 390 MW in Washington State, 338 MW in Oregon, 75 MW in Idaho and 138 MW in Montana.

For this EIS, City Light assumes that acquisition of wind energy resources could involve purchasing electricity generated by an existing or future wind energy project and/or participating in the development of new wind energy facilities. In either case, the wind energy project(s) could be located virtually anywhere within the Northwest, either west or east of the Cascade Mountains. Based on the distribution of existing projects in the Northwest, however, the wind energy facilities would likely be located east of the mountains. Wind farms in the Northwest and elsewhere in the U.S. tend to be located in rural or remote areas.

Converting energy from the wind into electrical energy occurs through five basic steps or functions. (1) Electricity is generated by wind turbines, which typically consist of a tubular steel tower supporting a nacelle (the housing for an enclosed generator that is connected via a gear box to the rotor) and a three-bladed rotor. Wind blowing against the turbine blades causes them to rotate, which in turn rotates an electrical generator in the nacelle that produces an electrical current. (2) The generated electricity is carried down cables within the tower to a base panel at ground level inside the tower. (3) The electricity then is fed to a pad-mounted transformer located adjacent to the tower that increases (steps up) the power to a higher voltage. (4) The stepped-up power from the transformer then is fed into a power collection system that connects groups of wind turbines within the project to a project substation. (5) Substation equipment transforms or again steps up the voltage of the electricity from the project. Energy is then fed by a transmission line connection from the substation to the regional electrical transmission system, through which it is conveyed to utility distribution systems for delivery to customers.

Modern wind turbines are large structures that usually exceed 300 feet in height, and a variety of heavy equipment is required for construction of a wind project. Key construction activities typically include constructing a project access road system; clearing and grading to establish turbine sites and staging and lay-down areas;

excavating and installing foundations for the turbine towers; assembling the towers and installing the nacelles and rotors; constructing the substation and operations and maintenance center; installing permanent meteorological (met) towers; connecting the turbines, met towers and substation with power collection and signal cables (typically located underground); constructing the transmission line connecting the substation with the transmission grid; and testing all facilities prior to commercial operation. Today's utility-scale wind farms typically encompass a total project area of several thousand acres or more, although the permanent facilities comprise no more than 5 to 10 percent of the total acreage. Construction activities cause temporary disturbance considerably more extensive than the permanent footprint of the project facilities, although the disturbed areas not occupied by permanent facilities are restored following construction.

2.2 Environmental Impacts and Mitigation

2.2.1 Soils and Geology

2.2.1.1 Construction Impacts

As described above, construction of wind projects involves a variety of land-disturbing activities such as clearing and grading to build access roads and construction pads, and excavating for turbine foundations and the power collection system. These activities result in surface and sub-surface disturbance that can expose soils to erosion by wind and water. Heavy equipment operation causes compaction of native soils. Blasting may be needed if rock is encountered at depth in turbine foundations. If geologic hazards are present within the project area, those hazards could be activated by the construction disturbance. Wind project construction also requires consumption of geologic materials such as sand and gravel for use in concrete, road surfaces and bases, and as backfill.

Construction impacts on geology and soils can be minimized by careful planning and design, and through use of best management practices (BMPs) in the field (NWCC, 2002). Planning and design measures to reduce impacts include locating project facilities to avoid geologic hazards and erosion-prone areas, conducting site-specific evaluations of geotechnical conditions, and designing project facilities to meet the conditions encountered. The area of construction disturbance for a wind project is typically large enough to require a National Pollutant Discharge Elimination System (NPDES) permit for discharge of construction stormwater (BLM, 2004). NPDES permit conditions include the required development and implementation of a surface water pollution prevention plan (SWPPP), which in turn requires a variety of BMPs to minimize erosion and control runoff and sedimentation. In addition, there would be a potential for release of hazardous fluids to ground water (fuel and hydraulic oils, etc.) during construction. Typically, there would be a spill prevention control and countermeasure plan (SPCC) that would minimize impacts on ground water.

Based on the required use of erosion and sedimentation control measures, and the application of sound planning and design principles, impacts from construction of wind en-

ergy facilities on geologic and soil resources are expected to be moderate. While quantities of sand, gravel and other materials required for construction can be substantial, these materials are commonly available and project demands are unlikely to affect local supply conditions.

2.2.1.2 Operation Impacts

On-site geologic and soil conditions typically stabilize following construction and restoration of the disturbed areas (BLM, 2004). Ongoing disturbance during operation would be limited to occasional vehicle traffic on project roads, and impacts would be low.

2.2.1.3 Mitigation

- Minimize the extent of ground disturbance required, such as by using existing roads to the extent possible. Locate new access roads to follow the local topography, and minimize sidehill cuts.
- Cover and stabilize exposed areas consistent with applicable standards, salvage removed topsoil and reclaim disturbed areas as soon as possible.
- Identify and avoid unstable slopes and other geologic hazards, and avoid creating excessive slopes during construction; use special construction techniques where applicable.
- Develop and implement a temporary storm water management system to control runoff, erosion, and sedimentation during construction.
- Implement a SPCC.

2.2.2 Air Quality

2.2.2.1 Construction Impacts

Minor emissions of air pollutants and greenhouse gases occur during fabrication of wind turbines and associated equipment, and with transportation of wind farm components to the project site. The quantities of air pollutants associated with these functions for any given wind project would be extremely small and difficult to calculate, and would be regulated under existing air quality programs.

Equipment exhaust and fugitive dust generation would be the principal potential sources of air pollutants during construction of a wind energy project (BLM, 2004). Construction equipment, vehicles transporting construction materials and wind turbine components to the site, and construction workers' vehicles would all produce exhaust emissions. Air pollutants in these emissions can include CO, NO_x, VOCs, SO_2, particulates and air toxics. In some cases, temporary concrete batch plants are established at the project site to supply concrete for project facilities. Batch plant emissions (primarily particulates) represent an additional source of air pollutants, although these are offset to some degree by reduced transportation of concrete and/or concrete inputs. Emissions from these sources would be short-term; emission levels would likely be low and they would occur on an exposed, windy site where good dispersion could be expected. Therefore,

exhaust emissions from construction equipment are not likely to cause significant air quality impacts or have a measurable effect on ambient air quality near a site.

Exposed surfaces, including graded land and unpaved roads, and dirt tracked or deposited onto paved roads, can generate fugitive dust (Washington Department of Ecology, 2003). The emission of wind-blown dust is directly related to the extent of exposed area, the surface conditions (e.g., silt and moisture content of the exposed soil) and amount of activity on the exposed area. To the extent that exposed soils are not wetted or otherwise stabilized, they could generate windblown dust and cause dust deposition in the surrounding area. In addition, mobile heavy equipment (such as loaders) would generate fugitive dust during construction. State laws require owners or operators of fugitive dust sources to take reasonable precautions to prevent fugitive dust from becoming airborne, and to operate the source to minimize emissions.

Fugitive dust deposition is generally not considered to be a health issue; however, excess dust deposition is considered a nuisance as it can increase the soiling of surfaces. Some states do not have any quantitative standards pertaining to dust deposition. In Washington, the Department of Ecology responds to and resolves dust-related complaints and provides technical guidance to prevent impacts from fugitive dust. Fugitive dust resulting from a wind energy project is not anticipated to produce any measurable effect on the overall ambient air quality in the area surrounding a site.

Overall, impacts during construction would likely be low.

2.2.2.2 Operation Impacts

Air emissions during operation of wind energy facilities are negligible. The wind turbines themselves do not produce emissions in operation. Minor emissions of Volatile Organic Compounds (VOC) can occur during routine maintenance, such as changing lubricating and cooling fluids or painting equipment (BLM, 2004). Routine operation and maintenance activities create fugitive dust and exhaust emissions from patrol and repair vehicles traveling across the wind farm site, or from periodic brush clearing. These activities are limited in extent and duration, and the associated emissions would have a negligible impact on air quality. There are no greenhouse gas emissions during the operation of wind farms.

2.2.2.3 Mitigation

- Surface on-site access roads and construction activity areas with aggregate materials, where appropriate.
- Use dust abatement techniques, such as watering or application of dust palliatives, on roads and disturbed surfaces during construction.
- Post and enforce speed limits (typically 25 miles per hour) on project roads.
- Cover stockpiles of soils, construction materials and (if applicable) storage piles at concrete batch plants.

- Minimize the extent of disturbed areas and restore disturbed areas as soon as possible following construction.
- Train construction workers on proper handling of construction materials to minimize fugitive emissions.
- Cover loads of construction materials prior to hauling.

2.2.3 Surface and Groundwater

2.2.3.1 Construction Impacts

Construction of wind energy facilities can affect water resources through alteration of surface and groundwater flow patterns, discharges to existing water sources, and the consumption of water during the construction process. Surface disturbance of the project area for construction of roads, turbines and other facilities can alter the surface drainage patterns and create areas of impervious surfaces, which would lead to greater levels of runoff. If uncontrolled, runoff from disturbed areas can produce temporary increases in soil erosion, resulting in elevated turbidity in runoff water and sedimentation in stream channels. As indicated previously, the area of construction disturbance for a wind project is typically large enough to require an NPDES permit for discharge of construction stormwater (BLM, 2004). NPDES permit conditions include the required development and implementation of a surface water pollution prevention plan (SWPPP), which will in turn require a variety of BMPs to minimize erosion and control runoff and sedimentation. Consequently, the construction process would include implementation of a temporary on-site stormwater management system to control site drainage and minimize temporary impacts to water quality. While access road systems for large wind farms are rather extensive, long-term changes to local or regional drainage characteristics are typically minor because surface disturbance for project development affects only a small fraction of the total project area. Therefore, impacts on water quality and drainage conditions during construction would likely be low.

Grading and excavation activities (such as for turbine foundations and underground power collection cables) and extraction of geologic materials for use in construction can change groundwater flow patterns, and result in discharges to groundwater (BLM, 2004). Trenching for installation of power collection cables is typically shallow (about 4 feet deep) and at most sites is unlikely to intersect groundwater. Turbine foundations are often up to approximately 40 feet deep and are more likely to encounter groundwater, but subsurface flow patterns would be changed only if the excavation established a significant hydrologic connection between two aquifers, or between groundwater and surface water.

Wind farm construction typically involves water consumption for several activities, including dust suppression, vehicle washdown, and potable water supply for the construction crew. Water is also an input to the concrete used for turbine foundations and pads for transformers, buildings, and substations. Depending on site-specific conditions, construction water supplies are either trucked to the site or obtained from local surface or groundwater sources. Obtaining a water supply from new sources on or near

the project site would be subject to the applicable state and local permit requirements for use of surface or groundwater. Water consumption for project construction is a temporary impact of about one year in duration. Volumes of water withdrawal would be estimated prior to construction; however, typical volumes are such that a measurable effect on the availability of local water supplies for existing users would not be expected.

Overall, impacts on water resources during construction would likely be low.

2.2.3.2 Operation Impacts

Most wind farms use almost no water during operation. Limited quantities of water are needed for functions such as maintenance cleaning, and to provide a potable water supply for the operations and maintenance facilities and crew. Long-term effects on water quantity and quality would be limited to any permanent changes in drainage patterns and the runoff from the small area of impervious surface created by the permanent project facilities. Similar to construction, a permanent stormwater management system that contains best management practices for pollution prevention would need to be provided to accommodate a site's surface water runoff. Based on the requirements for such a system and the limited runoff volume to be managed, prevailing water quality standards would be met and impacts on water quantity and quality are likely to be low.

2.2.3.3 Mitigation

- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.
- Characterize the surface and groundwater hydrology prior to construction, develop an understanding of discharge and recharge relationships, and avoid creating new hydrologic connections through excavation and related activities.
- Monitor water quantity and quality conditions if construction activity is to occur near aquifer recharge areas.
- Use originally excavated material for foundation and trench backfill as much as possible, and dispose of excess material only in approved locations.
- Implement BMPs for use, handling and storage of fuels, pesticides and other hazardous materials during both construction and operation.

2.2.4 Plants and Animals

2.2.4.1 Construction Impacts

Construction of wind energy facilities can have a variety of direct and indirect consequences for plants and animals. Direct effects commonly include removal of vegetation and the habitat it provides for wildlife, and mortality or injury to animal species that inhabit the site at the time of construction. Indirect effects can stem from a number of disturbance mechanisms that can interfere with normal animal behaviors or introduce adverse changes to their habitat. Based on experience to date with wind energy development in the U.S., however, permitting agencies are likely to find the construction im-

pacts on plants and animals to be insignificant unless protected species or their habitats are present and likely to be damaged during construction (NWCC, 2002).

Construction for wind farms requires clearing of existing vegetation around areas to be occupied by roads, turbines, substations and other project facilities. Because construction activity occurs in a larger area than is occupied by the permanent facilities, much of the area of temporary disturbance is revegetated following completion of construction. Consequently, much of the disturbance area represents a temporary loss of vegetation and the habitat that it provides. Productivity in the temporary disturbance area can also be reduced over the long term through soil compaction and loss of topsoil, unless these effects are addressed through the restoration process. The permanent wind farm facilities occupy a small fraction of the total project area (typically no more than 5 to 10 percent, and often less), although this area represents a permanent loss of vegetation and habitat on a previously undeveloped site.

Mobile wildlife or aquatic species present on a project site are likely to be displaced during construction, while those that are less mobile can be killed or injured as a result of construction activity. In addition to these direct impacts, remaining vegetation and habitat quality for wildlife can be diminished indirectly through dust generated by construction, erosion and runoff, and increased opportunities for invasive species. Similarly, aquatic habitat can be degraded by runoff, dust and exposure to contaminants through spills. Noise, the presence of humans and vehicles, and similar aspects of construction activity can modify the behavior of wildlife remaining on the site and in adjacent areas.

Overall, the impacts of wind project construction on plants and animals are expected to be low to moderate. Impacts to protected or sensitive plants, animals and their habitat can usually be avoided or minimized through careful planning, design and construction measures. By extent, most of the construction impacts are temporary or do not occur at the same level once construction is completed, and most of the habitat affected during construction can be replaced through site restoration. The extent of permanent habitat loss is small relative to the size of the project area, and replacement habitat is commonly provided on site or nearby.

2.2.4.2 Operation Impacts

Several types of potential long-term impacts to plants and animals are associated with wind farm operation. These can include collision hazards for birds and bats, electrocution hazards, interference with migratory behavior, and a variety of disturbance factors that can result from project operation (BLM, 2004). The collision hazard is probably the greatest operational impact to wildlife, and is the most controversial biological factor in the siting and development of wind power projects (BLM, 2004; NWCC, 2002).

Pre-development studies of bird resources and use patterns are standard components of wind farm siting, and there has been extensive comparative research on both projected (pre-development) and observed (post-development) bird mortality from collisions

with wind turbines, met towers and transmission lines. In addition to determining absolute numbers of bird fatalities, these studies have estimated mortality rates on a per-turbine basis and in relation to the rotor-swept area (RSA) of the turbines at individual facilities. The history of bird mortality at the Altamont Pass Wind Resource Area in California, and extensive publicity associated with that mortality, have raised extensive concern among resource agencies, conservation groups and the public about the potential for wind farm impacts on birds.

In general, however, the experience at other operating wind farms throughout the U.S. has been that impacts on birds (and bats) have been minor (NWCC, 2002). Comparative studies of bird mortality have indicated that bird mortality at Altamont Pass has been substantially higher on a per-turbine and/or per-RSA basis than the mortality at other operating wind projects, and have identified a variety of potential reasons for the differences in mortality (BLM, 2004). Altamont Pass is the location of the first large-scale wind energy development in the U.S., with most of the turbines initially installed in the 1980s, and it was a test site for many different turbine designs installed by many different developers. Unfortunately, the area was not studied extensively to determine bird use prior to development, and is now known to be a major migration and use area for birds. Key species present at Altamont Pass and reflected in the mortality statistics include a number of species with a high public profile, primarily raptors such as golden eagles, kestrels, and red-tailed hawks. Researchers have concluded that unusually high raptor densities, regional topography, and the older turbine technology may be factors contributing to the higher mortality results for Altamont Pass, compared to other U.S. wind projects.

Bat mortality can also occur at wind farms and has recently been the subject of increased research attention. There have been incidents of unexpectedly large bat mortality, generally during migration season, and in particular at a wind farm in West Virginia. Less is known about bat interactions with wind turbines than about bird interactions, but a number of studies have been done to learn about this phenomena. The U.S. Fish and Wildlife Service is participating in a collaborative effort with wind developers to conduct additional research into ways to site turbines and deterrent measures to avoid impacts to bats. Comparative studies to date, however, have indicated that bat mortality at most wind farms, particularly those in the western states, has been considerably less than in the West Virginia case.

Large birds can be electrocuted when they touch two electrical conductors or a conductor and a grounded wire, and electrocution fatalities on transmission and distribution lines have been documented for some time. Transmission lines associated with wind farms can therefore present electrocution hazards, although these hazards can be effectively mitigated when appropriate design standards are applied (NWCC, 2002). Noise produced by wind turbines and other wind farm equipment (typically vehicles), and the occasional presence of humans represent potential operational sources of disturbance impact for wildlife.

In most cases, the ongoing plant and animal impacts of wind farms operating in the Northwest and elsewhere in the U.S. would probably be considered insignificant by most authoritative, objective reviewers. Conversely, most reviewers would likely consider the wind energy impacts on birds at Altamont Pass to be significant, and might come to similar conclusions about bat impacts at one or two projects in the eastern states. Given the overall industry experience, and assuming the use of appropriate pre-development studies and planning measures, it would be reasonable to expect the operation impacts of a new wind project at a typical location in the Northwest to be no worse than moderate. Because bird and bat use and mortality could be substantially above average at certain locations, however, conclusions about long-term impacts on plants and animals would need to be made on a case-by-case basis.

2.2.4.3 Mitigation

The U.S. Fish and Wildlife Service (USFWS; 2003) issued voluntary guidance addressing the siting, construction, operation, and decommissioning of wind farms to assist the wind energy industry in avoiding or minimizing impacts to wildlife and their habitats. (The Washington Department of Fish and Wildlife has issued similar guidance for wind energy development in Washington.) This is to be accomplished through:

(1) proper evaluation of potential Wind Resource Areas (WRAs),
(2) proper location and design of turbines and associated structures within WRAs selected for development, and
(3) pre- and post-construction research and monitoring to identify and/or assess impacts to wildlife.

These guidelines are based on current science and will be updated as new information becomes available. They are voluntary, and interim in nature. They will be evaluated over a two-year period, and then modified as necessary based on their performance in the field, on comments from the public, and on the latest scientific and technical discoveries developed in coordination with industry, states, academic researchers, and other Federal agencies. After this period, the U.S.F.W.S plans to develop a complete operations manual for evaluation, site selection, design, construction, operation, and monitoring of wind energy facilities in both terrestrial and aquatic environments. In the interim, the specific actions recommended by the current USFWS guidelines represent appropriate mitigation measures for the plant and animal impacts of wind farms.

Specific measures directly identified in the USFWS guidelines and/or in other sources include the following:

- Conduct proper pre- and post-development studies of plant and animal resources.
- Avoid siting wind projects in areas that are heavily used by migrating birds and/or bats, and/or that have a high incidence of fog and mist.
- Avoid siting wind projects in areas that support unique or sensitive plants or wildlife habitat.

- Use existing roads and disturbed areas for project development to the greatest extent possible, and minimize the area disturbed for project construction.
- Avoid stream crossings to the extent possible and design necessary stream crossings to minimize disturbance and maintain aquatic habitat conditions.
- Use facility designs (e.g., modern, slow moving wind turbines on tall monopole structures; free-standing permanent meteorological towers; underground electrical lines) that discourage use by birds for perching or nesting, and minimize the risk of collision or electrocution.
- Configure turbines to avoid landscape features known to attract raptors.
- Develop and implement a plan to restore habitat in disturbed areas as soon as possible following construction.
- Purchase or set aside land for management to replace habitat values lost through project development.
- Implement measures to minimize the opportunities for establishment of invasive species.
- Landscape site buffer areas with native plant species that could attract wildlife compatible with the energy use, and ensure that areas around project structures do not have vegetation that would support wildlife use.
- Maintain low-growing vegetation in transmission rights-of-way.
- Monitor project impacts on wildlife during construction and operation, and report the results of the monitoring effort.

2.2.5 Energy and Natural Resources

2.2.5.1 Construction Impacts

Each step in the development of wind energy generation facilities requires various types and amounts of energy and natural resources as inputs. Prior to construction, energy (fossil fuels and electricity), water and mineral resources are used during the fabrication of wind turbines and other wind farm components. Energy is also used to transport wind farm components to the project site. On-site construction of wind farms requires fossil fuels to power construction equipment. Geologic materials such as sand and gravel are used in road construction, as fill materials and as inputs for making concrete. Water is also required for concrete, and for dust suppression. Wind energy facilities are not widely regarded as having intensive requirements for energy and natural resources, and the quantities of energy and other natural resources consumed during manufacturing, transport and construction are not significant relative to other demands for those resources. Impacts would be low.

2.2.5.2 Operation Impacts

Operation of wind turbines does not consume a fuel or water. Operation and maintenance of a wind farm requires small supplies of diesel fuel and gasoline for operating vehicles, water for domestic use, and electricity for support facility operation. Minor quantities of gravel or other materials may be needed for periodic road maintenance or

similar activities. Energy and natural resource demands during project operation are sufficiently small that the associated impacts can be considered nonexistent.

2.2.5.3 Mitigation

Based on the level of impacts to energy and natural resources identified, no mitigation would be needed.

2.2.6 Environmental Health

Experience with wind energy development in the U.S. has included a variety of public concerns related to environmental health. Pertinent topics in this category include occupational safety, public safety issues associated with electricity generation and transmission, several public safety issues specific to wind turbines, aviation safety, noise, and shadow flicker. Most of these issues apply to the operation of wind energy facilities.

2.2.6.1 Construction Impacts

Environmental health concerns during construction of wind projects primarily involve occupational safety for workers. Wind farm development entails several occupational hazards unique to construction of wind turbines and their support facilities, as well as hazards typically found in heavy construction and the electric power industry. Occupational health and safety regulations apply to these hazards, as do health and safety plans used by contractors.

Most construction activities, including construction of wind energy facilities, produce noise that is audible beyond the boundaries of the construction site and that can be significant. The primary noise sources from wind farm construction are heavy equipment operation and truck traffic, and can include blasting. Because of their inherent nature and temporary duration, construction activities are typically exempt from community noise levels established in state and local regulatory standards, although they are usually confined to normal daytime hours. Impacts would be low.

2.2.6.2 Operation Impacts

Wind farm operations and maintenance workers are also exposed to occupational safety hazards associated with maintenance of tall, complex structures (wind turbines) and electrical systems. Occupational health and safety regulations and project health and safety plans apply to these hazards.

Risks associated with exposure to electrical and magnetic fields (EMF) and the occurrence of electromagnetic interference (EMI) are common concerns related to the generation and transmission of electricity, and they have been identified as project development issues in some wind farm cases. The electrical and magnetic fields associated with wind turbines and wind farm power collection systems, substations and transmis-

sion lines are lower in strength than the fields associated with extra-high-voltage transmission lines where EMF and EMI have typically been raised as issues. In addition, access controls on wind farms generally prevent public exposure to the fields that are present.

The history of wind farm siting and operation includes numerous cases of public concern over safety hazards unique to wind energy. These issues include the risks of several types of mechanical failures, such as wind turbine collapse, blade throw and ice throw, and the risks of fire or explosion created by wind farm equipment. While the unique hazards associated with wind energy have received considerable attention through Internet postings and the popular literature, the documented incidents and problems have generally been sparse and related to old wind turbine technology. With current wind turbine technology and design, wind farm public access controls and adequate setback requirements are sufficient to address these types of safety risks (NWCC, 2002).

Wind turbines and met towers create a nominal potential for aviation safety hazards because they are tall structures that conceivably could interfere with navigable airspace. FAA regulations require that the agency be notified of the proposed construction of any features that could be obstructions to aircraft (including any structures over 200 feet in height), and the FAA evaluates that air navigation hazards associated with such construction proposals. The FAA also administers regulations that require marking (paint and/or safety lighting) for potential obstructions, including wind farms. These regulatory provisions are considered sufficient to address the aviation safety hazards of wind farms.

Wind turbines are the primary source of noise from operating wind energy facilities. Wind farms are located in windy areas, and the background noise produced by the wind is often sufficient to mask the operating noise of wind turbines. Wind farms are also typically located in rural areas where ambient noise levels are low, however, and even a modest increase in noise levels can be a concern if residents are located near a wind farm. Modern wind turbines are relatively quiet under normal operating conditions and primarily produce broadband noise, which is considered less intrusive than impulsive, low-frequency or tonal noise (NWCC, 2002). Potential issues over operational noise from a project are typically addressed through detailed noise analysis and the application of setbacks in project siting and development.

Shadows created by wind turbines can be greatly elongated during times of the day and year when the sun is at a low angle. When such shadowing occurs with operating wind turbines, the result can be a strobing effect that is called shadow flicker. While shadow flicker is an intermittent occurrence of short duration, it can be annoying to people outdoors or in their homes. Shadow flicker would only occur within a certain distance of a wind turbine, and a setback distance of approximately 10 rotor diameters is likely to be sufficient to avoid impacts to potential receptors.

The cumulative world and national experience with wind energy has produced ample documented evidence that the environmental health hazards (or nuisance hazards, such as shadow flicker) associated with wind farms can be reasonably managed through careful site selection, project design and operation measures. Nevertheless, there has been sufficient public interest and concern in some siting cases to indicate that wind farm hazards can be perceived as a significant risk, and these risks can be important issues in the permitting of wind farms. Evaluation of the significance of these potential operation impacts would require a site-specific analysis of population and proximity factors for any individual wind farm proposal. Overall, it is expected that impacts would be low to moderate.

2.2.6.3 Mitigation

- Ensure adherence to all applicable occupational safety regulations and standards and project health and safety plans in construction and operation of wind farms.
- Apply measures to limit occupational EMF exposures.
- Establish safety zones and setbacks to prevent public exposure to potential safety hazards associated with wind farms, during both construction and operation.
- Plan and design the project to comply with FAA requirements for notification and marking of tall structures to ensure aviation safety.
- Limit noisy construction activities to daytime hours, if there are potential receptors nearby.
- Analyze and evaluate operating noise conditions during project planning and design to ensure satisfaction of applicable community noise standards.
- Consider implementing a noise complaint and investigation program for the project operation period.
- Locate project facilities to minimize exposure of receptors to shadow flicker.

2.2.7 Land Use

Land use impacts from wind energy development could include conversion of existing uses on the project site, conflicts with applicable land use plans and regulations, and conflicts with existing uses in adjacent or nearby areas. Wind project impacts on land use are highly dependent on the project location; most often, project sites are in farm or rural areas where issues of compatibility with adjacent uses are minor. In some cases, wind projects can bring in financial benefits that allow continued ranch or farm operation of the host properties and avoid conversion of land to other uses.

2.2.7.1 Construction Impacts

Development of a wind farm requires the temporary displacement of existing uses within the area of project construction, and the long-term conversion of some land to wind energy production. The amount of land used for a wind farm is primarily limited to turbine foundations and pads, access roads, substations and operations and maintenance facilities. The permanent footprint of these facilities typically represents a small portion of

the total project area. For example, the average utility-scale wind turbine takes up one-quarter acre of land (Fleishmann, 2006), while a mile of access road would likely occupy 3 to 4 acres. The project substation and transmission line connection can be located off site and require acquisition of land or easements outside the wind farm boundary. Displacement or loss of existing uses is typically compensated through lease agreements with participating landowners, and through purchase or easement agreements for off-site facilities.

In addition to displacement of existing uses, construction activities for wind farms can cause access disruptions for adjacent uses. In such cases, construction management plans would typically include provisions for alternate access or other means to minimize the disruptions. Based on the limited extent and intensity of wind farm construction impacts on land use, these impacts are likely to be low to moderate in any given project context.

2.2.7.2 Operation Impacts

In the Northwest, wind farms are typically located in rangeland, pasture or cropland that continues to be used for farming, with little ongoing impact to farm operations. If there are residential or recreational uses on nearby lands, wind farm operation could result in some proximity-related impacts associated with noise, potential project hazards and/or the physical and visual presence of the facilities. Specific issues of this type are addressed under the headings for Environmental Health (2.2.6) and Aesthetics and Recreation (2.2.8). With respect specifically to land use compatibility, approval of a wind farm would require a determination by state and/or local land use authorities that the new use would be consistent with local comprehensive plan (if applicable) and zoning designations for the project site. This evaluation would depend on the applicable conditions in a given jurisdiction, and cannot be predicted on a general basis.

Operation of a wind farm is not expected to change the underlying use of the host properties, and is generally considered to be a beneficial factor in maintaining the current use(s). Industry experience has also not indicated that the long-term presence of a wind farm is likely to promote changes of use on adjacent properties, although it may serve to inhibit conversion of nearby rural lands to developed uses. Consequently, the long-term impacts of a wind farm on land use are likely to be low to moderate. In cases where local residents have concerns over environmental health hazards and/or visual impacts, however, these concerns are likely to be represented as a significant issue of land use compatibility.

2.2.7.3 Mitigation

- Evaluate the project site before construction to make sure it conforms with local planning and zoning requirements and avoids compatibility issues with nearby uses.
- Locate any new transmission facilities parallel to existing rights-of-way and avoid bisecting existing land uses.

- Ensure that lease/easement terms and payments to land owners can compensate for any changes/modifications in land use.
- Develop construction management plans that avoid or minimize disruptions to adjacent existing uses.

2.2.8 Aesthetics and Recreation

It is generally recognized that the most important or prominent impacts of wind energy facilities can be aesthetic impacts (BLM, 2004). This is primarily because of the large size (over 300 feet in height) and high visibility of modern, utility-scale wind turbines. While project construction activities can produce landscape changes that are regarded as aesthetic impacts, the primary focus has been on the long-term presence of wind energy facilities during their operation period.

2.2.8.1 Construction Impacts

Construction activities for wind farm development create several possible sources of visual impacts. Clearing and grading to accommodate project facilities and construction of access roads usually create visual contrast that can be easily evident to viewers in the area. While this disturbance generally occupies a relatively small portion of the project area, it is nevertheless rather extensive because project areas for wind farms tend to be large. Transporting and installing turbine components involves large vehicles and cranes that can be visible from relatively long distances. These visual impacts would be temporary, although restoration of surface scars could require several years. The significance of aesthetic impacts during construction would depend primarily on the conditions near the site, particularly the numbers of exposed viewers and their sensitivity to landscape change. Impacts would be moderate.

Recreational uses near a wind farm site could be subject to visual impacts and noise during the construction period. Depending upon proximity and access relationships, it is also conceivable that travel routes to recreation sites could be disrupted by construction activities. These effects would be temporary, lasting no more than approximately one year, and would be intermittent during that period. Unless a wind farm site were near a heavily used recreation resource, construction impacts on recreation would likely be no worse than moderate.

2.2.8.2 Operation Impacts

Wind energy facilities tend to be visible from considerable distance because of the size of the wind turbines and because they are often situated on ridges or in wide-open spaces, where wind is more reliable. In addition to the size of the structures, specific aspects of wind farms that can be noticeable to viewers include safety lighting required by the Federal Aviation Administration (FAA) on tall structures, color contrast of turbines with their background, configuration and design of turbines, silhouetting on ridgelines, glare or glint from reflective surfaces, and the potential for shadowing effects at low sun angles.

The significance of the long-term visual impacts of wind farms varies by site and the degree of visual accessibility to the public. Assessment of visual impacts is highly subjective and opinions about the aesthetic character of wind turbines vary - some people view the appearance of turbines favorably, while others consider them to be visual blight. Accordingly, impacts could range from low to high.

In general, existing and proposed wind farms in the Northwest are not located in areas of high recreation use, but they may be visible from major highways or residential sites. Operation impacts of wind farms on recreation would primarily occur through exposure of recreationists to views of the wind energy facilities. Recreational uses located close to wind farms could also experience operational noise from the turbines.

2.2.8.3 Mitigation

- If possible, locate wind farms in areas with less viewer exposure and away from popular recreation areas.
- Integrate facility design and configuration into the surrounding landscape, such as providing visual order and unity in the turbine arrays; employing uniform size, shape and color in the turbine towers, nacelles and rotors; using nonreflective paints and coatings; burying power collection cables; and locating substations and operations buildings where they would not be “skylined” or evident from sensitive viewpoints.
- Minimize surface disturbance for roads, turbine pads and other features, particularly on steep slopes, and control erosion.
- If necessary and effective, provide vegetative screening to obstruct views of project facilities from surrounding sensitive areas.
- Keep project facilities clean and well-maintained throughout project operation, including prompt repair or replacement of inoperable turbines.
- Consider use of aesthetic offsets (mitigation of existing aesthetic impacts from other sources, such as reclamation of unneeded roads) to mitigate unavoidable visual impacts.

2.2.9 Cultural Resources

2.2.9.1 Construction Impacts

Wind energy development has the inherent potential for impacts to archaeological resources because it requires surface disturbance and subsurface excavation (NWCC, 2002). Historic sites and resources of traditional cultural value can also be located near wind farm sites. The occurrence and significance of construction impacts on cultural resources are highly dependent on facility location. Project sites are most often situated in farm or rural areas, where historical sites tend to be less numerous and where farming or other extractive activities may have already disturbed archaeological resources. If cultural resources are present within a wind farm project area, it is possible that disturbance of those sites could be avoided through careful location of turbines, roads and

other facilities. If cultural resources are present and construction impacts cannot be avoided, a resource inventory and mitigation program would be needed. Overall, impacts during construction could range from low to moderate.

2.2.9.2 Operation Impacts

Indirect operation impacts on cultural resources, primarily visual, could occur. Views of wind turbines or other facilities would be possible or likely from archaeological or historic sites remaining within a wind farm project area or in nearby areas, which could affect the setting and integrity of the site. Traditional cultural properties or historic landscapes can be quite expansive, and even distant views of wind energy facilities from such resources could be considered intrusive. Depending upon land use and access conditions, development of a wind farm could improve access to a local area and indirectly result in a greater human presence in the area, which could result in unauthorized collection of artifacts or vandalism (BLM, 2004). Overall, impacts could range from low to moderate.

2.2.9.3 Mitigation

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and Native American tribes with interests in the project area to determine the likelihood of any cultural resources within or near the project area, including the proposed route for transmission facilities.
- Conduct records searches and field surveys, if necessary, to identify and assess resources that may be present.
- Modify the project configuration, to the extent possible, to avoid cultural resources identified through the inventory process.
- If cultural resources are present in development areas and impacts cannot be avoided, develop and implement a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO and any affected tribes, develop an appropriate mitigation program, and negotiate next steps.

2.2.10 Economy

2.2.10.1 Construction Impacts

Economic impacts from construction of wind energy facilities are generally considered to be positive (NEA, 2003). There would be a relatively small, short-term increase in employment in the local area during construction, divided between local and non-local workers, and a corresponding increase in personal income. Local spending for construction materials and services would also be a beneficial impact associated with project development. Project development also involves employment in equipment fabrication and transportation that is diffused among a variety of locations.

2.2.10.2 Operation Impacts

A small permanent increase in employment and personal income would be associated with operation and maintenance of a wind energy facility. On-site operation and maintenance crews generally number less than approximately 20 workers, even for a large project. Because wind farms are typically located in rural areas with small local economies, the addition of even a small number of permanent jobs with good incomes is typically identified as a positive feature.

Wind energy facilities that are developed and owned by private entities (as opposed to public utilities) are taxed as real and/or personal property and contribute to the tax base of the local jurisdiction. Because wind farms are relatively capital intensive, this contribution can be quite substantial in a small, rural economy.

Wind energy developers typically lease the land on which the project facilities are built and provide annual lease payments to the landowners. Lease payments represent an ongoing stream of increased personal income for the local economy, and a substantial and diversified income source for the landowner. In some cases, the financial benefits of a wind project can allow continued ranch or farm operation on the host properties and avoid conversion of land to other income-producing uses.

2.2.10.3 Mitigation

Based on the nature of the potential economic impacts identified for wind farm construction and operation, no mitigation would be needed.

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3.0 Natural Gas/Combustion Turbines

3.1 General Description[1]

In recent decades, the economic, technical and environmental attributes of combined-cycle gas turbines has eclipsed traditional coal-fired steam-electric technology. Combustion turbines use jet engine technology to generate electricity. 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. The term Combined Heat and Power (CHP) is used to describe a process in which the waste heat from a turbine is captured and used for heating air or water, thus increasing the overall efficiency of the use of the natural gas. This is also referred to as co-generation.

3.1.1 Technology

Combustion turbines allow for flexible operation. They are highly dispatchable, meaning that 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. 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 base load service is anticipated.

Turbine equipment is available in sizes ranging from 1 MW to 225 MW, with larger units tending to have higher efficiencies. Due to economies of scale and the need for new transmission, combined-cycle combustion turbines tend to be large projects with multiple turbines (400 – 600 MW). Availability of combustion turbines is not always certain. During the energy crisis of 2000 – 2001, the ability to secure combined-cycle combustion turbines was limited. Manufacturers could not make them fast enough to meet demand. As the natural gas prices escalated and demand dropped, combustion turbines could be acquired for cents on the dollar.

The best sites provide access to natural gas pipelines at elevations near sea level, where combustion turbines produce more usable power. One of the Northwest's three interstate gas pipelines that transport natural gas from British Columbia (Northwest Pipeline) intersects City Light's Skagit generation project transmission line. Numerous turbines are located along this pipeline. The other two interstate gas pipelines transport

[1] A primary source for information was the U.S. Department of Energy's Energy Information Agency's (EIA) table of "Cost and Performance Characteristics of New Central Station Electricity Generating Technologies" from the Annual Energy Outlook, 2006.

gas from Alberta in Canada and from the Rocky Mountains, converge in northeastern Oregon, then proceed through Portland and south into California.

3.1.2 Fuel

3.1.2.1 Background

While the Northwest is not noted for having significant natural gas supplies, the region has good pipeline access to important western North America natural gas-producing areas. Natural gas prices are subject to significant volatility ranging from very low prices such as was seen in the early 1990s, to very high prices during the energy crisis of 2000 and 2001, and more recently as a result of the hurricanes in the gulf coast. Absent changes in the structure of natural gas marketing, this pattern of volatility is likely to continue. Natural gas prices have generally been increasing due to a decline in well productivity and loss of the Northwest's historic gas market advantage by expansion of pipeline transportation from Alberta to eastern markets. Efforts are underway to build terminals on the West Coast to obtain natural gas via imports of liquefied natural gas (LNG). LNG imports are expected to play an important role in determining marginal gas prices. Additional new sources of supply may come from the Alaskan North Slope and the McKenzie Delta, coal bed methane and tight sands, and U.S. and Canadian offshore fields.

The primary fuel used for combustion turbine generation is natural gas. Distillate fuel oil is typically used as a backup fuel in the event that natural gas supplies are disrupted. Gasified fuels, such as syngas derived from coal, may also be used in combustion turbines as described in Section 4.1.2 on Integrated Gasification Combined Cycle plants.

Natural gas-fired combined-cycle plants have been the bulk power generation resource of choice since the early 1990s due to long periods of low natural gas prices, reliable and efficient equipment, low capital costs, short lead-time, operating flexibility, and low air emissions. Sixty-four percent of the 6,840 megawatts of generation constructed in the Northwest since 1990 have been gas-fired combined-cycle capacity and these plants now comprise about 14 percent of regional capacity (NWPCC, 2005). While the current high price and volatility of natural gas has slowed the growth in building and operating combustion turbines for base load generation, new natural gas supplies are expected to make up shortfalls, reduce volatility, and set the marginal prices in the long term. In addition, the ability to site the resource near the load and have access to both the natural gas pipeline and transmission at locations where water is available and ambient air quality and elevation permit maximum efficiency will make natural gas a competitive long-term resource.

3.1.2.2 Fuel Supply

Conventional Drilling

Natural gas is located in underground geological formations across North America. It is extracted through wells and transported to generation facilities through underground pipelines that are hundreds or thousands of miles long. Conventional drilling and construction and maintenance of pipelines result in disruption to soils and geology, and possibly to surface and groundwater. Natural gas supply from conventional drilling is available from sources in the United States and by pipeline from Canada and Mexico.

Coal Bed Methane

Natural gas can be released from coal seams, and then remain trapped near the seam by a layer of water. This configuration is called coal seam methane. It is a technique that is not in wide use in the Western United States (USDOE, 2006a), but may become more common as natural gas supplies decrease, prices increase, and the interest in domestic supplies of natural gas increases. This process often involves removing large amounts of water containing trapped methane (natural gas) released by coal seams. Often the water contains salts and minerals. Disposing of the water can create environmental damage to soil and groundwater if it is released directly above ground. The groundwater system is affected by removal of the water.

Liquid Natural Gas

Natural gas can also be imported by ship from countries outside North America. The gas is cooled and pressurized into its liquid state for this type of transport because transporting natural gas in its gaseous form is impractical. The liquid gas can then be converted back into gaseous form when it reaches port and injected into a pipeline to a generating facility. Currently, this source of natural gas makes up only a small part of the supply, and only a few places in the United States receive liquid natural gas. However, in response to natural gas price increases and supply shortages, many facilities have been proposed, including several that could serve natural gas plants in the Northwest. The Federal Energy Regulatory Commission would regulate the port facilities. There is active debate about the safety and environmental impacts of these port facilities. The regulation of natural gas extraction in the source countries is unknown.

3.1.2.3 Mitigation for Impacts Due to Fuel Extraction and Transportation

The Federal Energy Regulatory Commission is responsible for reviewing natural gas pipeline construction, operation, and decommissioning. The review includes an environmental review under the National Environmental Policy Act and completion of an Environmental Impact Statement.

3.1.3 Simple Cycle Combustion Turbines (SCCT)

In the basic simple-cycle combustion turbine (SCCT) design, a rapidly spinning shaft and blade assembly are arranged within a close-fitting case. At one end of the SCCT, air is taken into the compressor, consisting of a series of multi-bladed fans, and 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.

Two principal types of SCCTs are 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 that 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 the aero-derivative type.

Simple-cycle combustion turbines are typically used for meeting system peaks and reserve requirements and for supporting the transmission grid. In a hydro-based utility, they can also be considered as back-up for hydroelectric generation in poor water years or operated during shoulder periods using non-firm gas, thus allowing the water to be conserved and used during peak periods. While the Northwest hydroelectric system currently has sufficient capability, there are limitations. SCCTs can be used in lieu of or to conserve the hydroelectric resource.

SCCTs typically have low to moderate capital costs, excellent operating flexibility and moderate electrical efficiency with modular construction, short construction time, compact size, low air emissions, and low water consumption. Fuel cost is generally not a major issue as the plant is used typically for peaking and emergencies. SCCT projects are typically easy to site and develop compared to most other types of generation. They are unobtrusive and require minimal water. Air emissions can be controlled to low levels.

3.1.4 Combined-Cycle Combustion Turbines (CCCT)

In a combined-cycle combustion turbine (CCCT), 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 CCCT units, provided adequate space is available to accommodate the additional equipment required. The addition of the steam cycle increases electric generation efficiency by about 40 percent.

A CCCT is a low capital cost, highly efficient generator of electricity. The largest component of the cost of a CCCT is the fuel. Currently, the uncertainty and volatility of the price of natural gas has made other resource alternatives (e.g., coal) look more attractive. Carbon caps or penalties for coal encourage use of natural gas.

3.1.5 Combined Heat and Power (CHP)

Combined heat and power (CHP) generation, or co-generation, is the joint production of electricity and thermal energy using one primary fuel. The thermal energy can be used for a variety of purposes, including steam production, space heat, hot water, drying, and cooling. CHP therefore improves the overall energy efficiency of the production process.

A variety of fuels can be used in CHP applications, but most use natural gas, biomass such as wood residues, spent pulping liquor, or biogas. CHP can rely on a variety of technologies as well, including combustion turbines, conventional boilers, reciprocating internal combustion engines, and fuel cells.

CHP development is undependable and generally of a small scale, and is therefore not evaluated in the portfolio analysis. However, if a CHP facility should become available, it would be considered. The most likely CHP resource available to City Light and evaluated here is a topping-cycle variety, which consists of a natural gas-fired combustion turbine with a heat recovery steam generator (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.

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

Because CHP or co-generation 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.

3.2 Environmental Impacts and Mitigation

3.2.1 Soils and Geology

3.2.1.1 <u>Construction Impacts</u>

Construction of the power plant and related facilities would result in disturbances to soils and geologic formations. Disturbances that occur due to construction staging would be temporary, but disturbances to soils due to the presence of roads, the plant, or related facilities, such as the pipeline, would be permanent. In addition, there would be a potential for release of hazardous fluids to ground water (fuel and hydraulic oils, etc.) dur-

ing construction. Typically, there would be a spill prevention control and countermeasure plan (SPCC) that would minimize impacts on ground water.

Plants typically require approximately 10- to 30-acre sites, including actual building and equipment footprints, access roads, and construction staging areas. SCCT and CCCT plants would typically be located on previously undeveloped land, which would result in the largest disturbance to soils and geology. If the plants are located on land that has already been disturbed, the incremental impacts would be less. CHP plants are generally located in an existing structure or within the footprint of an already-planned structure, therefore reducing the incremental construction impacts.

Soil would be disturbed and geological formations permanently altered by building pipelines. The longer the pipeline, the greater in magnitude the disturbances to soils and geology would be. Depending on the size and location of the plant and related structures, disturbances to soils and geologic formations would be low to moderate.

3.2.1.2 Operation Impacts

The extraction of natural gas would include activities such as drilling and operation of large equipment, which require the disturbance of soils and can lead to erosion of soils and permanent changes in geologic formations. The drilling activities themselves would also result in changes to geologic formations. The extent of the soil and geologic disturbances would depend on the size of the area over which the extraction-related activities would occur, and the depth of the drilling. To the extent that most drilling operations are of a certain size due to the high capital expense of equipment and other investments, disturbances to soils and geology are likely to be moderate.

When facility construction is complete, the operation of the plants and pipeline would not typically result in significant disturbances to soils and geologic formations. The use of vehicles and equipment during operation and maintenance activities would disturb soils at a low level, and waste generated as a result of plant operation would require disposal in a landfill. This disposal would represent a low to moderate soils and geology disturbance, depending on the plant location and capacity of the landfill used.

3.2.1.3 Mitigation

- Follow local grading regulations.
- Follow Federal regulations set forth in the Surface Mining Control and Reclamation Act (OSM, 2006).
- Use Best Management Practices (BMPs) will be employed, such as using straw, silt fences, and water detention ponds to reduce soil erosion and control storm water runoff. Implement a storm water pollution prevention plan (SWPPP).
- Obtain clearing and grading permits required by local jurisdictions for soil and vegetation disturbance. These permits could also contain requirements for BMPs.
- Implement a SPCC.

3.2.2 Air Quality

3.2.2.1 Construction Impacts

Construction of combustion turbine plants and related facilities such as gas pipelines would require equipment that emits CO_2. These emissions would contribute to the greenhouse effect. With industrialization and population growth, greenhouse gas emissions have significantly increased. Therefore, the insulation effect has significantly increased. Climate scientists generally agree that if CO_2 releases continue at a similar rate, global temperatures will continue to rise and the climate will change. Climate models predict an increase in violent weather, which can lead to decrease in populations of plant and animal species, as well as adverse impacts to human health. In the Northwest, likely results of global warming include disruption to normal hydrological cycles resulting in less snow pack and more flooding, therefore affecting hydropower generation, salmon survival, and water resources in general (SCL, 2006b).

Although these emissions would be temporary and one-time, they would last as long as the construction period, which can range from a few months to a few years depending on the size of the plant or the length of the gas pipeline. Air emissions impacts due to construction activities would be low.

3.2.2.2 Operation Impacts

Equipment used for extracting natural gas emits carbon dioxide (CO_2) and methane (CH_4). CO_2 and CH_4 are classified as greenhouse gases. Natural gas is primarily CH_4, which has a global warming potential 23 times greater than CO_2. CH_4 has a high potency, meaning that even small releases can result in large changes in air quality. Although estimates of the amount of CH_4 released during drilling vary, an estimate often used is one to four percent of the amount of CH_4 that is ultimately consumed in an end-use such as producing electricity (NREL, 2001). The magnitude of contribution to the amount of CO_2 and CH_4 in the atmosphere resulting from natural gas extraction would range from low to moderate, depending on the location and size of the activities. The larger the geographic extent of extraction activities, the higher the magnitude of the contribution would be.

Of the federally designated "criteria pollutants" including sulfur dioxide (SO_2), nitrogen oxides (NOx), particulates (PM), hydrocarbons, ozone, carbon monoxide (CO), and lead SO_2, NO_x, PM, and CO_2 are common emissions from combustion turbine plants. Table C-1 shows emission rates for combustion turbine plants.

Table C-1. Air Emissions per Unit of Electricity, by Generation Type (lbs/MWh[a])

Generation Type	SOx	Nox	Particulates	CO_2
CCCT	0.00432	0.216	0.00504	857
SCCT	0.00581	0.2906	0.00678	1,153
CHP [b]	0.0028	0.0144	0.00336	571

[a]Units are pounds per megawatt hour (lbs/MWh).
[b]CHP plants use combinations of the fuels listed in this table.
Source: SCL 2006a.

SCCT plants are less efficient compared to CCCT plants, and therefore need more fuel to produce the same amount of electricity as a CCCT. As a result, emissions rates for SCCT plants are higher. CHP is the most efficient use of natural gas, resulting in the lowest emission levels. Almost no sulfur exists in natural gas, so sulfur oxide (SO_x) emissions would be negligible in both CCCT and SCCT plant designs. CCCT NO_x emission rates are lower than for SCCT, but would vary with operating conditions. Control equipment and operational changes can be used to reduce NO_x emissions.

Table C-2 describes the impacts to air quality and public health that result from emissions due to combustion turbine energy production. Air quality impacts, including public health impacts due to changes in air quality and contributions to global warming, are of relatively greater concern in air basins where ambient concentrations of criteria pollutants exceed the federal Ambient Air Quality Standards (AAQS) (BPA, 1993). Areas where ambient concentrations are greater than the AAQS are referred to as non-attainment areas. The Puget Sound region is currently in attainment for all regulated pollutants. However, concern exists that attainment for particulates will be difficult to maintain with future regional growth and transportation changes. Air quality impacts can be high, although some impacts may be mitigated.

3.2.2.3 Mitigation

- Perform new Source Review (Air Operating Permit, Prevention of Significant Deterioration) and obtain necessary permits.
- Compliance with the Clean Air Act (CAA), National Ambient Air Quality Standards, and the Clean Air Interstate Rule will be achieved for NOx and SOx. CAA regulations are often implemented by state air agencies, to which authority has been delegated by the US EPA. Agencies such as the Puget Sound Clean Air Agency translate the CAA regulations into specific permit requirements and emission standards for power plants.
- Compliance with the CAA will be achieved for particulates.
- Washington state energy facility siting standards will be met for greenhouse gases.

Table C-2. Description of Impacts Due to Emissions of Criteria Pollutants During Operation

Pollutant	Description of Impact
SOx	Breathing oxides of sulfur (SOx) irritates the lungs, which can lead to coughing, lung damage, and difficulty breathing in animals and humans. SOx also combines with precipitation to form an acid solution, causing damage to plants and acidifying water bodies, resulting in damage to aquatic life.
NOx	Breathing oxides of nitrogen (NOx) irritates the lungs, which can lead to coughing, lung damage, and difficulty breathing in animals and humans. NOx combines with precipitation to form an acid solution, causing damage to plants and acidifying water bodies, resulting in damage to aquatic life. NOx also combines with airborne chemicals to form ground level ozone (smog) which causes breathing difficulty and impairs visibility.
Particulate Matter (PM)	Particulate matter (PM_{10}) is small particles, less than 10 micrometers in diameter, which are emitted by combustion energy sources. $PM_{2.5}$ (particles smaller than 2.5 micrometers in diameter) is considered to be especially damaging to the lung and heart functions because it can be breathed in and lodged deep in the lungs. Particulate matter can result in breathing difficulty, bronchitis, asthma, damage to heart and lung functions, reduced visibility.
CO_2	CO_2 is a greenhouse gas. Industrialization and population growth has increased the contributions of greenhouse gas emissions into the atmosphere. If CO_2 releases continue at a similar rate, global temperatures will continue to rise and violent weather could increase as a result, leading to harmful health effects upon humans, animals, and plants. In the northwest, likely results of global warming include disruption to normal hydrological cycles resulting in less snow pack and more flooding, therefore affecting hydropower generation, salmon survival, and water resources (SCL 2006).
Source: SCL 2006a.	

- Meet requirements for Best Available Control Technology (BACT). Any new plant is required to install air pollution control equipment that is commercially available and economically feasible. The technologies that are considered to be BACT change as technology changes and through federal legislation and agency rulemaking.
- Do not exceed National Ambient Air Quality Standards (NAAQS) for any pollutant. Before a new plant can receive an operating permit from the local air quality agency, it must do computer modeling to show that the NAAQS will not be ex-

ceeded. Plants will also monitor emissions during operation to show they remain in compliance.

- Meet the Acid Rain Reduction program (SOx trading program) regulations will be met.

3.2.3 Surface and Groundwater

3.2.3.1 Construction Impacts

Construction of the plant and related facilities would result in the use of water to control dust and to clean and cool equipment. These impacts would be greater in magnitude with a longer construction period and a larger construction footprint. Typically, these types of impacts can be mitigated and would be low.

3.2.3.2 Operation Impacts

The extraction of natural gas could result in depletion or contamination of surface and ground water sources because underground geological formations are tapped for gas by drilling. Drilling equipment requires water for cleaning and cooling, and could also contaminate surface water resources if fuel or chemicals leak from the equipment.[2]

Both cable tool drilling, which involves raising and dropping a heavy metal bit into the ground to drill shallow, low pressure formations, and rotary drilling, which involves using a sharp, rotating metal drill bit for deeper wells under higher pressure, require water (NGO, 2006). Cable tool drilling requires using water in the well hole to combine with all of the drill cuttings. Water is required for rotary drilling as a component of liquid drilling fluid used in the circulating system, the purpose of which is to cool and lubricate the drill bit, control well pressure, remove debris and cuttings, and coat the walls of the well with a mud-type cake. Directional or horizontal drilling can be employed in order to leave a surface water body intact while reaching a source for natural gas underneath that water body.

The coal seam methane technique, discussed in Section 3.1.2.2, often involves removing large amounts of water containing trapped methane (natural gas) that is released from coal seams. Often the water contains salts and minerals. Disposing of the water can damage groundwater bodies if not re-injected. The removal of the water would represent low to moderate impacts upon the groundwater system.

The likelihood and magnitude of potential depletion or contamination of surface and ground water resources are highly dependent on the location and size of the drilling activity and the presence of surface or ground water sources at the drilling site. These impacts can range from low to moderate and are typically mitigated.

[2] Underground, in reservoirs that contain oil and gas, the gas is the least dense and is therefore found closest to the surface, with the oil beneath it and water typically beneath the oil. (http://www.naturalgas.org/overview/background.asp).

Combustion turbine plants typically (1) use water for process and cooling, and (2) generate wastewater. SCCT plants do not require cooling. Ground or surface water sources are needed for supplying both the water used as a carrier of combustion energy to a turbine for conversion into electricity, and for cooling the plant. If the wastewater, which is usually at a higher temperature than when withdrawn from its source, is discharged into surface or groundwater bodies, the chemical and thermal pollution is transferred to those water bodies. Changing the flow rate of water can change water quality, including turbidity and temperature. Potential effects include dewatering sections of rivers and forming new surface water bodies. The magnitude and extent of impacts would vary widely with the location and size of the plant, the cooling technique employed, the source of the water, and the wastewater disposal technique and location.

Table C-3 shows water required for combustion turbine energy plants. The once-through cooling technique requires more water than re-circulation. Re-circulating the water reduces the amount of water withdrawn from a surface or ground source; however, because more water is lost to evaporation, less water is returned to the source, compared to once-through cooling. Also, more chemicals such as chlorine and biocides are used in re-circulation systems and need disposal when they leave the cooling system. Dry cooling uses very little water, but is not common in existing plants (EF/HF, 2006), because it causes a loss of energy output and does not perform as well as water cooling in extreme temperatures.

Impacts to surface and groundwater resources due to operation of combustion turbine plants would range from low to moderate and are typically mitigated.

Table C-3. Water Use for Combustion Turbines (gallons/MWh)

Plant and Cooling Type	NWPCC 5th Plan (Withdrawal)	California Energy Commission (2005)
CCCT (once-through)	7,500 - 20,000	250
CCCT (re-circulate)	~230	
CCCT (dry)	~40	
SCCT (probably once)		500
CHP	[a]	[a]
[a]CHP plants use combinations of the other types listed in this table. Source: SCL 2006a.		

3.2.3.3 Mitigation

- Re-use cooling water, use dry cooling, or use recycled or reclaimed wastewater to reduce the amount of water required. Wastewater can be treated in many ways, and might be used for industrial or irrigation purposes, depending on location (OEFSC, 2006).
- Comply with the Clean Water Act.

- Comply with the National Pollutant Discharge Elimination System (NPDES) permit program.
- Use treated wastewater for cooling, where available and appropriate for the type of technology in use.
- Use water sources with high quality that would not be compromised by use for power plant cooling, where available and appropriate for the type of technology.

3.2.4 Plants and Animals

3.2.4.1 Construction Impacts

If present, vegetation and wildlife habitat would be removed or disturbed at the plant site and along the path of the pipelines during construction. Habitat includes areas used for nesting, feeding, and migration. Air emissions due to equipment used at the construction sties could contribute to degraded water quality. Both air and water impacts could adversely affect plants and wildlife health. Noises associated with construction could disturb wildlife habitat.

The magnitude, extent, and likelihood of the impacts would depend on the locations and length of the pipeline routes and location of plant site. Impacts would be lower if the plant was built in an area that is already developed. Overall, impact may be moderate.

3.2.4.2 Operation Impacts

If present, vegetation and wildlife habitat could be removed or disturbed at the drilling site. Air emissions due to equipment used at the extraction site could contribute to degraded water quality. Both air and water impacts could adversely affect wildlife health. Noises associated with drilling at the extraction site could disturb wildlife habitat and habits. The magnitude, extent, and likelihood of the impacts would depend on the location of the extraction site and the surrounding plant and animal activity and types of species. Extraction typically occurs in non-urban areas, suggesting that impacts upon plants and animals would be relatively higher when compared to a plant site in a suburban or urban area. Impacts would typically be low to moderate.

Operation may have impacts on plants and animals, as it creates waste, noise, and air emissions; uses water; and requires the continued clearance of vegetation from the site. Impacts to plants and animals due to plant operation would be low.

3.2.4.3 Mitigation

- Comply with Endangered Species Act.
- Employ Best Available Science (BAS).

3.2.5 Energy and Natural Resources

3.2.5.1 Construction Impacts

Equipment including cranes, trucks, and tools used for construction of the plant and the pipeline consume energy during construction activities. Also, energy is required for their manufacture and transport to the construction sites. The types of fuel consumed during construction activities include diesel, gasoline, and electricity. Energy use during non-working hours would include security lighting. Diesel and gasoline would be used for transporting materials (e.g., sand and gravel, steel parts) and the workforce to the sites. This type of energy use would be temporary and would represent a low impact on total energy resources.

3.2.5.2 Operation Impacts

Equipment including cranes, drills, trucks, and tools used for extraction of natural gas not only consume energy during extraction activities, but also for their manufacture and transport to the drilling site. The types of fuel consumed during extraction activities include diesel, gasoline, and electricity. Energy would not be consumed due to the transportation of the natural gas in the pipeline to the plant, with the exception of energy consumed related to pipeline maintenance activities.

Natural gas is the primary fuel used for combustion turbine plants, and is a non-renewable fuel. Approximately 40 percent of electricity in the Northwest is generated by fossil fuels, under average conditions (NWPP, 2006). 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, wind power, and geothermal energy) would result in less depletion of fossil fuel resources.

Natural gas is estimated to be available to the Northwest region. The existing reserves in the western U.S. and Canada would be sufficient to meet the forecast demand in the region for the next 20 years. Fuel oil for backup generation is also widely available and is easily transported to generating facilities in the Northwest region. However, supply and costs of these fuels have been volatile in the past, and it is difficult to forecast precisely what the supply situation will be in the future.

The amount of natural gas used to produce a unit of electricity is highest with a SCCT (9,688 mmBtu/MWh); the heat rate for a CCCT is 7,200 mmBtu/MWh. Differences in efficiency and fuel use are based on how much of the heat in the natural gas stream is captured for producing more electricity or other useful energy, such as steam or space and water heating. Increase in demand for natural gas over the next 20 years will increase pressure to produce natural gas from domestic sources and to increase imports, particularly LNG. Overall, impact would be expected to be high.

3.2.5.3 Mitigation

- Comply with regulations concerning energy use. Some states have Renewable Portfolio Standards requiring that electric utilities supply a percentage of energy from renewable sources.

3.2.6 Environmental Health

3.2.6.1 Construction Impacts

Construction-related activities can result in increased noise levels due primarily to the use of heavy equipment. Noise generated during construction activities could lead to adverse impacts upon the health of the workers. Workers' health could also be impacted by handling materials that require solid or hazardous waste disposal, such as diesel fuel, gasoline, lubricants, cleaning solvents, paint, used oil, spent antifreeze, unused adhesives, chemicals, batteries, empty containers, scrap wood and metal, and trash. With mitigating measures in place, these impacts would likely be low.

3.2.6.2 Operation Impacts

Noise generated during extraction could lead to adverse impacts on the health of the workers. Workers' health could also be impacted by handling materials that require solid or hazardous waste disposal, such as diesel fuel, gasoline, lubricants, cleaning solvents, paint, used oil, spent antifreeze, unused adhesives, chemicals, batteries, empty containers, scrap wood and metal, and trash. With mitigating measures in place, these impacts would be low.

Combustion turbine plant operation can produce increased noise levels due to equipment and gas venting through the stacks. With mitigation, noise impacts due to operation would be low to moderate, depending in part on the proximity of sensitive noise receptors.

3.2.6.3 Mitigation

- Comply with state and local noise regulations.
- Restrict construction activities to normal daytime hours.
- Manage solid and hazardous wastes produced during extraction and construction in accordance with applicable federal, state, and local laws and regulations.
- Transfer wastes to appropriate facilities for recycling, treatment, processing, or disposal.
- Insulate buildings that house turbines and generators.
- Install and use noise control devices in the stacks.
- Restrict nighttime operation if sensitive land uses are nearby.
- Separate enclosures for major noise sources such as turbines, pumps, and generators.
- Locate stations away from sensitive areas.

3.2.7 Land Use

3.2.7.1 Construction Impacts

Construction periods can last a few months to a few years, but are temporary. Although plants are generally located away from population centers, some are located near or in urban areas, particularly CHP plants. Air emissions, noise, and vehicle traffic can increase and cause proximity impacts to nearby properties during construction. These impacts can be low to moderate, depending on the mitigating measures employed, the length of the construction period, and the types of neighboring lands uses. Facility development would result in the displacement of existing land uses on the site.

3.2.7.2 Operation Impacts

Typical land uses in areas of gas extraction include rural residential, rural industrial, recreational, mining, forestry, and other resource-related commercial activity. These activities tend to be low in density and confined to certain contained spaces.

If a new plant is located in an urban industrial area, or a plant is an addition to or an expansion of an existing plant, land uses impacts would be low because the plant would be consistent with existing land uses and consistent with current zoning. CHP plants are often built next to or as part of existing plants. Facilities, including plants and pipelines, built on raw or greenfield sites (as is typical with SCCT and CCCT plants) would result in the largest incremental impact because the proposed use would be different from the existing use.

Local zoning regulations would apply to any new facility to ensure consistency with current standards. Although plants are generally located away from population centers, some are located near or in urban areas, particularly CHP plants. Air emissions, noise, and vehicle traffic to and from the plant can increase and cause disturbances to nearby properties. These impacts can be low to moderate, depending on the mitigation measures employed and the location of the site among land use types. Vehicle traffic and noise during operation is typically lower than during construction.

3.2.7.3 Mitigation

- Locate facilities where land use displacement and compatibility impacts would be minimized.
- Compliance with zoning and land use regulations, which are generally set at the local level.

3.2.8 Aesthetics and Recreation

3.2.8.1 Construction Impacts

Construction is not typically viewed as an aesthetically pleasing activity, and could decrease view quality temporarily. These impacts would typically be no more than moderate because of their temporary nature.

3.2.8.2 Operation Impacts

Extraction activities would likely occur in rural areas away from population centers. However, some activities could be visible from transportation corridors, resulting in an adverse impact to views of natural areas from the highway. Extraction activities and the presence of pipelines could also affect views from wilderness areas and recreational hiking trails. The extraction sites are often considered to be unattractive due to the disturbance to soils, heavy machinery, and potential for noise and dust. Extraction locations are typically contained, even though they may still be visible from afar. Pipelines in Washington are generally buried or close to the ground and would have a low impact on views in rural, forested areas.

Wilderness areas are sensitive to any development, including development related to the production and transmission of electrical power. These areas are also sensitive to airborne pollutants that may originate from combustion turbine plants. For example, the aesthetic visibility in some wilderness areas (e.g., Mount Rainier) could be adversely affected by airborne oxides of nitrogen. Also, the deposition in alpine lakes of nitrates and sulfates from rainfall could have adverse effects on fisheries, which can affect recreation activities.

In general, power plants are industrial buildings and not considered to be aesthetically pleasing. These facilities are generally closed to the public and do not create any recreational opportunities and could, depending on location, restrict recreational activities or be visible from recreational areas. These impacts would likely be low to moderate.

3.2.8.3 Mitigation

- Comply with zoning and land use regulations, which are generally set at the local level.

3.2.9 Cultural Resources

3.2.9.1 Construction Impacts

Depending on location, construction of a plant or pipeline on a raw or undisturbed site could result in harm to cultural resources. Cultural resources are non-renewable artifacts or evidence of human occupation or activity and could take the form of a district, site, building, structure, artifact, ruin, object, work of art, architecture, or natural feature. A review or survey of recorded cultural sites and items is typically performed prior to construction activities. CHP plants are more likely to be located in existing or planned structures; therefore, the likelihood that cultural resources would be encountered during construction is less when compared to SCCT and CCCT plants. If cultural

resources are expected to be encountered, coordination with traditional groups with interests in the area would be conducted as well as monitoring during extraction to ensure care is taken if cultural resources are uncovered. Impacts would be low to moderate, depending on the location and extent of construction activities.

3.2.9.2 Operation Impacts

Cultural or historic resources could be encountered during extraction activities. A review or survey of recorded cultural sites and items is typically performed prior to extraction activities. If cultural resources are expected to be encountered, coordination with traditional groups with interests in the area would be conducted as well as monitoring during extraction to ensure care is taken if cultural resources are uncovered. Impacts could be low to moderate, depending on the location and extent of the extraction activities.

Operation of the combustion turbine plants would not affect cultural resources.

3.2.9.3 Mitigation

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and Native American tribes with interests in the project area to determine the likelihood of any cultural resources within or near the project area, including the proposed route for transmission facilities.
- Conduct records searches and field surveys, if necessary, to identify and assess resources that may be present.
- Modify the project configuration, to the extent possible, to avoid cultural resources identified through the inventory process.
- If cultural resources are present in development areas and impacts cannot be avoided, develop and implement a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO and any affected tribes, develop an appropriate mitigation program, and negotiate next steps.

3.2.10 Economy

3.2.10.1 Construction Impacts

Economic impacts due to construction are generally viewed as beneficial. Additional jobs, related labor income, and spending would be associated with construction of each type of combustion turbine plant, at levels typically dependent on the size (MW) of the plant. Owners of projects usually attempt to procure non-specialty materials and supplies locally where possible, although specialty equipment and natural gas would be purchased non-locally. To the extent materials are purchased and workers are hired locally, local communities benefit economically. Secondary spending, jobs, and related

labor income would also occur due to workers' household spending and spending by suppliers.

Construction workforce sizes can range from under 100 workers for a small peaking plant located adjacent to an existing plant, to a few thousand workers at peak construction times for a large CCCT plant with a short construction period. Average construction workforce estimates are not typically greater than several hundred workers. Economic benefits associated with construction would be moderate and temporary.

3.2.10.2 Operation Impacts

Typically, economic impacts of extraction activities are beneficial because they increase economic activity. Extraction activities would result in the creation of direct spending, employment, and labor income, representing economic benefits to the areas where materials and supplies are purchased, and areas from where workers are hired. As a result, secondary spending, jobs, and related labor income would also occur due to workers' household spending and spending by suppliers. Economic benefits related to extraction would last approximately as long as extraction activities.

Operation would require far fewer employees when compared to construction, although these employees would have permanent jobs, as opposed to temporary jobs. Operation could require no additional employees if the plant is an addition to an existing plant. The number of operation employees typically ranges from two to 30, and is completely dependent on the size and magnitude of the operation. These new, relatively high-paying jobs, would create new labor income, which would accompany the annual spending by the owners of the plant to support maintenance and demand for supplies. To the extent employees are hired locally, the local area would benefit. Secondary spending, jobs, and related labor income would occur due to employees' household spending and spending by suppliers. Economic benefits associated with operation would be permanent although at a low level.

The number of permanent jobs is highest for a CCCT and the lowest for a CHP plant because CHP plants are generally smaller in size.

3.2.10.3 Mitigation

No mitigating measures are usually required. Note than social and environmental justice impacts are sometimes paired with economic impacts. The Energy Facility Site Evaluation Council (EFSEC) does not currently require an analysis of environmental justice, but may in the future, which could require mitigation.

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4.0 Coal

4.1 General Description[3]

Coal is the most abundant fuel source found in the United States for generating electricity and provides the majority of electric power in this country. Coal is the second largest component of Washington's power supply (Washington Department of Community Trade and Economic Development, 2005. Two types of coal resources are considered in this EIS: conventional pulverized coal and integrated gasification combined cycle (IGCC).

The abundance of low cost[4], low sulfur coal found in Montana, Wyoming and western Canada could support the electrical needs of the Pacific Northwest for the next 20 years (Northwest Power and Conservation Council, 2005). Production costs are low enough to permit coal to be shipped by rail or barged to power plants near load centers. Alternatively, transmission lines can move the electricity from plants located near the coal mine to the load centers. A typical Powder River basin sub-bituminous coal from Montana or Wyoming, the most likely source for new coal development, has a moderate heat value (8,750 Btu/lb) and low sulfur (0.4 percent) content.

The largest uncertainties for coal are the potential for carbon emissions restrictions and the associated costs, and the absence of available transmission facilities. With no improvement in coal-fired power generation technology, carbon dioxide penalties would likely depress demand and prices. If advanced technologies for separating carbon for sequestration become available, domestic and overseas demand and prices are likely to remain stable or increase.

4.1.1 Pulverized Coal

Pulverized coal technology is a proven technology that has enjoyed declining costs due to continued plant performance improvements, automation and reliability improvements, equipment cost reduction, shortened construction schedule, and increased market competition[5].

In a conventional steam-cycle coal plant, coal is washed, ground, and blown into a large furnace where it is burned. The heat from the coal combustion changes water in a boiler under high pressure to high-temperature steam. The steam is used to operate a

[3] A primary source for information was the U.S. Department of Energy's Energy Information Agency's (EIA) table of "Cost and Performance Characteristics of New Central Station Electricity Generating Technologies" from the Annual Energy Outlook, 2006. The EIA provides basic information about plant characteristics at the national level, including plant capacity, heat rates, capital costs, variable costs, and fixed costs. This information was augmented with cost data from Task Force Reports provided to the Western Governor's Association, discussions with industry experts, and review of the Northwest Power and Conservation Council and utility resource plans.

[4] Coal prices have declined in response to productivity improvements in mining and transportation and stagnant demand.

[5] U.S. Department of Energy. *Market-based Advanced Coal Power Systems*. March 1999.

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.

Environmental control has become increasingly important and new units are typically equipped with low-NOx burners, sulfur dioxide removal equipment, filters for particulate removal and closed-cycle cooling systems. Selective catalytic reduction of NOx and CO emissions is becoming increasingly common and post-combustion mercury control is expected to be required in the future.

Most North American coal steam-electric plants operate at sub-critical steam conditions. Super-critical steam cycles operate at higher temperature and pressure conditions at which the liquid and gas phases of water are indistinguishable. This results in higher thermal efficiency with corresponding reductions in fuel cost, carbon dioxide production, air emissions, and water consumption. Super-critical units are widely used in Europe and Japan and it is likely that future pulverized coal steam power plants will use super-critical steam cycles. Use of super-critical technology would add a cost penalty of 2 percent and a heat rate improvement of 5 percent (World Bank, 1998).

Conventional coal plants have well-tested, reliable designs. They are generally designed as large, centralized units sized from 250 MW up to 700 MW that are co-located with similar units to achieve economies of design, infrastructure, construction, and operation. In the west, coal-fired plants have generally been sited near a mine, although some plants are supplied with coal by rail at intermediate locations between a mine and load centers.

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.

Conventional coal plants are capital intensive but operation costs are low given current coal price projections. Steam cycle coal plants are typically operated as baseload generators although they can be engineered to follow the load. The thermal inertia of getting boilers, turbines, and condensers up to operating temperature inhibits quick response to variations in load. 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.

4.1.2 Integrated Gasification[6] Combined Cycle (IGCC)

IGCC uses gasified coal to power a combined-cycle combustion turbine (see Section 3.0 on combustion turbine technology). IGCC technology combines the high efficiencies of combined-cycle combustion turbines with the relatively low cost and abundant supply of coal. It has a high degree of modularity and better emissions control than conventional pulverized coal technology. While coal gasification is an old technology, coal gasification power plants are in the demonstration stage of development. The existing IGCC generation is typically fueled by petroleum residuals (coke). Several issues need to be resolved before there is widespread use of coal-fueled IGCC including capital cost reduction and consistent plant reliability. Coal gasification technology offers the potential for low-cost mercury removal, superior control of air emissions, optional separation of carbon for sequestration, and optional co-production of hydrogen, liquid fuels or other petrochemicals. The low air emissions of coal gasification plants might open siting opportunities nearer load centers.

Coal gasification thermally decomposes solid coal into a high-quality gas fuel called synthetic gas. Either air or oxygen can be used to partially oxidize the coal, producing low- or medium-Btu synthetic gas, respectively. 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.

An integrated gasification combined-cycle plant typically consists of:

1. coal preparation area that prepares the coal for feeding into the gasifier;
2. air separation plant that produces oxygen to increase the energy content and reduce the volume of synthetic gas;
3. a gasifier that mixes the coal and oxidant at high temperature and produces hot, raw, synthetic gas, and non-combustible coal that is crushed for disposal or marketable aggregate;
4. a gas cooling system where the gas is scrubbed, cooled, and filtered to remove particulate material; sulfur compounds are removed using regenerative sorbants then converted to marketable elemental sulfur; mercury can be captured by passing it through activated carbon beds;
5. water gas shift reactors where the synthetic gas is passed through to separate CO_2[7] or hydrogen-based co-products; and
6. the clean gas that is then supplied to the combined-cycle combustion turbine for electricity generation.

[6] Integration refers to the extraction of pressurized air from the gas turbine compressor for use as feedstock to the air separation plant, and use of the energy released in the gasification process for power generation to improve net plant efficiency.

[7] Separation of up to 90 percent of the carbon dioxide content of the synthesis gas appears to be feasible using available technologies. The carbon dioxide could then be compressed to its high-density supercritical phase for transport to sequestration sites (Northwest Power and Conservation Council, 2005).

IGCC plants are quite efficient relative to conventional steam-cycle plants. Heat rates typically are near 9,000 Btu/kWh compared to about 9,500 Btu/kWh for a conventional steam-cycle plant.

4.2 Environmental Impacts and Mitigation

The use of coal as a fuel for electricity production has a number of adverse environmental impacts. These impacts occur during fuel extraction from coal mining, construction of mining and power plant facilities, operation of the mine and power plant facilities, and disposal of waste materials from coal mining and combustion processes.

The impacts of traditional pulverized coal plants and Integrated Gasification Combined Cycle (IGCC) plants are similar, with the exception of air emission impacts. IGCC emissions in all categories are lower than for pulverized coal.

It has been assumed that coal supply will be from mines in the western United States. In the West, most coal mining is from surface mines rather than underground mines. Only one active coal mine in Washington is used to provide fuel for coal plants; it is located near the city of Centralia. It is likely that coal would have to be transported by railcar from a remote location in the west to supplement any coal that might be available in Washington. Some of the impacts of fuel extraction can be mitigated through reclamation after the mines are closed, but others, particularly near water resources during operations, cannot be mitigated.

With respect to waste disposal, fly ash from pulverized coal can be used in concrete as substitute for cement, which would avoid landfill costs. This also results in less raw cement production, thereby reducing the use of raw materials and energy, and lowering the production of greenhouse gas. The amount of waste material that can be sold depends on the market and availability of transportation.

The experience with waste disposal at IGCC facilities is limited, since there are only two operating plants in the U.S. One of the plants has been able to find uses for waste coal material remaining after the gasification process. It processes the waste to separate material that can be used as fuel and sent back to combustion; the remaining material is sold. It is likely that other IGCC plants would adopt a similar approach (Wicker, 2005).

4.2.1 Soils and Geology

4.2.1.1 Construction Impacts

Construction would involve extensive land-disturbing activities such as clearing and grading to build access roads, construction pads for the power generation and cooling facilities, coal storage and processing areas, and ash and sludge disposal areas. As noted previously, a 500-MW unit would encompass an area of 600 to 700 acres. These activities result in surface and sub-surface disturbance that can expose soils to erosion by wind and water. Heavy equipment operation causes compaction of native soils. If

geologic hazards are present within the project area, those hazards could be activated by the construction disturbance. Project construction also requires consumption of geologic materials such as sand and gravel for use in concrete, road surfaces and bases, and as backfill. In addition, there would be a potential for release of hazardous fluids to ground water (fuel and hydraulic oils, etc.) during construction. Typically, there would be a spill prevention control and countermeasure plan (SPCC) that would minimize impacts on ground water.

Construction impacts on geology and soils can be minimized by careful planning and design, and through development and implementation of a surface water pollution prevention plan (SWPPP), which will in turn require a variety of best management practices (BMPs) to minimize erosion and control runoff and sedimentation (NWCC, 2002). Planning and design measures to reduce impacts include locating project facilities to avoid geologic hazards and erosion-prone areas, conducting site-specific evaluations of geotechnical conditions, and designing project facilities to meet the conditions encountered. In addition, construction impacts would be lessened if the facility is located on already developed land. Even with implementation of appropriate mitigation, impacts are expected to be moderate to high because of the extensive area that would be disturbed.

4.2.1.2 Operation Impacts

Operation impacts could occur as a result of mining coal, operation of the generating facility itself, and from waste disposal. Mining coal permanently alters landscapes and potentially contributes to soil erosion, which could adversely affect soil productivity, watersheds, and ultimately vegetation and wildlife. Specifically, large amounts of soil are moved to recover coal buried up to several hundred feet below the surface. Annually, 0.25 acre per aMW would be consumed for mining of coal. The surface contours are permanently altered, and soil is moved around the site over decades as the mine is operated. Soils are eroded, compacted, and potentially contaminated with heavy metals and mercury from the coal. Some impacts are likely to be permanent, as rock blasting, soil compaction, and erosion cannot be undone. Mitigation is required through a Reclamation Plan, which outlines how the soil is to be distributed after the mine closes to return the topography as close to its pre-mining condition as possible.

If the fly ash that results from coal combustion is used, for example, as a substitute for cement in concrete or as a road building material, the incremental impacts would be low. If the ash has to be disposed of in a landfill, the impacts would be greater, since a large amount of ash is produced. Ash could affect the soil environment through contamination; the type of contamination depends upon on the chemical composition of the coal fuel and disposal methods. Leaching could occur if disposed of in landfills or ponds. Proper pond lining can prevent leaching. Overall, impacts would be moderate to high.

4.2.1.3 Mitigation

- Minimize the extent of ground disturbance required, such as by using existing roads to the extent possible. Locate new access roads to follow the local topography, and minimize sidehill cuts.
- Cover and stabilize exposed areas consistent with applicable standards, salvage removed topsoils and reclaim disturbed areas as soon as possible.
- Identify and avoid unstable slopes and other geologic hazards, and avoid creating excessive slopes during construction; use special construction techniques where applicable.
- Develop and implement a temporary stormwater management system to control runoff, erosion, and sedimentation during construction.
- Implement a SPCC.

4.2.2 Air Quality

4.2.2.1 Construction Impacts

The extensive construction activities at a coal-fired plant will produce equipment exhaust and fugitive dust. Construction equipment, vehicles transporting construction materials and facility components to the site, and construction workers' vehicles would all produce exhaust emissions. Air pollutants in these emissions can include CO, NO_x, VOCs, SO_2, particulates, and air toxics. Emissions from these sources would be short-term, would likely be low, and are not likely to cause significant air quality impacts or have a measurable effect on ambient air quality near a site.

Exposed surfaces can generate fugitive dust. To the extent that exposed soils are not wetted or otherwise stabilized, they could generate windblown dust and cause dust deposition in the surrounding area. Fugitive dust deposition is generally not considered to be a health issue; however, excess dust deposition is considered a nuisance as it can increase the soiling of surfaces. Fugitive dust resulting from construction of a coal-fired energy project is not anticipated to produce any measurable effect on the overall ambient air quality in the area surrounding a site.

4.2.2.2 Operation Impacts

The principal pollutant emissions of concern for a coal-fired plant, which are produced by mining, processing, transporting, and burning the coal, are NO_x, SO_2, CH_4, CO_2, particulates, and mercury. The issues associated with these pollutants are summarized below:

NO_x and SO_x - Oxides of nitrogen and sulfur impact air quality both directly and indirectly. The direct effect of breathing them is irritation of the lungs, which can lead to coughing, lung damage, and difficulty breathing in both animals and humans. Indirectly, NO_x and SO_x combine with precipitation to form an acid solution, causing damage to plants and acidifying water bodies, resulting in damage to aquatic life. NO_x also com-

bines with other chemicals in the air to form ground level ozone (smog), which causes breathing difficulty and impairs visibility. NO_x emissions from a coal plant would be an estimated 0.15 lbs per million Btu, which is about five times the rate for natural gas. SO_x emission rates are higher for pulverized coal (0.154 to 0.242 lbs/mm Btu) than for IGCC (0.077 to 0.121 lbs/mmBtu).

CO_2, CH_4 (Greenhouse Gases) - There is widespread agreement among climate scientists worldwide that human activity is increasing the greenhouse gases in the earth's atmosphere and accelerating global warming. Heat trapping of "greenhouse gases" in the Earth's atmosphere -- primarily water vapor (H_2O), carbon dioxide (CO_2), and methane (CH_4) -- serve as a "blanket" for keeping the Earth's climate habitable. With industrialization and population growth, greenhouse gas emissions from human activities (like the burning of coal) have significantly increased. As CO_2 and other greenhouse gases increase in the atmosphere, so does their insulating effect, causing the Earth to get warmer. $C0_2$ is a major byproduct of burning coal; it is not a regulated pollutant but is a major factor in global climate change.

Climate scientists generally agree that with continued release of CO_2 into the atmosphere, global temperatures will continue to rise and climate will change. In addition to a gradual increase in temperature, climate models predict an increase in violent weather - severe storms, floods, and drought - with potentially devastating impacts on plant and animal populations, and adverse effects on human health. Burning of coal produces CO_2 and contributes to the greenhouse effect.

The University of Washington's Climate Impacts Group has reported on possible impacts to the Northwest region. The most likely scenario would be disruption to normal hydrological cycles resulting in less snowpack and more flooding -- affecting hydropower generation, salmon survival, and water resources in general.

Greenhouse gas emission rates from coal plants are the highest of all generation sources (208 lbs of CO_2 per million Btu for coal compared to 117 lbs/mmBtu for natural gas). The rate for IGCC is lower than for pulverized coal plants, due to the higher efficiency in IGCC technology. There has been considerable discussion of the potential to capture carbon dioxide in the gasification process of an IGCC and sequester it in underground geological formations, thus avoiding releasing it into the atmosphere. It is technically possible, but there are several technical and economic hurdles to large-scale commercial development of this technology. One issue is the cost, and another is the availability of geological storage sites for carbon dioxide close enough to the plants. There is also the question of whether the carbon dioxide would be permanently stored in the formations or might leak out. For the purposes of the IRP analysis, the IGCC plant was modeled as being ready for carbon capture and sequestration, but not actually implementing the technology in the planning timeframe.

Some methane (CH_4) can be released when mining for coal, both as it is released from the coal itself and through the release of methane that is trapped around the coal underground. Methane has a global warming potential 23 times as high as carbon diox-

ide. Abandoned coal mines also continue to produce methane gas after the coal mining ceases. Mine reclamation plans often require some monitoring and flaring of this methane.

Particulates - These are small particles, less than 10 micrometers in diameter (PM_{10}), which are often emitted by combustion energy sources. A subcategory of these particles, those smaller than 2.5 micrometers in diameter ($PM_{2.5}$), is considered to be especially damaging to the lung and heart functions because they can be breathed in and lodged deep in the lungs. Particulates can result in breathing difficulty, bronchitis, asthma, and damage to heart and lung functions. Particulates also reduce visibility, which can be a safety concern in some situations, as well as an aesthetic problem.

Mercury – Mercury is a very hazardous heavy metal that is gasified in the combustion process of coal. It has been identified as a significant hazard to brain development in babies, both before birth and during infancy and childhood. Mercury emissions from coal plants vary dramatically with the type of coal and its source. It is estimated that emission rates using pulverized coal would range from 4.6 to 5.74 lbs/mmBtu while IGCC use would result in substantially lower emissions (0.23 to 0.287 lbs/mmBtu). Washing coal before combustion can remove 37 percent of the mercury. This mercury then must be disposed of along with the water. Some mercury is captured in control equipment designed for capturing SOx and particulates. The amount of mercury that these controls capture varies widely among coal types and plants, from very little to almost 90 percent.

Emissions of pollutants would need to be controlled through a variety of techniques. Even with mitigation, impacts would likely be high for pulverized coal and moderate to high for IGCC.

4.2.2.3 Mitigation

- Wet exposed soils during construction to reduce fugitive dust emissions.
- Use low sulfur coal.
- Implement flue gas scrubbing, electrostatic precipitators, and baghouses.
- Use Best Available Control Technology/lowest achievable emission rate (BACT/LAER) techniques.

4.2.3 Surface and Groundwater

4.2.3.1 Construction Impacts

A relatively large surface area would be disturbed for construction of a coal-fired plant. Construction of plant facilities and access roads can alter surface and groundwater flow patterns, cause discharges to existing water sources, and consume water during the construction process. Surface disturbance of the project area can alter the surface drainage patterns and create areas of impervious surfaces, which would lead to greater levels of runoff. If uncontrolled, runoff can produce temporary increases in soil erosion,

resulting in elevated turbidity in runoff water and sedimentation in stream channels. However, the construction process would include implementation of a temporary on-site stormwater management system to control site drainage and minimize temporary impacts to water quality. Therefore, impacts on water quality and drainage conditions during construction would likely be low.

Construction would consume water for several activities, including dust suppression, vehicle washdown, and potable water supply for the construction crew. No measurable effect on the availability of local water supplies would be expected.

4.2.3.2 Operation Impacts

Water consumption at both the plant site and at the mine could affect surface and groundwater quantity/supplies, and wastewater discharges from plant operations could affect water quality. Likewise, runoff from the coal mine could lead to degraded water quality. Water is required in pulverized coal plants to create steam to run the turbines that generate electricity. In IGCC plants, much less water is needed, but still an amount equivalent to what is needed for a CCCT. Water is also needed as a medium to absorb waste heat and for facilitating ash disposal. The estimated water usage could run as high as 20,000 to 50,000 gallons/MWh for a conventional coal-fired plant, while an IGCC plant would require about 300 to 800 gallons/MWh.

The Energy Foundation/Hewlett Foundation provides a description of some of the water quality issues at a coal-fired plant:

"During the process of electricity generation, impurities build up in the boiler. To maintain quality, the water is periodically purged from the boiler and replaced with clean water. Purged water, termed boiler blowdown (not to be confused with cooling water blowdown), is usually alkaline and contains both the chemical additives used to control scale and corrosion, as well as trace amounts of copper, iron and nickel that leach from boiler parts. Other sources of water discharged from the plant include metal and boiler cleaning wastes (such as iron, copper, nickel, zinc, chromium and magnesium). Water from non-cooling sources is discharged through either a public wastewater treatment facility or the plant's onsite wastewater treatment facility. At the plant site as a whole, there are even more sources of water discharge including: coal pile runoff that forms when water comes into contact with coal storage piles (usually acidic and can contain high concentrations of copper, zinc, magnesium, aluminum, chloride, iron, sodium and sulfate); area storm sewers and leachate collection systems; and pyrite transport water generated from coal cleaning (containing suspended solids, sulfate, and metals found in coal). A small amount of water is often also withdrawn and discharged to support operation of air emissions controls. The combustion waste stream, a mixture of fly ash, bottom ash, boiler slag and sludge from emissions control devices, typically is drenched with water and placed in ponds where the solids settle out, and water is discharged into receiving waters. These wastes can contain high concentrations of arsenic, cadmium, chromium, lead, selenium, sulfates and boron."

Mining coal also can have adverse impacts on surface and ground water sources. These water sources can be disturbed by the movement of soils and removal of large amounts of coal, as well as from the chemicals that are washed away from the exposed coal piles by precipitation. Coal usually has to be washed to remove dirt and impurities, and this water must be extracted from a surface or groundwater source, and then is itself contaminated with this dirt and impurities, which often include heavy metals. Treatment and disposal of this water is a risk to water quality.

Overall, because of the extensive water requirements for both mining and plant operations, and the risks of adversely affecting water quality from the many waste discharge streams, potential impacts are expected to be high.

4.2.3.3 Mitigation

- Use a recirculating system for cooling to reduce water requirements.
- Use treated wastewater where available.
- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.
- Characterize the surface and groundwater hydrology prior to construction, develop an understanding of discharge and recharge relationships, and avoid creating new hydrologic connections through grading and related activities.
- Monitor water quantity and quality conditions if construction activity is to occur near aquifer recharge areas.
- Implement BMPs for use, handling, and storage of fuels, pesticides and other hazardous materials during both construction and operation.
- Dispose of ash at approved sites.

4.2.4 Plants and Animals

4.2.4.1 Construction Impacts

Direct effects during construction commonly include removal of vegetation and the habitat it provides for wildlife, and mortality or injury to animal species that inhabit the site at the time of construction. A pulverized coal-fired plant can occupy a site of up to 700 acres for the plant itself and fuel storage. Construction requires clearing of existing vegetation around areas to be occupied by roads, boiler and generator, fuel storage, substations and other project facilities. This area represents a permanent loss of vegetation and habitat on a previously undeveloped site. Mobile wildlife or aquatic species present on a project site are likely to be displaced during construction, while those that are less mobile can be killed or injured because of construction activity within the area of disturbance.

Indirect effects can stem from a number of disturbance mechanisms that can interfere with normal animal behaviors or introduce adverse changes to their habitat. Remaining vegetation and habitat quality for wildlife can be diminished indirectly through dust generated by construction, erosion and runoff, and increased opportunities for invasive

species. Similarly, aquatic habitat can be degraded by runoff, dust and exposure to contaminants through spills. Noise, the presence of humans and vehicles, and similar aspects of construction activity can modify the behavior of wildlife remaining on the site and in adjacent areas. Overall, impacts would likely be moderate to high depending upon site location and the quality and sensitivity of habitat.

4.2.4.2 Operation Impacts

In general, there would be no impacts at the plant site during operation because additional disturbance would not occur. However, animals, particularly waterfowl, could come into contact with water stored in onsite ponds containing water contaminated with chemicals and metals from coal and treatment chemicals from the power plant. Also, impacts will occur at the mine site as areas are cleared of vegetation and animals are displaced. Overall, impacts would likely be moderate to high depending upon location and quality of habitat.

4.2.4.3 Mitigation

- Conduct adequate surveys of plant and animal resources.
- Avoid siting facilities in areas that support unique or sensitive plants or wildlife habitat.
- Where possible, use existing roads and disturbed areas for project development, and minimize the area disturbed for project construction.
- Design necessary stream crossings to minimize disturbance and maintain aquatic habitat conditions.
- Develop and implement a restoration plan to restore disturbed plant and animal habitat.
- Purchase or reserve areas to replace habitat values lost through project development.
- Implement measures to minimize establishment of invasive species.
- Landscape site buffer areas with native plant species.
- Establish a monitoring program to assess impacts on the area's plants and animal species.

4.2.5 Energy and Natural Resources

4.2.5.1 Construction Impacts

Moderate quantities of energy and natural resources would be consumed during construction of plant facilities; impacts would be moderate.

4.2.5.2 Operation Impacts

Coal is not a renewable resource. It is produced in a process that takes millions of years, and its extraction and combustion for electricity takes only a tiny fraction of that time. A large coal-fired plant would contribute to the depletion of this resource. Energy

and natural resources would be consumed in transporting coal and in other aspects of plant operation. Overall, impacts would be moderate to high due to the consumption of a non-renewable resource.

4.2.5.3 Mitigation

No mitigation would be required.

4.2.6 Environmental Health

4.2.6.1 Construction Impacts

Environmental health concerns of a coal-fired plant primarily relate to occupational safety for workers involved in facility construction. Adherence to occupational health and safety regulations, in addition to health and safety plans used by contractors, would reduce the level of such impacts.

Construction of the facilities would produce noise that is audible beyond the boundaries of the construction site. Noise sources would include heavy equipment operation, construction of the structures and ancillary facilities, and truck traffic. Because of their short-term duration, construction activities are typically exempt from noise regulations established in state and local regulatory standards, though they are usually confined to normal daytime hours. Impacts could be low to moderate.

4.2.6.2 Operation Impacts

The facility would be large with many sources of noise. Principal noise-producing sources would be operation of the boiler and generator, transport and handling of coal, and emissions controls. Depending upon site location, noise could be incompatible with surrounding land uses. The facility can likely be planned and laid out so that noise levels at the site boundary do not exceed permissible levels of local noise codes.

There would also be substantial noise generated during mining operations. Since mining would likely occur in a rural, unpopulated area, noise impacts for mining would be low to moderate. Overall, noise impacts would likely be moderate to high.

4.2.6.3 Mitigation

- Restrict construction activities to daylight hours.
- Lay out plant facilities so that noise standards are not exceeded at the site boundary.

4.2.7 Land Use

4.2.7.1 Construction Impacts

Development of a coal-fired facility would require long-term displacement and conversion of the existing uses within the plant site and a large area for coal production. A plant site would require up to 700 acres (about 1.33 acres per MW for pulverized coal and 0.75 acres per MW for IGCC). Potential impacts would be highly dependent on the project location, and would vary considerably from site to site. It is plausible that sites could be in either developed industrial areas (low impact) or rural areas (greater impact). Transmission lines would cause additional land use impacts. Overall, impacts would likely range from moderate to high.

4.2.7.2 Operation Impacts

Operation of a coal-fired facility could result in some proximity-related impacts associated with noise, traffic, and the physical presence of the facilities, which would vary with site location. Also, there may be compatibility impacts associated with surrounding land uses due the large size of the facility. Impacts would likely be moderate to high.

Coal mining would result in permanent changes to the use and landscape of the mine site. The mine would likely be open-pit and would represent a major contrast with existing and surrounding land uses. The mine would require approximately 0.25 acre per aMW year. Impacts could range from moderate to high.

4.2.7.3 Mitigation

- Locate the plant site to minimize land use impacts.
- Evaluate the project site before construction to make sure it conforms with local planning and zoning requirements and avoids compatibility issues with nearby uses.
- Locate any new transmission facilities parallel to existing rights-of-way and avoid bisecting existing land uses.
- Develop construction management plans that avoid or minimize disruptions to adjacent existing uses.

4.2.8 Aesthetics and Recreation

4.2.8.1 Construction Impacts

There would be substantial changes in visual quality of the setting during construction attributable to the construction activities themselves and the new plant and facilities. The effect of these changes would depend upon the sensitivity of the setting and the proximity and number of viewers. It is assumed that the plant facilities can be located to avoid recreation areas and conflicts with recreationists. Overall, impacts would likely be moderate.

4.2.8.2 Operation Impacts

Potential impacts from operation would be similar to those experienced during construction, although over a longer time frame. The significance of such impacts would again be dependent on the quality of the setting and the number and type of exposed viewers and their sensitivity to landscape change. Coal-fired plants and their associated structures, including cooling towers and steam plumes, would provide a stark visual contrast in most cases with the existing setting. As industrial facilities, they have a distinctive visual impact that is difficult to mitigate. There is some flexibility in location, so the facilities could be built at sites with less visual impact. Siting would be limited by proximity to labor force, rail service, transmission infrastructure, water supply, and roads.

Surface coal mines create a considerable visual contrast with the surrounding area of the mine site. Vegetation and soil are disturbed over large areas for decades as the mine is operated. If required, transportation of coal to a remote plant is by railcar, and railroads and railcar traffic also have visual impacts. The impacts on recreation would vary by location of the mine and railway route. The impacts and mitigation options are similar to those available for other resource options, though there is limited flexibility in locating a mine, since it would be situated wherever the coal is located. Overall, impacts would likely be high during operation when mining is considered.

4.2.8.3 Mitigation

- If possible, provide vegetative or landscape screening to obstruct views of the facility and mine site from surrounding areas.
- When possible, locate facilities in areas with less viewer exposure and away from popular recreation areas.
- Integrate design and configuration of structures into the surrounding landscape.

4.2.9 Cultural Resources

4.2.9.1 Construction Impacts

Known cultural resource sites would be avoided in locating a plant site. However, resources could be discovered or disturbed during construction activities. The level of impact would depend upon the importance of the resource and the degree of disturbance. It is assumed that if resources are discovered, mitigation would be implemented to recover information represented by the cultural resource. Impacts are expected to be low to moderate.

4.2.9.2 Operation Impacts

The large area used for surface mines increases the likelihood that cultural or historic resources could be disturbed; impacts could be high. There would be no impacts associated with the plant site during operation.

4.2.9.3 Mitigation

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and Native American tribes with interests in the project area to determine the likelihood of any cultural resources within or near the project area, including the proposed route for transmission facilities.
- Conduct records searches and field surveys, if necessary, to identify and assess resources that may be present.
- Modify the project configuration, to the extent possible, to avoid cultural resources identified through the inventory process.
- If cultural resources are present in development areas and impacts cannot be avoided, develop and implement a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO and any affected tribes, develop an appropriate mitigation program, and negotiate next steps.

4.2.10 Economy

4.2.10.1 Construction Impacts

There would be substantial beneficial impacts during construction. A 500-MW coal-fired plant would require approximately 2,350 full-time equivalent workers over a multi-year period. In addition to the employment gains, the local economy would benefit from spending by workers as well as by the facility for materials, equipment, and supplies.

4.2.10.2 Operation Impacts

Beneficial impacts during operation would be smaller but longer term. Permanent employment for plant operations, mining, processing of fuel, and transporting coal would provide high-paying jobs for an estimated 600 workers. Overall impacts would be beneficial

4.2.10.3 Mitigation

No mitigation would be needed.

4.3 References

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5.0 Transmission

5.1 General Description

New or upgraded transmission facilities may be required to transmit the electricity from new generation facilities to the SCL service area or to deliver it to the existing regional transmission grid. Also, new transmission facilities may be needed to improve reliability, redundancy, or otherwise increase the capacity of the system in a manner that could reduce or defer the need for new generation facilities. Actual transmission requirements cannot be determined until specific information on the size, location, and operating characteristics of proposed new resources is known. In general, resources farther from load centers and from existing transmission lines would require more transmission facility construction than would resources close to load centers and existing transmission lines. Table C-4 shows general transmission line requirements for the various resource types.

Transmission facility construction could include building new or upgrading existing transmission lines or substations. The transmission lines themselves (i.e., the conductors) would move electricity from the generating source to the demand centers. They would be suspended on either lattice steel towers or wood or steel single-pole structures; designs vary, but often towers are a hundred feet or more in height. Transmission lines would require access roads for construction and maintenance. New substation facilities would house transformers, breakers, and other electrical equipment.

The area around transmission lines would need to be kept clear of vegetation to prevent damage to the lines, for example from trees falling into them during storms. Vegetation is cleared during construction of the lines to allow towers and access roads to be built. A clearance distance between any objects, including vegetation, and the lines is set by national electrical standards, and varies with the voltage and design of the transmission system. Ongoing vegetation management is required throughout the life of the transmission line. Vegetation management can be done through physical removal or with herbicides, and often a combination of both techniques is employed

Transmission lines would pass through a variety of jurisdictions and over many types of landscapes to reach areas where the electricity is used. In the Pacific Northwest, over 75 percent of the existing transmission system is owned and operated by the Bonneville Power Administration, and permitting and construction authority would likely fall to BPA. Other possible permitting and approval authorities include federal land management agencies from which a right-of-way permit might be needed, and/or state and local land use jurisdictions. (In Washington, the Energy Facility Siting Council is the transmission siting authority.) In addition, the Federal Energy Regulatory Commission (FERC) may have authority over permitting and construction of transmission lines for projects that are "National Interest Transmission Corridors" and where state jurisdictions do not issue permits. The appropriate environmental review process would be followed depending upon the federal or state agency with jurisdiction over the transmission facility project.

Table C-4. Approximate Transmission Facility Requirements

Resource Type	Miles of New Transmis-sion Lines Needed[a]	Upgrade of Existing Transmission
Conservation	None	None
SCL Owned Hydropower	0	Uses existing transmission
Contracts/Exchanges	0	Uses existing transmission
Natural Gas – Combined Cycle and Simple Cycle (W WA)	50	
CHP (Combined Heat and Power)	None	None
IGCC Coal (W WA)	50	0
Pulverized Coal (Mon-tana)	950	0
Wind (Northwest)	200	0
Wind (Montana)	950	0
Biomass, Wood (W WA)	Assumes some upgrades to BPA or SCL transmission may be necessary but because the generating capacity would be small, the upgrades would be relatively minor.	
Biogas, Landfill Gas (W WA)	Assumes some upgrades to BPA or SCL transmission may be necessary but because the generating capacity would be small, the upgrades would be relatively minor.	
Geothermal (ID, OR, W WA)	W WA – could use SCL's existing transmission or may require some upgrades to BPA, but would be minor in nature. OR - Assumes some upgrades to BPA may be necessary but because the amount is small, the upgrades would be relatively minor and would generally use SCL's existing capacity on 3rd AC or from John Day. ID – assumes exchange with BPA to Mid-C but some mi-nor upgrades may be necessary from Mid-C across Cas-cades North to Seattle.	

[a] **Miles from the point where the resource interconnects to the grid to Seattle.**

5.2 Environmental Impacts and Mitigation

5.2.1 Soils and Geology

5.2.1.1 Construction Impacts

Direct impacts on soils could result from clearing of vegetation from rights-of-ways and substation sites, grading of tower and substation sites and access roads, drilling of footings for transmission structures, and compaction of soils by heavy equipment. Clearing and grading strips vegetation and the uppermost, most biologically active portion of the soil. Loss of plants and soil disrupts biological functions and reduces productivity at least temporarily, and could lead to soil erosion. Compaction degrades soil structure, which reduces moisture retention, gas exchange and, thus, respiration and other metabolic functions of soil organisms. The extent of construction impacts at any one site would depend upon the quality of soils, the amount of moisture in the soils, the amount of surface water flowing across the site, the steepness of slopes and, for new structures, the type of structure erected. In general, locations west of the Cascades and areas with steeper slopes have greater potential for adverse impact. Overall, construction impacts are expected to be low to moderate.

5.2.1.2 Operation Impacts

Maintenance of transmission facilities would require incidental repairs to access roads and management of vegetation, which could cause localized soil disturbance. In most instances, operation and maintenance would have a low direct impact on soils because the affected areas would be small, confined to the area of a particular maintenance action, and dispersed in time and along the length of a corridor.

5.2.1.3 Mitigation

- Implement planning and design measures to avoid areas of sensitive soils and geologic hazards.
- Conduct site-specific evaluations of geotechnical conditions, and design project facilities to meet the conditions encountered.
- Locate structures as far as possible from streams and wetlands.
- Space and size culverts, cross-drains, and water bars to adequately handle runoff.
- Develop a surface pollution prevention plan (SWPPP) and Best Management Practices (BMPs) to avoid soil erosion and control runoff and sedimentation.
- Schedule construction during the dry season to the extent possible when stream flow, rainfall, and runoff are low, to minimize erosion, sedimentation, and soil compaction,
- Use mechanical barriers to reduce erosion in areas that are disturbed.
- Retain vegetative buffers where possible to prevent sediment from reaching streams.
- Revegetate disturbed areas with native seed.

5.2.2 Air Quality

5.2.2.1 Construction Impacts

Construction activities could increase dust and particulate levels on a temporary basis in a localized area. Operation of heavy equipment and vehicles during construction would result in increased emissions of pollutants such as carbon monoxide, carbon dioxide, sulfur oxides, particulates, oxides of nitrogen, and volatile organic hydrocarbons. These activities would be short term and localized. Greenhouse gas emissions may also result from: equipment using fossil fuel; the removal of vegetation that would otherwise sequester carbon; and from electrical equipment used in substations, such as breakers, that may contain SF6 gas as an insulator. SF6 gas is very potent, with a global warming potential 23,900 times that of carbon dioxide. In properly functioning equipment, this gas is not released. New equipment contains much less SF6 than older models, and is it designed to avoid and contain leaks. Proper maintenance and monitoring can prevent and detect leaks, minimizing greenhouse gas emissions

Altogether, construction activities would be expected to have a low impact on air quality.

5.2.2.2 Operation Impacts

Transmission lines would emit limited amounts of ozone and nitrogen oxides as a result of the corona effect. However, these substances would be released in quantities generally too small to be measured or to have any adverse effect on humans, animals, or plants. In addition, there would be vehicle emissions during maintenance activities. Impacts on air quality during operation and maintenance would be expected to be low.

5.2.2.3 Mitigation

- Use water trucks to control dust during construction.
- Maintain vehicles and equipment in good operating condition to minimize exhaust emissions.

5.2.3 Surface and Groundwater

5.2.3.1 Construction Impacts

Direct surface water impacts would most likely occur in association with erosion and increased runoff from construction activities where structures or access roads are near water bodies or wetlands. Culvert installation and replacement for access roads could disturb bank soils and shoreline vegetation. Where roads are improved adjacent to stream channels, direct deposition of soil into the stream channel could increase turbidity and sedimentation. Vegetation removal and soil disturbance can increase water erosion rates, resulting in sediment deposition directly into stream channels and increased turbidity. Erosion rates would likely return to existing levels once vegetation is reestablished, and turbidity and sedimentation impacts on water resources would be reduced.

Impacts would depend on the timing of construction, weather conditions, local topography, the erosion potential of soils, and the effectiveness of BMPs implemented during construction to minimize soil erosion. In addition, there would be a potential for release of hazardous fluids to ground water (fuel and hydraulic oils, etc.) during construction. Typically, there would be a spill prevention control and countermeasure plan (SPCC) that would minimize impacts on ground water. The probability of oil and fuel spills and, therefore, impacts on water resources, would be low. Overall, surface water impacts during construction are expected to be low to moderate depending upon location.

Direct impacts on groundwater from construction of transmission facilities are expected to be low. Groundwater quality could be affected by compaction, which would reduce infiltration capacity and increase surface water runoff to streams. Any impacts would be localized and short term.

5.2.3.2 Operation Impacts

Maintenance activities such as grading access roads, replacing failed culverts, and controlling vegetation could increase erosion and surface water turbidity, and reduce shade causing increased water temperatures if widespread. Use of herbicides for vegetation management could also cause impacts if herbicides reach streams due to overspray or transport of herbicide residues. Overall effects on surface water are expected to be low to moderate. There would be an ongoing potential for release of hazardous fluids to ground water during maintenance activities that would necessitate an operational SPCC. Soil compaction and reduced infiltration from maintenance activities would also occur. Altogether, impacts on groundwater are expected to be low.

5.2.3.3 Mitigation

- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.
- Retain vegetative buffers where possible.
- Conduct construction activities during the dry season as much as possible.
- Locate roads and structures to avoid wetlands.
- Develop a Spill Prevention Control and Countermeasure (SPCC) Plan to minimize the potential for spills of hazardous material.

5.2.4 Plants and Animals

5.2.4.1 Construction Impacts

Construction of transmission facilities would likely result in clearing and crushing of vegetation and damage to plant roots from soil compaction within the transmission line right-of-way, access roads, and at structure and substation sites. The level of impact would depend on the quality of vegetation and soils, site topography, and the type of stream crossing (bridges or culverts). Indirect impacts could occur as a result of nox-

ious weeds colonizing disturbed areas. Overall, impacts on vegetation would be low to moderate.

As noted in Section 5.2.3.1, increased turbidity and sedimentation could occur, which could lead to fish mortality during spawning and incubation periods. It could also affect fish by abrasion, clogging of gills, decreased feeding success due to reduced visibility, degradation of spawning gravels, increased egg and fry mortality, and reduced fry growth rates. Where transmission facilities are constructed near streams, impacts could reach a moderate level.

Depending upon the type of vegetation that is cleared and the species using the area, wildlife could experience low to moderate impacts as a result of losses in habitat; such losses are likely to be small compared to habitat in surrounding areas. Increased noise during the breeding season could result in moderate impacts on wildlife if the noise reduces the foraging effectiveness of adults or causes adults to abandon nest sites. Overall impacts on wildlife are expected to be moderate to high.

5.2.4.2 Operation Impacts

Maintenance of transmission line corridors would require vegetation management activities including periodic trimming, cutting, or clearing of trees and shrubs to allow access to transmission facilities, and removal of danger trees. Impacts on vegetation are expected to be low, while impacts on fish may be low to moderate depending on the type of activity and proximity to streams. Animals, particularly birds, can interact with transmission lines. Many bird species use transmission lines as perches, and some bird species, including large birds of prey, use transmission towers as nesting sites. Some level of bird mortality would be expected as a result of collisions with conductors and structures. Migratory waterfowl have the highest incidence of mortality from collisions with transmission lines, particularly near wetlands, feeding areas, or open water. Perching on the lines presents little risk of electrocution for small birds. However, for larger birds whose wings and nests can span the transmission lines, there is the potential for electrocution. Small climbing mammals can also contact electrical lines and be electrocuted. Developing access into areas where habitat is currently difficult to access can increase human intrusion (e.g., hunting and fishing) and adversely affect fish and wildlife. Impacts on birds and other wildlife are expected to be low.

5.2.4.3 Mitigation

- Limit disturbance when working near water bodies.
- Limit clearing of vegetation to that necessary to prevent interference with transmission lines or to create access roads.
- Develop a vegetation management plan and revegetate disturbed areas with native seed.
- Minimize the use of herbicides and use those that have the least impact to the surrounding environment.
- Avoid areas with high quality habitat and or sensitive species.

- Ensure that there is adequate separation between conductors and places that birds would perch in order to avoid electrocution.

5.2.5 Energy and Natural Resources

5.2.5.1 Construction Impacts

Energy and resources would be consumed in the manufacture and installation of transmission facilities; impacts would likely be low to moderate.

5.2.5.2 Operation Impacts

Transmission systems do, in a sense, consume energy. Some of the electricity that is transported over the lines is lost to resistive heating of the conducting materials and in the transformers. These losses vary with the voltage of the transmission system, whether the system is operated with direct or alternating current, the amount of electricity transmitted over the lines at any given time, and the ambient temperature. Generally, it is assumed that 4 percent to 8 percent of the electricity originally put into the transmission system at a generation site is lost by the time the electricity is received at the location of end use. Impacts would be low to moderate.

5.2.5.3 Mitigation

No mitigation would be needed.

5.2.6 Environmental Health

5.2.6.1 Construction Impacts

Environmental health concerns during construction are principally related to occupation safety. Clearing rights-of-way, erecting structures, and stringing conductors all pose potential safety hazards. Helicopters are sometimes used to string conductors. There would also be a risk of fire. Occupational health and safety regulations apply to these hazards, as do health and safety plans used by contractors.

Construction activities (clearing, blasting, grading, erecting towers, stringing conductors, etc.) would produce noise that is audible beyond the boundaries of the construction site and that can be adverse. Because of their temporary duration, construction activities are typically exempt from community noise levels established in state and local regulatory standards, although they are usually confined to normal daytime hours.

Overall, impacts from an environmental health perspective could be low to high.

5.2.6.2 Operation Impacts

Serious or even fatal electric shocks could occur if an individual came in contact with a conductor. However, the National Electric Safety Code specifies minimum allowable distances between conductors and the ground or other objects. Thus, the probably of electric shocks is low.

5.2.6.2.1 Electric and Magnetic Fields - Background

Power lines, appliances, and wiring – and anything else that generates, transmits or uses electricity – all produce electric and magnetic fields (EMF). Electric and magnetic fields are properties of the space near their electrical source and describe the forces that would be experienced by an object that is capable of interacting with these fields. *Electric fields* are the result of voltages applied to electrical conductors and equipment, and *magnetic fields* are produced by the flow of electric currents. The strength of both electric and magnetic fields decreases as you get farther away from the source of the field.

Since electricity is being used nearly on a constant basis, EMF can be found in nearly all locations people spend time – homes, workplaces, cars, the supermarket, etc. A person's average exposure depends upon the sources they encounter, how close they are to them, and the amount of time they spend there. In most homes, background magnetic field levels average about 1 milligauss (mG), resulting from wiring within the home, electrical appliances, and power lines outside the home (Zaffanella, 1993). Since the intensity of magnetic fields diminishes quickly with distance from the source, distance from a power line reduces the effect on the magnetic field level within the home. In fact, the strongest sources of magnetic fields that are encountered indoors are electrical appliances.

Questions have been raised as to whether exposure to electric or magnetic fields causes adverse health effects. Hundreds of studies have been conducted over the past 30 years to address this question. These studies have looked for relationships between EMF exposures in our homes and workplaces and cancer or other adverse health outcomes. Some of the epidemiology[8] studies have reported associations[9] between EMF exposure and adverse health outcomes, while others have not. Most of the attention has focused on the possible association between childhood leukemia and magnetic field exposure, because of some early epidemiology studies that suggested a possible association.

[8] Epidemiology is the study of the frequency and distribution of disease and health in human populations, and the factors that contribute to disease and health events.

[9] Epidemiology studies estimate associations, which are quantitative measures of how often an exposure and a disease occur together. If a study reports a statistical association between an exposure and a disease, it means that the disease and the exposure occur together more often than one would expect just as a result of chance. A statistical association between an exposure and a disease does not mean that the exposure causes the disease.

The following sections address how scientists have evaluated this body of research, the conclusions they have drawn, and whether any standards or guidelines exist to limit our exposure to EMF.

5.2.6.2.1.2 Scientific Process for Evaluating Risk

The scientific process entails looking at *all* the evidence on a particular issue in a systematic and thorough manner. Each study is evaluated to determine its strengths and weakness, and then the entire body of research is evaluated together, giving more weight to studies of higher quality. This process is referred to as a weight of evidence review and it generally includes three sources of information*:* epidemiology studies in humans, experimental studies in animals (*in vivo*), and experimental studies in isolated cells and tissues (*in vitro*). The overall pattern of results from epidemiology and experimental studies needs to be considered together. In epidemiology studies, researchers observe people going about their ordinary life without having control over people's exposures. On the other hand, scientists tightly control all aspects of animal studies and, therefore, have greater certainty about the potential effects of exposure.

Numerous multidisciplinary international and national scientific agencies have assembled scientific panels to conduct weight-of-evidence reviews of the research literature on EMF and possible adverse health effects. These scientific panels include the National Radiological Protection Board of Great Britain (NRPB, 2002), International Commission for Non-Ionizing Radiation Protection (ICNIRP, 2003), International Agency for Research on Cancer (IARC, 2002), and National Institute for Environmental Health Sciences (NIEHS, 1998). It is important to look to these agencies for conclusions, since they have the expertise required to make decisions about health and they rely on balanced, objective scientific methods.

5.2.6.2.1.3 Conclusions of Weight-of-Evidence Reviews

The conclusions from several organizations including the IARC, ICNIRP, NRPB and NIEHS are generally consistent[10]. The assessments agree that there is little evidence suggesting that EMF is the cause of adverse health effects, including adult and child-

[10] Both the IARC and the NIEHS have an established method for classifying the possible carcinogenicity of exposures. Categories include (from highest to lowest risk): carcinogenic to humans, probably carcinogenic to humans, possibly carcinogenic to humans, unclassifiable, and probably not carcinogenic to humans. Since some epidemiology studies reported an association between higher average magnetic field levels and childhood leukemia and the influence of bias could not be ruled out, magnetic fields were categorized as a "possible carcinogen" under the IARC and NIEHS classification systems. It is important to remember that the categorization "possible carcinogen" does not mean that magnetic fields cause cancer, nor does it suggest that the possibility is likely. In both the IARC and NIEHS reviews, the scientific panels concluded that the evidence was insufficient to establish a causal relationship between magnetic fields and childhood leukemia. Three scientists from the California EMF program also conducted a review of the research on EMF and health effects in 2002. This review, although considered by the State of California, has not provided the basis for any change to the recommendations of the CA Department of Health Services, which state that magnetic fields are not a known cause of adverse health effects (http://www.dhs.ca.gov/ehib/emf/general.html).

hood cancer, Alzheimer's disease, amyotrophic lateral sclerosis, and reproductive effects. Overall, the epidemiology studies have not reported consistent or strong findings that suggest an increased risk associated with electric or magnetic fields, nor have animal studies reported consistent increases in cancer among animals exposed to high levels of electric or magnetic fields. Furthermore, no mechanism has been discovered in laboratory studies that would explain how electric or magnetic fields could initiate disease. Most of the reviews note that epidemiology studies *in total* suggest an association between magnetic fields at higher average exposure levels and childhood leukemia. However, because of the limitations of these epidemiology studies and the lack of consistent findings from animal and laboratory studies, none of these panels concluded that this association is causal in nature.

The only studies that can be said to confirm a relationship between electric and magnetic fields and an adverse biological or health effect are those in which very high levels of exposure to these fields produce currents and fields in the body, a shock-like effect. The levels at which these short-term effects occur are very high and several organizations have recommended exposure guidelines to protect against their occurrence. Fields at these high intensities are not found in residential environments.

5.2.6.2.1.4 Recent Research

Since the time of the last weight-of-evidence review by the ICNIRP in 2003, 16 epidemiology studies have been published related to EMF exposures and adverse health outcomes[11]. The absence of an association between magnetic fields and adult leukemia/brain cancer in these recent studies adds additional support to earlier conclusions that there is weak evidence for an association. Recent studies related to birth defects also reported no associations with magnetic field exposures. With regard to breast cancer, the recent body of research, which is of higher quality than previous studies, did not report a consistent association between breast cancer and magnetic field exposure, providing strong support for the conclusion that magnetic field exposure does not influence the risk of breast cancer. Recent studies related to neurodegenerative diseases reported some associations, although the studies were weak in design. Since there is currently no biological data that would support the plausibility of such an association, the results need to be replicated in better studies before any conclusions can be drawn.

Included in the above noted 16 epidemiology studies, two case-control studies[12] related to magnetic field exposure and childhood leukemia have been recently published (Draper et al., 2005 and Kabuto et al., 2006). Unlike the other studies, both reported results that suggest magnetic field exposure could increase the risk of childhood leukemia. However, when the quality and meaning of these studies are more closely examined, neither of the studies provides strong support for a relationship between magnetic

[11] A systematic literature review was conducted to identify epidemiology studies published January 2003-July 2006. Sixteen relevant case-control or cohort studies were identified with a detailed exposure assessment. These studies include 2 childhood cancer studies, 2 adult leukemia studies, 1 adult brain cancer study, 5 breast cancer studies, 4 neurodegenerative disease studies, and 2 reproductive studies.

[12] A case-control study compares persons without a disease (controls) to persons with a disease (cases) to see if they differ on any factors or exposures of interest.

fields and childhood leukemia. The statistical association reported by Draper et al. was reported for distances far greater than magnetic fields from transmission lines could occur (distances where source is local); therefore, the observed association cannot be related to magnetic fields from the transmission lines. While the study by Kabuto et al. had a good method for measuring exposure to EMF, a large percentage of eligible participants declined to participate in the study. Low participation is a significant source of bias in studies. Therefore, using a weight of evidence review, less weight would be placed on this study relative to studies that also had good exposure assessments but did not have a low participation rate. By contrast, within the group of studies noted above, three case-control studies of childhood leukemia have been conducted with high participation rates, a large sample size, and detailed magnetic field measurements (Linet et al., 1997; McBride et al., 1999; UKCCS et al., 2000). No consistent increase in risk was reported in these studies. In summary, recent studies related to childhood leukemia do not alter the conclusion of the review panels that there is not consistent or convincing evidence that exposure to magnetic fields is a cause of childhood leukemia.

5.2.6.2.1.4 Standards and Guidelines

No scientific organization has recommended limiting exposure to the levels of EMF that we typically encounter on a daily basis. Several international scientific organizations have published guidelines for exposure to EMF based on *acute* (short-term) health effects (e.g., the stimulation of nerves and muscles, a shock-like effect) that can occur at very high field levels. The ICNIRP recommends a residential exposure limit of 833 mG and an occupational exposure limit of 4200 mG (ICNIRP, 1998). The International Committee on Electromagnetic Safety (ICES) also recommends limiting exposures at high levels because of the risk of acute health effects, although their guidelines are even higher than ICNIRP's guidelines (ICES, 2002). These levels of magnetic fields are rarely encountered by the general public, and not from electric transmission lines.

In addition to scientific organizations, government bodies can also issue standards or guidelines, although these recommendations are not always based on health effects. For example, six states have standards or guidelines for electric fields on or at the edge of the right-of-way (ROW) that to minimize the perception of shocks. Two states, Florida and New York, have enacted standards to limit magnetic fields at the edge of transmission line ROWs (150 mG and 200 mG, respectively). However, the basis for limiting magnetic fields from transmission lines in these two states was to maintain the "status quo" so that fields from new transmission lines would not be higher than those produced by existing transmission lines.

5.2.6.2.1.5 Conclusion

The scientific agencies that have considered this issue concluded that the extensive body of research that currently exists does not suggest that EMF from electrical sources causes any long-term adverse health effects. Recent research does not provide any new evidence to alter these conclusions. The only studies that can be said to confirm a

relationship between EMF and an adverse effect are those in which very high levels of exposure to these fields produce short-term, shock-like effects. The levels at which these short-term effects occur are very high and are rarely encountered by the general public. In summary, there is no scientific basis to indicate any adverse health effects to the public as a result of the electric and magnetic fields from transmission lines.

There are nevertheless, design techniques that can be used to minimize EMF surrounding transmission lines, and transmission systems are often built using these methods.

5.2.6.3 Mitigation

- Ensure that contractors prepare and maintain a health and safety plan.
- Secure construction sites at night.
- Use up-to-date design techniques to minimize EMF and induced currents.

5.2.7 Land Use

5.2.7.1 Construction and Operation Impacts

New transmission lines would require dedicated corridors where existing uses would be precluded in most cases. While transmission lines are sited to minimize land use conflicts, this is not always possible. Therefore, there are likely to be direct land use impacts in development of new transmission lines and, in some cases, upgrading of existing lines. Direct impacts could include permanent withdrawals of land from existing uses, interference with adjacent land uses on an on-going basis, and temporary disturbance of existing uses. The magnitude and extent of the impact would depend on the type of structure (towers vs. single poles) and the land use in question.

In general, transmission lines suspended on lattice-steel towers require wider rights-of-way (up to 100 feet or more for double-circuit lines) than do single-pole structures and thus would have a greater impact. Transmission lines extending through rural areas where the land use is agriculture or rangeland would cause mostly temporary impacts during construction since these uses are often allowed to continue within the right-of-way after construction is completed (although the presence of towers would continue to interfere with farming operations). On the other hand, where lines extend through forest lands, the timber resource is permanently withdrawn from production. Likewise, transmission lines through built-up areas would displace most residential, commercial, or industrial uses. From a land use compatibility standpoint, transmission lines generally would be more compatible with commercial and industrial uses than with residential uses. Also, during construction, temporary interference with traffic could occur when conductors are strung over roadways. Overall, land use impacts could range from low to high.

Consistency with land use plans and policies would be variable. Some jurisdictions provide for transmission lines as a conditional use, and some do not address the use at

all. In some cases, transmission lines may not be consistent with local jurisdictions' plans and policies. As noted previously, in addition to possible local land use approval, there are several agencies at the federal and state levels that may assert permitting and approval authority.

5.2.7.2 Mitigation

- Site transmission facilities where conflicts and compatibility issues are minimal.
- Inform affected landowners of the schedule of construction activities.
- Compensate farmers for crop damage.
- Restore compacted soil in cropland.

5.2.8 Aesthetics and Recreation

5.2.8.1 Construction Impacts

Construction activities related to clearing of rights-of-way and structure sites, grading of access roads, erection of structures and their components, and pulling and tensioning sites for the conductors would cause short-term impacts on the visual environment. If construction occurs in areas near recreation facilities, they could adversely affect the recreational experience of users. Overall, construction-related impacts are likely to be low to moderate.

5.2.8.2 Operation Impacts

Potential long-term impacts would result from changes in the visual appearance of transmission line corridors. Transmission towers are often more than 100 feet tall and the corridors can extend for hundreds of miles. Visual impacts vary depending upon the location and distance from sensitive viewing places and the number of potential viewers. Different landforms and vegetation influence visual impact; topography and forest cover may screen transmission line features at many locations. Because transmission lines are often considered to be visually unappealing, many people perceive that they negatively influence property values. Visual impacts are greatest where the transmission line is clearly visible to many people from sensitive viewing locations such as along transportation corridors or in public places. Overall, visual impacts could be low to high/significant.

Transmission lines often cross recreational areas such as state and national forests. In most cases, there would be no direct interference or impacts on recreationists. However, the quality of recreation experience could be diminished by the presence of the lines. On the other hand, in many areas transmission and recreation can coexist, as long as the recreation activity does not require permanent infrastructure or allow people unsafe access or proximity to the transmission infrastructure. Walking, horse riding, and skiing trails are often built near or crossing transmission corridors. Overall, impacts on recreation are expected to be low to high.

5.2.8.3 Mitigation

- Use tower steel that has been treated to reduce reflectivity.
- Use non-specular conductors and non-luminous insulators.
- Plant vegetative screens where this would obscure the transmission facilities (e.g., at substation sites and near sensitive viewing locations).
- In siting transmission lines, avoid parks and other recreation areas and use existing vegetation and topography whenever possible to limit views of the lines and structures.
- Locate construction staging areas out of sight of potential viewers when possible.
- Ensure that contractors maintain construction sites free of debris.

5.2.9 Cultural Resources

5.2.9.1 Construction Impacts

Since transmission facilities cover large distances, they could cross over or near cultural resources. Construction requires surface and subsurface disturbance that could affect cultural resources. The occurrence and significance of construction impacts on cultural resources are highly dependent on facility location. If cultural resources are present within a transmission corridor, it is possible that disturbance of sites could be avoided through careful location of structures, access roads, and other facilities. If cultural resources are present and construction impacts cannot be avoided, a cultural resource mitigation and management program would be needed. In general, cultural resource impacts are likely to be low since most potential sites can be avoided.

5.2.9.2 Operation Impacts

Operation impacts on cultural resources could occur through indirect impact mechanisms, primarily visual. Views of transmission facilities would be possible or likely from archaeological or historic sites that are near the transmission facilities, which could affect the setting and integrity of the site. Traditional cultural properties or historic landscapes can be quite expansive, and even distant views of transmission facilities from such resources could be considered intrusive. In addition, access roads developed for construction and maintenance could improve access to an area that has cultural resources and indirectly result in a greater human presence in the area, which could result in unauthorized collection of artifacts or vandalism.

5.2.9.3 Mitigation

- Conduct a cultural resources study in areas that are being considered for siting of transmission facilities.
- Consult with the appropriate State Historic Preservation Officer (SHPO) and area tribes to determine the likelihood of any cultural resources within or near the project area.

- Avoid known cultural resource sites in the siting of transmission lines, access roads, tower sites, substations, and other transmission facilities.
- If cultural resources are present and impacts cannot be avoided, prepare a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO immediately, and develop an appropriate mitigation program and negotiate next steps.

5.2.10 Economy

5.2.10.1 Construction Impacts

There would be a small to moderate, short-term increase in employment during construction (both local and non-local workers) and a corresponding increase in personal income in the area. Also, there would be a beneficial impact associated with spending for construction materials and transmission facilities.

5.2.10.2 Operation Impacts

There would be a small permanent increase in employment and personal income associated with operation and maintenance of the transmission lines. Maintenance employment would be periodic and the size of the maintenance crew would vary with location (e.g., a larger crew would be needed where vegetation maintenance is needed).

5.2.10.3 Mitigation

No mitigation would be needed.

6.0 Geothermal

6.1 General Description

Geothermal energy is a form of renewable energy derived from a natural heat source deep in the earth's crust. The heat is brought near the surface by thermal conduction and by intrusion into the earth's crust of molten magma originating from great depth, heating any nearby groundwater. As the groundwater is heated, geothermal energy is produced in the form of hot water and steam. This renewable energy source can then be extracted from the earth and used in the production of electricity.

In geothermal power plants, steam produced from geothermal reservoirs provides the force that spins the turbine generators and produces electricity. The used geothermal water is then returned down an injection well into the reservoir to maintain pressure, to sustain the reservoir, and eventually to be reheated. The temperature and pressure of the geothermal resource are the primary factors that determine the generation technology used to convert the geothermal fluid energy to electric energy. There are three mature generation technologies that can use geothermal resources for the production of electricity: flashed steam, binary cycle, and dry steam.

Flashed-steam plants are used with resources of about 300 degrees Fahrenheit or greater. In these plants, the pressurized geothermal fluid is brought to the surface by means of wells and piped to a central power plant. The fluid is partially depressurized, forming steam that is used to drive a steam turbine generator. The residual liquid and steam condensate is reinjected into the geothermal reservoir.

Binary cycle technology is used for lower temperature hydrothermal reservoirs. The geothermal liquid is brought to the surface using wells, and passed through a heat exchanger where the energy is transferred to a low boiling point fluid. The vaporized low boiling point fluid is used to drive a turbine-generator, condensed, and eventually recycled to the heat exchanger. The cooled geothermal fluid is then reinjected into the geothermal reservoir.

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 and the only known site in the United States is The Geysers in California. Because City Light is unlikely to develop any dry steam geothermal resource, it is not considered further in this EIS.

The two geothermal technologies discussed here are widespread, 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 can be dispatchable but are normally operated as baseload resources. Geothermal power plants typically produce electricity about 90 percent of the time, though they can be expected to run 95 to 98 percent of the time.

Geothermal development potential in the Pacific Northwest is unclear as only extensive exploratory drilling can demonstrate the presence of a viable of geothermal fuel source. 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 are considered to be the most uncertain with regards to their development potential. The Western Governor's Association Geothermal Task Force Report identified over 5,000 MW of promising geothermal resource in the West and nearly 1,300 MW of geothermal that is developable in the Northwest in the near term. Current projects under development in the Northwest include Raft River in Idaho, Newberry Crater in Oregon, and Glass Mountain, Lake City, and Surprise Valley in northern California. Basin and Range geothermal resources are used for electric power generation in Nevada, Utah, and eastern California. Recent proposals for geothermal development in southern Idaho, if successful, would be the first commercial development of Basin and Range resources in the Northwest.

6.2 Environmental Impacts and Mitigating Measures

6.2.1 Soils and Geology

6.2.1.1 Construction Impacts

Prior to construction, exploratory drilling must be conducted to determine the potential of the geothermal resource. This requires the construction of access roads, clearing of the drill site, and drilling and removal of soils from the holes. These activities may disturb the soil and geology of the area, depending on the specific activity being conducted. Additional soil disturbance could occur from construction of the permanent holes to bring hot water and steam to the surface, foundations for the turbine and generator equipment, and the supporting facilities and buildings required for the operation.

Drilling through geological formations in which the heat and water are held would affect those formations, and could permanently alter their hydrological functions. Depending on the types of soils and the extent of the area that would be disturbed, these impacts could be significant. A proposed geothermal operation could also influence an area's potential for geologic hazards, including seismic activity, volcanic eruption, and ground subsidence. The extent of such impacts would depend on an area's potential for erosion, its topography, unique geologic features, and mineral resources and the subsequent effects of such hazards on project facilities and personnel. A complete soil and geologic survey of the potential site would determine if the area could adequately support a geothermal operation while adequately protecting soil and geologic resources of the area. Once a potential site is determined adequate, the extent and magnitude of the impacts to these resources would be analyzed. Overall, potential impacts could be high.

6.2.1.2 Operation Impacts

As noted above in *Construction*, the specific operational impacts on an area's soils and geology would be directly related to the conditions on-site, and would therefore vary widely depending on a given area. In general, pumping water from underground can cause soils to slide and land to subside. There is also the potential for increased seismic activity around geothermal withdrawal areas. The extent of this shifting, and the magnitude of any seismic activity that might result, is difficult to predict without specific site data. Any additional impacts would be related to maintenance of the site, and would be limited as long as good erosion control practices are followed and water from the geothermal wells is adequately controlled.

Depending on the geothermal site, the groundwater may contain solids that must be filtered before the steam is sent to the turbine generators. These solids must be disposed of, either by recovering and selling them as marketable products, or by disposal in a landfill.

There would be no measurable difference between the two types of geothermal processes with respect to the potential impacts to an area's soils or geologic resources in either construction or operation. Overall, impacts could be low to high depending upon site features.

6.2.1.3 Mitigation

- Conduct a full soil and geologic survey of the potential site area to determine adequacy of soils and geologic formations in supporting a geothermal operation.
- Implement proper erosion control measures.
- Minimize the footprint of the operations area through careful project planning.

6.2.2 Air Quality

6.2.2.1 Construction Impacts

Potential construction impacts on air quality from geothermal energy production would be related to the location, size, and type of geothermal plant being constructed. The existing air quality of the area, including precipitation, temperature and humidity, wind patterns, and overall climate and meteorology would also determine the specific level of potential impact to an area's overall air quality. Due to the uncertainty on the specific geothermal plant being proposed, the specific type and magnitude of the plant's impact on the area's air quality cannot be determined at this time. However, as common construction activities would apply to any power plant development, general impacts may be identified.

In general, construction of geothermal power plants would involve equipment exhaust and fugitive dust generation, in addition to combustion emissions from drilling rig engines. Construction and transportation equipment would produce exhaust emissions

including CO, NO_x, VOCs, SO_2, and particulates. The specific quantities of these air pollutants would be difficult to calculate without knowing the extent of the development. However, all pollutants would be regulated under existing air quality programs.

Exposed surfaces and the construction site would have the potential to generate fugitive dust. Fugitive dust deposition is generally not considered to be a health issue, although dust deposition is considered a nuisance as it can increase the soiling of surfaces. Although Washington does not have any quantitative standards pertaining to dust deposition, Ecology responds to and resolves dust-related complaints, in additional to providing technical guidance on fugitive dust deposition.

There would not be an appreciable difference in air quality impacts between the two types of geothermal plants analyzed in this EIS (binary and flashed-steam). Overall, impacts could likely be low.

6.2.2.2 Operation Impacts

Although some geothermal plants have air emissions, the technology used in the model is binary geothermal, which is assumed to have zero emissions. With binary technology, steam is contained and not released to the atmosphere. Flashed-steam systems would generate only SOx and CO2 emissions, with the specific amount being dependent on the size of the specific plant.

Geothermal steam can also contain hydrogen sulfide gas (H_2S), which has a distinctive rotten-egg smell, but usually it is below the level that most people would be able to detect (at high concentrations, H_2S can be lethal). Emissions would vary by site, and adequate control technologies are available for reducing hydrogen sulfide emissions. Geothermal plants emit most particulates directly, and also emit small amounts of SOx that can be converted into particulates in the atmosphere (Geothermal Energy Association, 2006).

Overall, impacts to an area's air quality from the operation of a geothermal plant would be low as they would emit mostly water vapor. The specific level of impact would be determined once more is known regarding the specific size, location, and type of technology being used at a given site.

6.2.2.3 Mitigation

- Implement processes to separate H_2S gas into elemental sulfur and hydrogen.
- Re-inject gases into original reservoirs.

6.2.3 Surface and Groundwater

6.2.3.1 Construction Impacts

Construction-related impacts to surface and groundwater resources would also be dependent on the specific location and size of the specific development. Construction of such facilities, including associated drilling operations, could affect water resources by changing surface and groundwater pathways, discharges to existing water sources, and the consumption of water used during various construction activities. Increasing the amount of impervious surfaces in the area would lead to increased runoff rates, which could influence soil erosion, leading to an increase in sedimentation of nearby water sources. Depending on the area of construction, the geothermal plant would require an NPDES permit for discharge of construction stormwater (BLM, 2004). NPDES permit conditions include the required development and implementation of a surface water pollution prevention plan (SWPPP) and a variety of BMPs to minimize erosion and control runoff and sedimentation.

In addition, there would be a potential for release of hazardous fluids to ground water (fuel and hydraulic oils, etc.) during construction. Typically, there would be a spill prevention control and countermeasure plan (SPCC) that would minimize impacts on ground water.

Through the use of a SWPPP and associated BMPs, along with the implementation of an on-site stormwater management system to control site drainage, impacts on water quality and drainage conditions during construction would likely be low.

Water required for dust suppression and other construction-related activities (such as fire-suppression) would also increase the use of water on-site. The exact type and amount of such use would be determined once a specific site is chosen.

6.2.3.2 Operation Impacts

Geothermal plants use 5 gallons of freshwater per megawatt hour, while binary air-cooled plants use no fresh water. This compares with 361 gallons per megawatt hour used by natural gas facilities (Geothermal Energy Association, 2006). However, operation of a geothermal facility could still have impacts on ground and surface water, depending on the location of the site relative to surface water bodies, and the condition of the aquifer providing the geothermal steam, due to the large amount of water extracted from underground, even if that water is returned. Extracting steam at a rate higher than it could be replenished could lead to depletion of the geothermal resource or affect adjacent ground water and/or surface water sources. If water from the geothermal well is discharged to ground or surface water, impacts could occur to the temperature and chemical composition of those water bodies through the introduction of contaminants and heat. Overall, impacts during operation could be moderate.

6.2.3.3 Mitigation

- Prevent water from being released to land/surface water bodies.
- Re-inject groundwater back into geothermal wells, and use air cooling where possible.
- Use wastewater from non-geothermal plant sources, such as from municipal water treatment facilities, if the source is within a reasonable piping distance. This can decrease potential impacts from the wastewater potentially being discharged into a surface waters, and provides recharge water for the aquifer supplying geothermal energy.
- Implement a SPCC.

6.2.4 Plants and Animals

6.2.4.1 Construction Impacts

Construction of a geothermal operation could have potentially significant impacts on the plants and animals in and around the proposed site area. Vegetation would be removed at the drilling site, along the path of the pipelines, and at the plant site. Habitat for animals would be disturbed, by both vegetation removal and drilling, and pipeline and plant construction. The severity of the impacts would depend on the particular drilling site, pipeline routes, and the specific plant site. Other potential impacts could include:

- Introduction of noxious weeds.
- Potential impact on special status plant and animal species.
- Effects on plant and animal species from artificial lighting and noise.
- Temporary modification (or permanent displacement) of plant and animal habitat.
- Extirpation of animal species without migration/dispersal routes.
- Impacts on aquatic species from changes in water quantity or quality (temperature and sediment), mass wasting, and other alterations of the hydrologic regime.

Some impacts would be unavoidable, but mitigating measures would be implemented to limit the extent and magnitude of such impacts, including avoiding areas that are home to sensitive/threatened/endangered plant and animal species.

6.2.4.2 Operation Impacts

Operation of a geothermal plant would have impacts on plants and animals as it would create some amount of waste, noise, air emissions, water use, and required clearance of vegetation from the site. The extent and magnitude of such impacts would be dependent on the specific site, scale of operation, and other project-level factors that are not known at this time. There would not be any measurable difference between the two types of geothermal processes analyzed for this study in either construction or operation. Overall, impacts could be low to moderate unless water resources and aquatic species are adversely affected, in which case impacts could be high.

6.2.4.3 Mitigation

Mitigation measures for plants and animals from the construction and operation of geothermal facilities would be similar to those identified for other energy facilities, including:

- Conduct adequate surveys of plant and animal resources.
- Avoid siting geothermal projects in areas that support unique or sensitive plants or wildlife habitat.
- Implement hydrologic and species monitoring program if aquatic resources are adversely affected.
- Where possible, use existing roads and disturbed areas for project development, and minimize the area disturbed for project construction.
- Time construction to avoid species of concern.
- Design necessary stream crossings to minimize disturbance and maintain aquatic habitat conditions.
- Develop and implement a restoration plan to restore disturbed plant and animal habitat.
- Purchase or reserve areas to replace habitat values lost through project development.
- Implement measures to minimize establishment of invasive species.
- Landscape site buffer areas with native plant species
- Establish a monitoring program to assess impacts on the area's plants and animal species.

6.2.5 Energy and Natural Resources

6.2.5.1 Construction Impacts

The construction of a geothermal facility would use a range of energy types and sources. Energy, including fossil fuels and electricity, water, and mineral resources would be used during well drilling and construction of other necessary geothermal structures and facilities. Energy would also be used to transport facility components to the project site, which could be extensive depending on a given site's location in relation to the required construction components. In addition, geologic materials such as sand and gravel would be used in road construction and as fill materials for making concrete. The potential impacts to energy and natural resources would likely be lower than for other facilities such as coal or natural gas plants, and would not be considered to be significant in comparison to a given areas overall use of energy and natural resources.

6.2.5.2 Operation Impacts

The specific amount of energy and natural resources used by a geothermal facility would be dependent on the specific size, location, and type of facility being proposed. However, according to the U.S. Department of Energy, geothermal energy uses less land than other energy sources, both fossil fuel and renewable (Geothermal Energy Association, 2006). In addition, no transportation of geothermal resources would be necessary, as the resource is acquired directly at its source. During the period of time commonly used to compare the life cycle impacts from different power sources (over 30 years), a geothermal facility uses 404 square meters of land per gigawatt hour, while a coal facility uses 3,632 square meters per gigawatt hour (Geothermal Energy Association, 2006). In general, geothermal energy is typically considered to be a renewable resource, and therefore has no impact on fossil fuel resources. Some water may be consumed, however. Overall, impact would be low.

6.2.5.3 Mitigation

Based on the anticipated level of impacts to energy and natural resources, no mitigating measures are necessary or proposed.

6.2.6 Environmental Health

6.2.6.1 Construction Impacts

Construction of geothermal facilities would primarily affect environmental health concerns regarding the occupational safety for workers. Geothermal facility development includes several occupational hazards unique to construction of well drilling and geothermal support facilities, as well as hazards found in dealing with high-temperature water and steam. Additional concerns would include general safety issues regarding the use of heavy construction and the electric power industry. Adherence to occupational health and safety regulations, in addition to health and safety plans used by contractors, would reduce the level of such impacts.

Construction of geothermal facilities would produce noise that is audible beyond the boundaries of the construction site, particularly in the drilling phase of the project. Additional noise sources would include heavy equipment operation and truck traffic. Because of their short-term duration, construction activities are typically exempt from noise regulations established in state and local regulatory standards, though they are usually confined to normal daytime hours. Impacts could be low to moderate.

6.2.6.2 Operation Impacts

Typical geothermal power plant operation produces little noise during its operation, as most of the operation is confined inside structures and is limited to production of steam and subsequent electricity. Noise levels of typical plants are commonly compared to “rustling leaves,” according to common sound level standards (Geothermal Energy As-

sociation, 2006). As the primary emission from geothermal plants is water vapor, no significant impacts on surrounding populations from emission pollution would occur. H_2S emissions could affect the health and comfort of workers if not properly handled through treatment processes (e.g., gas separation and re-injection). Overall, impacts to environmental health from geothermal facilities are anticipated to be moderate; however, more detailed analysis would be needed once more information is known about a specific site and type of facility being proposed.

6.2.6.3 Mitigation

- Muffle steam wells.
- Construct berms or other barriers to noise.
- Restrict operations to daylight hours.
- Implement treatment processes to handle H_2S gas.

6.2.7 Land Use

6.2.7.1 Construction Impacts

Development of a geothermal facility would require long-term displacement and conversion of the existing uses within a given area for geothermal energy production. Potential impacts from the facility on existing land uses would be highly dependent on the project location, and would vary considerably from site to site. Geothermal sites are often located in natural areas and forests, though they may also found in agricultural areas. The industrial nature of geothermal plants would conflict with the standard land use in natural and forested areas. However, federal lands do often allow the development of energy resources, so these plants are not automatically prohibited in national parks and forests. Additionally, on some federal land the facilities could be considered part of the multiple use mandate intended for public resources. Transmission lines would need to be constructed that would cause additional land use impacts.

A typical geothermal field uses 1-8 acres per megawatt (MW) versus 5-10 acres per MW for nuclear operations, and 19 acres per MW for coal power plants. Geothermal energy production would therefore create less direct and indirect land use impacts in comparison with other energy facilities. In addition, the nature of geothermal energy production, in comparison with other facilities (e.g., coal mining), would generally create less impact on adjacent land uses. Any proposed geothermal facility would be required to comply with applicable plans or policies and land use regulations that stipulate conditions for siting of such facilities. Overall, construction impacts would be moderate.

6.2.7.2 Operation Impacts

As geothermal plants are single-use facilities, this would preclude any other use of the site. For safety of the public and security of the plant, the area would be fenced in and access would be limited to facility personnel. The extent and magnitude of potential impacts from operation of a geothermal facility on existing land uses would be directly re-

lated to the type of area in which the facility would be located. It is likely that direct and indirect land use impacts would be less in undeveloped, rural areas, as compared to more developed sites, but the extent of such impacts could not be determined until a specific site is chosen for development. Overall, impacts could be moderate to high.

6.2.7.3 Mitigation

- Use slant drilling to access geothermal steam with less use of surface land for drilling pads, access roads, and piping.
- Use slimhole-drilling techniques to reduce the amount of well drilling.
- Reinject withdrawn water back into the ground to reduce chance of subsidence.
- Use proper siting techniques for new facilities.

6.2.8 Aesthetics and Recreation

6.2.8.1 Construction Impacts

Construction activities for geothermal facilities would include clearing and grading to accommodate project structures and construction of access roads and transmission corridors that may be evident to viewers in the immediate area. These visual impacts would only occur over the long term through the operation of the facility, although restoration of the area following the decommissioning of the plant could eventually revert the area to its natural state. Geothermal sites typically would be located in natural or forested areas, where views of industrial facilities would be in sharp contrast to the immediate surroundings. The significance of aesthetic impacts during construction would depend primarily on the specific site chosen for development, in additional to the type of the surrounding views and the number and type of exposed viewers and their sensitivity to landscape change. Impacts could be high.

6.2.8.2 Operation Impacts

Potential impacts from operation of a geothermal facility would be similar to those experienced during construction, although over a longer time frame. The significance of such impacts would again be dependent on the specific scenery of the area and the number and type of exposed viewers and their sensitivity to landscape change. Overall, impacts could be low to high.

6.2.8.3 Mitigation

Mitigating measures would be similar to other types of facilities analyzed in this EIS, particularly with respect to buffering the facility from surrounding views. Specific mitigation measures would be dependent on the specific location chosen for the proposed facility. General mitigation measures could include:

- When possible, locate geothermal facilities in areas with less viewer exposure and away from popular recreation areas.

- Integrate design and configuration of structures into the surrounding landscape.
- Minimize surface disturbance for roads, turbine pads and other features, particularly on steep slopes, and control erosion.
- Provide vegetative screening to obstruct views of the facility from surrounding areas.
- Keep project facilities well-maintained throughout project operation.
- Consider use of aesthetic offsets to mitigate unavoidable visual impacts.

6.2.9 Cultural Resources

6.2.9.1 Construction Impacts

Construction of geothermal facilities could affect existing resources in and around the construction footprint due to surface disturbance and subsurface excavation of the wells. The significance of impacts from construction of such facilities on cultural resources is highly dependent on the specific facility location. Facilities are commonly located near geysers, volcanoes, or other geologic formations that have been historically valued or used by Indian tribes or other early peoples. Impacts from construction would be moderate.

6.2.9.2 Operation Impacts

The primary impacts on cultural resources from operation of a facility would occur from visual or scenery-related impacts. If views of wells or other facilities would be present from or disrupt viewing of archaeological or historic sites, impacts could be significant. The specific type and extent of such impacts would be determined when a specific location for a potential geothermal facility is known. Impacts from operation would be low.

6.2.9.3 Mitigation

- Consult with the appropriate State Historic Preservation Officer (SHPO) and area tribes to determine the likelihood of any cultural resources within or near the project area.
- Conduct an archaeological and cultural resource survey of the area to identify and assess resources that may be present.
- If cultural resources are present and impacts cannot be avoided, prepare a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO immediately, and develop an appropriate mitigation program and negotiate next steps.

6.2.10 Economy

6.2.10.1 Construction Impacts

Construction of a geothermal facility would result in some increase in temporary employment during construction activities, potentially including both local and non-local workers, and a corresponding increase in personal income. Local spending for construction materials and services would also occur. Development of a geothermal facility would also involve employment in equipment fabrication in a variety of locations.

6.2.10.2 Operation Impacts

Operation of a geothermal facility would yield an increase in fulltime, year round, high paying permanent employees for both operation and maintenance. The operation of a geothermal facility would also yield direct income for local jurisdictions through taxes, as well as savings from the use of the technology over more costly energy sources. For example, Nevada's geothermal power plants produce about 240 megawatts of electricity, saving energy imports equivalent to about 800,000 tons of coal or 3 million barrels of oil each year. In addition, Nevada's geothermal power plants paid $800,000 in county taxes and $1.7 million in property taxes in 1993. The U.S. Bureau of Land Management collects nearly $20 million each year in rent and royalties from geothermal power plants in Nevada that produce power on federal lands (US Department of Energy, 2006). No adverse impacts are expected.

6.2.10.3 Mitigation

Due to the positive nature of the economic impacts from geothermal energy production, no mitigation measures are necessary or proposed.

6.3 References

Geothermal Energy Association (Washington DC). 2006. Geothermal Energy Association (Washington DC) web site. Accessed July 20, 2006. Available at www.geo-energy.org/aboutGE/environment.asp#airemissions.

US Department of Energy. 2006. US Department of Energy - Energy Efficiency and Renewable Energy web site. Accessed July 25, 2006. Available at: http://www1.eere.energy.gov/geothermal/printable_versions/geopower_landuse.html.

7.0 Biomass (Wood)

7.1 General Description

The wood biomass plants evaluated in the IRP produce electricity by directly combusting wood. The heat of combustion is used to turn water into steam in boilers, and the steam then drives a turbine, which turns a generator that converts the power into electricity. A water source for producing steam would be required that can supply 23,000 to 55,000 gallons per MWh for a once-through system (350 to 900 gallons per MWh for a system where water is recirculated).

Wood fuel sources could include logging residues, mill residues, the clean woody fraction of municipal solid waste (urban wood waste and construction debris), and dedicated wood crops. Nearly 50 million tons of logging residues greater than 4 inches in diameter remain on the ground annually in the U.S. (Grantham and Howard, no date). The energy potential of this residue is equivalent to 100 million barrels of oil. Though timber production and logging and mill residues have declined in the Northwest over the past two decades, stabilization and possible expansion of the timber supply and logging and mill residues can be expected as forest recovery occurs. In addition, the supply of forest thinnings could increase from more intensive commercial forest management, forest health restoration efforts, and wildfire control. The woody fraction of municipal solid waste is expected to increase in quantity with economic and population growth. Conventional steam-electric plants with or without cogeneration are likely to remain the chief technology for electricity generation using wood residues. The cost of generation using wood residue is less expensive than some forms of new generation provided the fuel is very low cost. To the extent fuel must be purchased and/or transported, costs are higher than other alternatives.

For biomass-fueled power plants, reliance on variable supplies of forest and agricultural residues means that a continuous supply of fuel may be uncertain. Generation of electric power requires large quantities of biomass. Fuel transportation, storage, and handling costs are a significant part of the costs of biomass energy production. For example, logging residues require additional processing due to their variable size and greater transportation costs when compared to mill residues. Designing the facility to use multiple fuel types can mitigate uncertain fuel supplies.

Fuel competition and transportation costs virtually preclude the construction of power plants of greater than 50 MW. Most future biomass plants are likely to be in the range of 15 to 30 MW. There is considerable uncertainty associated with the availability and cost of a firm fuel supply for biomass projects. The likely proximity to load ameliorates those costs and risks because new long transmission lines would not be required as they would for more remote resources.

7.2 Environmental Impacts and Mitigating Measures

7.2.1 Soils and Geology

7.2.1.1 Construction Impacts

Construction would involve a variety of land-disturbing activities such as clearing and grading to build access roads, construction pads, and fuel storage areas and excavating for turbine foundations and the power collection system. These activities would result in surface and sub-surface disturbance that can expose soils to erosion by wind and water. Heavy equipment operation causes compaction of native soils. If geologic hazards are present within the project area, those hazards could be activated by the construction disturbance. Project construction also requires consumption of geologic materials such as sand and gravel for use in concrete, road surfaces and bases, and as backfill.

Construction impacts on geology and soils can be minimized by careful planning and design, and through development and implementation of a surface water pollution prevention plan (SWPPP), which will in turn require a variety of best management practices (BMPs) to minimize erosion and control runoff and sedimentation (NWCC, 2002). Planning and design measures to reduce impacts include locating project facilities to avoid geologic hazards and erosion-prone areas, conducting site-specific evaluations of geotechnical conditions, and designing project facilities to meet the conditions encountered. Also, construction impact would be lessened if the facility is located on already developed land near wood processing facilities. With implementation of appropriate mitigation, impacts are expected to be low.

7.2.1.2 Operation Impacts

Operation impacts at the facility site would be negligible. Impacts on geology and soils could result from vibration associated with operation of turbines. However, planning and design measures to reduce operation impacts include locating project facilities to avoid geologic hazards and erosion-prone areas, conducting site-specific evaluations of geotechnical conditions, and designing project facilities to meet the conditions encountered. In addition, if the wood is waste, there would be no incremental impact to soils and geology, and perhaps a reduction in impacts since that wood material would otherwise need to be disposed of in a landfill. The greatest impacts would occur if the wood is residue from logging operations since its removal from steep fragile soils could lead to excessive soil disturbance and soil compaction where soils are wet. Further, if too much logging residue is removed, it can result in interruption to nutrient cycling.

If the wood were from a dedicated crop, there also would be disturbance to soils in the planting and harvesting process. These disturbances would include digging holes to plant; creating and maintaining access roads to plant, harvest, and remove the timber; and erosion that could result from these activities. Some of these impacts would be unavoidable. The incremental impacts could be reduced by growing wood on land that has already been disturbed for timber production or agricultural use. Additional soil

disturbance could occur if the ash from wood combustion has to be disposed of in a landfill, though this is likely to be a small impact relative to other waste sources or, in the case of waste wood, less than if the waste wood itself was disposed. Overall, operation impacts are likely to be low to moderate depending upon the source of the wood.

7.2.1.3 Mitigation

- Minimize the extent of ground disturbance required, such as by using existing roads to the extent possible. Locate new access roads to follow the local topography, and minimize sidehill cuts.
- Cover and stabilize exposed areas consistent with applicable standards, salvage removed topsoils and reclaim disturbed areas as soon as possible.
- Identify and avoid unstable slopes and other geologic hazards, and avoid creating excessive slopes during construction; use special construction techniques where applicable.
- Develop and implement a temporary stormwater management system to control runoff, erosion and sedimentation, including use of SWPPP and BMPs during construction.

7.2.2 Air Quality

7.2.2.1 Construction Impacts

Equipment exhaust and fugitive dust generation would be the principal potential sources of air pollutants during construction. Construction equipment, vehicles transporting construction materials and facility components to the site, and construction workers' vehicles would all produce exhaust emissions. Air pollutants in these emissions can include CO, NO_x, VOCs, SO_2, and particulates. Emissions from these sources would be short-term, would likely be low, and are not likely to cause significant air quality impacts or have a measurable effect on ambient air quality near a site.

Exposed surfaces can generate fugitive dust. To the extent that exposed soils are not wetted or otherwise stabilized, they could generate windblown dust and cause dust deposition in the surrounding area. Fugitive dust deposition is generally not considered to be a health issue; however, excess dust deposition is considered a nuisance as it can increase the soiling of surfaces. Fugitive dust resulting from construction of a biomass energy project is not anticipated to produce any measurable effect on the overall ambient air quality in the area surrounding a site. Overall, impacts would be low.

7.2.2.2 Operation Impacts

The principal air pollutants of concern from burning wood are oxides of nitrogen (NOx) and particulates. NOx can affect air quality both directly and indirectly. The direct effect of breathing NOx is irritation of lungs that can lead to coughing, lung damage, and difficulty breathing in both animals and humans. Indirectly, NOx combines with precipitation to form an acid solution, causing damage to plants and acidifying water bodies, resulting

in damage to aquatic life. NOx also combines with other chemicals in the air to form ground level ozone (smog), which causes breathing difficulty and impairs visibility. Some biomass power plants have a relatively high NOx emission rate compared to other combustion technologies (Power Scorecard, 2005), and rates vary widely with plant design and operational conditions. The estimated emission rate for NOx is 0.03 lbs per million Btu.

Particulates are small particles, less than 10 micrometers in diameter (PM_{10}), that are often emitted by combustion energy sources. A subcategory of these particles, those smaller than 2.5 micrometers in diameter ($PM_{2.5}$) is considered to be especially damaging to the lung and heart functions because they can be breathed in and lodged deep in the lungs. Particulates can result in breathing difficulty, bronchitis, asthma, and damage to heart and lung functions. Particulates also reduce visibility, which can be a safety concern in some situations, as well as an aesthetic problem. Without controls, particulate emissions would be substantial for a wood-burning facility. Conventional control technology would be employed to substantially reduce emissions of large particulates, which comprise most of the particulate emissions. Few plants use advanced control technology. Further, if logging residues are the fuel source, an overall reduction in particulate emissions would occur if the residue would otherwise have been burned in a slash burn.

Other pollutants from a biomass plant are carbon dioxide (CO_2), a primary greenhouse gas, and carbon monoxide (CO). For CO_2, there would be little or no net gain in atmospheric CO_2 if the cycle of growing the fuel is sustained. The IRP analysis assumes that the wood used as fuel is from a source that will be replanted and therefore biomass is considered to have zero greenhouse gas emissions. Also, if wood waste is diverted from landfills, this would reduce the production and atmospheric release of methane, a much more potent greenhouse gas than carbon dioxide. CO is sometimes emitted at levels higher than those for coal plants. Finally, substantial quantities of ash would be produced that would need to be disposed of at an approved landfill. Overall, impacts would be moderate.

7.2.2.3 Mitigation

- Wet exposed soils during construction to reduce fugitive dust emissions.
- Use best available control technology to reduce particulate emissions.

7.2.3 Surface and Groundwater

7.2.3.1 Construction Impacts

Construction of plant facilities and access roads can alter surface and groundwater flow patterns, cause discharges to existing water sources, and consume water during the construction process. Surface disturbance of the project area can alter the surface drainage patterns and create areas of impervious surfaces, which would lead to greater levels of runoff. If uncontrolled, runoff can produce temporary increases in soil erosion,

resulting in elevated turbidity in runoff water and sedimentation in stream channels. However, the construction process would include implementation of a temporary on-site stormwater management system to control site drainage and minimize temporary impacts to water quality. Therefore, impacts on water quality and drainage conditions during construction would likely be low.

Ground water could be adversely affected by releases of hazardous fluids (fuel and hydraulic oils, etc.) during construction. Typically, there would be a spill prevention control and countermeasure plan (SPCC) that would minimize impacts on ground water. Also, excavations that penetrate a shallow aquifer could adversely affect water quality and productivity of the aquifer.

Construction would consume water for several activities, including dust suppression, vehicle washdown, and potable water supply for the construction crew. No measurable effect on the availability of local water supplies would be expected.

7.2.3.2 Operation Impacts

A wood-fired plant will require a water source to produce steam. The amount of water required for operations for a wood steam plant is roughly equal to the amount required for other steam-based generation, such as traditional coal plants: 23,000 to 55,000 gallons of water per MWh of electricity produced. For a small plant (20 MW), that could equal 55 million gallons per year (California Energy Commission, 2005).

In addition, if the wood source is a dedicated crop, it may require water from surface or ground sources in the planting and early growing stages.

Long-term effects on surface water quantity and quality would be limited to any permanent changes in drainage patterns and the runoff from the area of impervious surfaces created by the permanent project facilities. . Similar to construction, a permanent stormwater management system that contains best management practices for pollution prevention would need to be provided to accommodate a site's surface water runoff. Based on the requirements for such a system and the limited runoff volume to be managed, prevailing water quality standards would be met and impacts on surface water quantity and quality are likely to be low.

If groundwater is a source of water for the facility, withdrawals could lead to water table depression, effects on neighboring wells, and reduced in-stream flows. Water rights would need to be obtained. Warming of local ground water could occur if plant cooling water percolates into groundwater, Impacts on groundwater are expected to be moderate.

7.2.3.3 Mitigation

- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.

- Characterize the surface and groundwater hydrology prior to construction, develop an understanding of discharge and recharge relationships, and avoid creating new hydrologic connections through grading and related activities.
- Monitor water quantity and quality conditions if construction activity is to occur near aquifer recharge areas.
- Implement BMPs for use, handling, and storage of fuels, pesticides and other hazardous materials during both construction and operation.
- Implement a SPCC.
- Implement planning and design measures to reduce operation impacts including locating project facilities to avoid areas of shallow ground water conditions.
- Implement a groundwater monitoring plan if groundwater withdrawals and discharges are planned.

7.2.4 Plants and Animals

7.2.4.1 Construction Impacts

Direct effects during construction commonly include removal of vegetation and the habitat it provides for wildlife, and mortality or injury to animal species that inhabit the site at the time of construction. A 40-MW wood-fired plant can occupy a site of about 30 acres for the plant itself and fuel storage. Construction requires clearing of existing vegetation around areas to be occupied by roads, boiler and generator, fuel storage, substations and other project facilities. This area represents a permanent loss of vegetation and habitat on a previously undeveloped site. Mobile wildlife or aquatic species present on a project site are likely to be displaced during construction, while those that are less mobile can be killed or injured as a result of construction activity within the area of disturbance.

Indirect effects can stem from a number of disturbance mechanisms that can interfere with normal animal behaviors or introduce adverse changes to their habitat. Remaining vegetation and habitat quality for wildlife can be diminished indirectly through dust generated by construction, erosion and runoff, and increased opportunities for invasive species. Similarly, aquatic habitat can be degraded by runoff, dust and exposure to contaminants through spills. Noise, the presence of humans and vehicles, and similar aspects of construction activity can modify the behavior of wildlife remaining on the site and in adjacent areas. Overall, impacts would likely be moderate depending upon site location and the quality and sensitivity of habitat.

7.2.4.2 Operation Impacts

In general, there would be no impacts at the plant site during operation because additional disturbance would not occur. With respect to fuel production, there would be no incremental impacts if the fuel is mill residues or other wood waste. Minor impacts would be associated with logging residues; although the areas involved will have been already disturbed, yarding and related activities may cause additional disturbance to terrestrial and aquatic habitats.

If the wood is from a newly dedicated crop, then the land used for the crop must be cleared of any existing vegetation, which could adversely affect some animal species and habitat. Application of herbicides and fertilizers would also impact plants and animals. It is possible that the wood crop would provide habitat for some of the same animals that used the land before, or for new animals that find the wood crop better suited to their needs. The impacts will vary with the site and its previous use, with the highest impacts in areas that were in their natural state and the least impacts on sites that were already in agricultural or commercial use. Minimizing the use of herbicides and fertilizers can reduce the impacts from those materials on plants and animals.

If groundwater or surface water withdrawals or discharges occur, streams, wetlands, and the aquatic species they support could be affected by changes in water quality and flow. Noise during operation could affect some sensitive wildlife species. Overall, potential incremental impacts on plants and wildlife from operation would be moderate.

7.2.4.3 Mitigation

Mitigation measures for plants and animals from the construction and operation of biomass facilities would be similar to those identified for other energy facilities, including:

- Conduct adequate surveys of plant and animal resources.
- Avoid siting facilities and dedicated crops in areas that support unique or sensitive plants or wildlife habitat.
- Where possible, use existing roads and disturbed areas for project development, and minimize the area disturbed for project construction.
- If logging residues are used as fuel, minimize disturbance in yarding and collecting residues.
- Design necessary stream crossings to minimize disturbance and maintain aquatic habitat conditions.
- Develop and implement a restoration plan to restore disturbed plant and animal habitat.
- Purchase or reserve areas to replace habitat values lost through project development.
- Implement measures to minimize establishment of invasive species.
- Landscape site buffer areas with native plant species
- Establish a monitoring program to assess impacts on the area's plants and animal species.
- Implement a water quality and quantity monitoring program.
- Provide a cooling system that does not release water with elevated temperatures.

7.2.5 Energy and Natural Resources

7.2.5.1 Construction Impacts

Small quantities of energy and natural resources would be consumed during construction of plant facilities; impacts would be low.

7.2.5.2 Operation Impacts

Wood for fuel, whether mill or logging residue, waste wood, or dedicated crop, is generally considered to be a renewable energy resource, provided that the source from which the wood fuel is derived is properly replanted, maintained, and harvested to ensure that it can be sustained as a source of fuel, and that the source does not involve old-growth forests, wetlands, wilderness areas, or other scarce natural resource areas. For dedicated crops, the fuel cropland could be reclaimed for growing natural vegetation once the crop use was discontinued.

Energy and natural resources would be consumed in transporting wood fuels and in other aspects of the operation; impacts would be low.

7.2.5.3 Mitigation

No mitigation would be required as long as a waste product is being used. If a natural area is converted to cropland, it may be necessary to restore a site elsewhere or provide other mitigation.

7.2.6 Environmental Health

7.2.6.1 Construction Impacts

Construction of a wood-fired power plant would primarily affect environmental health concerns regarding occupational safety for workers. Adherence to occupational health and safety regulations, in addition to health and safety plans used by contractors, would reduce the level of such impacts.

Construction of the facilities would produce noise that is audible beyond the boundaries of the construction site. Noise sources would include heavy equipment operation, construction of the structures and ancillary facilities, and truck traffic. Because of their short-term duration, construction activities are typically exempt from noise regulations established in state and local regulatory standards, though they are usually confined to normal daytime hours. Impacts could be low to moderate.

7.2.6.2 Operation Impacts

Principal noise-producing sources would be operation of the boiler and generator, handling of wood fuels in the storage area, and fuel conveyance. Depending upon site location, noise could be incompatible with surrounding land uses. The facility can likely be planned and laid out so that noise levels at the site boundary do not exceed permissible levels of local noise codes. If dedicated crops or logging residues are used as fuel, there would be noise associated with harvesting, collecting/yarding, and hauling fuels. Such noise would likely be typical for the areas in which these activities would occur (e.g., noise from yarding of forest residues would be similar to noise associated with logging). Overall, noise impacts would be low to moderate.

7.2.6.3 Mitigation

- Restrict construction activities to daylight hours.
- Lay out plant facilities so that noise standards are not exceeded at the site boundaries.

7.2.7 Land Use

7.2.7.1 Construction Impacts

Development of a wood-burning facility would require long-term displacement and conversion of the existing uses within the plant site and, in the case of dedicated crops, a large area for tree crop production. A plant site (including fuel storage) would require about 30 acres for a 40 MW plant. If the fuel source is wood waste and the plant is co-located with the waste generator (e.g., sawmill), land area requirements would likely be smaller. Also, compatibility with surrounding land uses would be greater with co-location. For other fuel sources, potential impacts would be highly dependent on the project location, and would vary considerably from site to site. It is plausible that sites could be in either developed industrial areas (low impact) or rural areas (greater impact). Location decisions would need to consider the cost trade-offs between fuel transport and need for transmission lines. Transmission lines would cause additional land use impacts. Overall, impacts would likely range from low to moderate.

7.2.7.2 Operation Impacts

Operation of a wood-fired biomass project could result in some proximity-related impacts associated with noise, traffic, and the physical presence of the facilities, which would vary with site location. Impacts would likely be low to moderate.

If the fuel source is from a dedicated crop, land use impacts would vary by the type of crop and location. If it is grown on land that is already used for agriculture or timber production, there could be small incremental impacts. If the crop is grown on land that was previously covered with native plants, then the impacts could be greater. The

amount of land required for a dedicated crop would vary with the type of crop. Impacts could range from low to high.

7.2.7.3 Mitigation

- Evaluate the project site before construction to make sure it conforms with local planning and zoning requirements and avoids compatibility issues with nearby uses.
- Co-locate facilities when possible.
- Locate any new transmission facilities parallel to existing rights-of-way and avoid bisecting existing land uses.
- Develop construction management plans that avoid or minimize disruptions to adjacent existing uses.

7.2.8 Aesthetics and Recreation

7.2.8.1 Construction Impacts

Changes in visual quality of the setting would occur during construction. The effect of these changes would depend upon the sensitivity of the setting and the proximity and number of viewers. It is assumed that the plant facilities can be located to avoid recreation areas and conflicts with recreationists. Overall, impacts would likely be low to moderate.

7.2.8.2 Operation Impacts

Potential impacts from operation would be similar to those experienced during construction, although over a longer time frame. The significance of such impacts would again be dependent on the quality of the setting and the number and type of exposed viewers and their sensitivity to landscape change. Plant facilities co-located with a mill would produce only minor impacts. If the fuel is wood waste there would be no incremental impacts. If the fuel is from a dedicated crop, aesthetic impacts and recreational conflicts could occur by clearing native vegetation, planting, and harvesting the crop. Impacts may be reduced by using native vegetation as the crop, or by using a crop that fits within the other uses of the site area (for example, growing a crop that is similar to other crops in an agricultural area, or growing trees in a forested area.) Overall, impacts could be low to high.

7.2.8.3 Mitigation

- When possible, locate biomass facilities in areas with less viewer exposure and away from popular recreation areas.
- Integrate design and configuration of structures into the surrounding landscape.
- Provide vegetative screening to obstruct views of the facility from surrounding areas.

7.2.9 Cultural Resources

7.2.9.1 Construction Impacts

Known cultural resource sites would be avoided in locating a plant site. However, resources could be discovered or disturbed during construction activities. The level of impact would depend upon the importance of the resource and the degree of disturbance. If resources are discovered, mitigation would need to be negotiated. Impacts are expected to be low to moderate.

7.2.9.2 Operation Impacts

There would be no impacts if mill waste is used, and probably no impacts if logging residues are used for fuel. If a wood crop is used the impacts would vary by site. Otherwise, there would be no impacts during operation.

7.2.9.3 Mitigation

- Consult with the State Historic Preservation Officer (SHPO) in the state where the resource is to be located and area tribes to determine the likelihood of any cultural resources within or near the project area.
- Conduct an archaeological and cultural resource survey of the area to identify and assess resources that may be present.
- If cultural resources are present and impacts cannot be avoided, implement a cultural resources mitigation and management plan in consultation with appropriate authorities to accomplish data recovery from the affected sites.
- If unanticipated resources are discovered during construction, halt work, notify SHPO immediately, develop an appropriate mitigation program, and negotiate next steps.

7.2.10 Economy

7.2.10.1 Construction Impacts

There would be substantial beneficial impacts during construction. A 40 MW wood-fired plant would require an average of 70 workers over a 2-year period with a peak of 300 workers (Washington Water Power, no date). In addition to the employment gains, the local economy would benefit from spending by workers as well as by the facility for materials, equipment, and supplies.

7.2.10.2 Operation Impacts

Beneficial impacts during operation would be smaller but longer term. Permanent employment for a wood-fired plant would require an estimated 20 workers (Washington Water Power, no date). The operations employment levels would likely be higher than for other power plant facilities due to the higher need for fuel handling and maintenance,

including ash handling. If the fuel source is mill waste, there would likely be little additional employment (besides the plant operations). If logging residues are the fuel source, there would be some additional employment associated with collecting and transporting the residue. If a dedicated crop is used for fuel, employment will increase to plant, maintain, and harvest the crop. The amount of employment would vary with site and crop type, and may be seasonal, temporary, and not high-wage.

7.2.10.3 Mitigation

No mitigation would be needed.

7.3 References

Grantham, John B. and Jack O. Howard. No date. Logging Residue as an Energy Source. U.S. Forest Service, Seattle, WA.

PACE University. 2005. Power Scorecard: Electricity from Biomass. www.powerscorecard.org.

California Energy Commission. 2005. Environmental Performance Report of California's Electrical Generation System, June 2005, page 110.

Washington Water Power. No date. Proposed Washington Water Power Co. Wood Waste Electric Generating Plant.

8.0 Hydro Efficiency Upgrade (Gorge Tunnel)

8.1 General Description

Gorge powerhouse is a hydroelectric plant that is part of the Skagit Project owned and operated by Seattle City Light. The powerhouse is supplied with water from Gorge Reservoir through a single tunnel. The project would involve installing a second companion tunnel that would decrease flow velocities, reduce energy lost to turbulence when water flows at high velocity, 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. This efficiency improvement would add 18 MW of capacity and increase annual generation by 45,000 MWh.

The second tunnel would branch off the existing tunnel below the existing reservoir intake, continue underground and parallel to the existing tunnel, and then reconnect with the existing tunnel above and just north of the powerhouse near the existing surge tank. A new intake would not be required and there would be no change in water diversion amounts, flow, or plant operations. The tunnel would be approximately 11,000 feet long and 14 to 16 feet in diameter.

A FERC license amendment and other permits would be necessary. The project would be completed within about eight years, with the first three years for the FERC license amendment. It is anticipated that a tunnel-boring machine would be used for construction of the tunnel, instead of the traditional drilling and blasting. It is anticipated that waste rock and soil would be transported off-site and used for construction purposes elsewhere. Fuel extraction impacts do not apply to this technology.

8.2 Environmental Impacts and Mitigation

8.2.1 Soils and Geology

8.2.1.1 <u>Construction Impacts</u>

Soils and rock would be removed and geologic structures would be disturbed to build the tunnel. Approximately 79,000 cubic yards of soil and rock would be removed. The soil and rock that would be disturbed would be primarily underground. Excavation and disposal of the soil and rock could lead to soil erosion and impacts from transporting the soil and rock. However, using debris in a project where clean soil was needed would reduce impacts. The feasibility of this option depends on the proximity of nearby construction projects. Overall, it is expected that impacts would be moderate.

8.2.1.2 Operation Impacts

No operation impacts are anticipated.

8.2.1.3 Mitigation

- Minimize the extent of ground disturbance required, such as by using existing roads to the extent possible. Locate new access roads to follow the local topography, and minimize sidehill cuts.
- Cover and stabilize exposed areas consistent with applicable standards, salvage removed topsoils, and reclaim disturbed areas as soon as possible.
- Identify and avoid unstable slopes and other geologic hazards, and avoid creating excessive slopes during construction; use special construction techniques where applicable.

8.2.2 Air Quality

8.2.2.1 Construction Impacts

There would be small amounts of air pollutants released during construction, from drilling, excavation, and vehicles used to build the tunnel. Construction equipment, vehicles transporting construction materials and facility components to the site, and construction workers' vehicles would all produce exhaust emissions. Air pollutants in these emissions can include CO, NO_x, VOCs, SO_2, and particulates. Emissions from these sources would be short-term, would likely be low, and are not likely to cause significant air quality impacts or have a measurable effect on ambient air quality near the site. There would be small amounts of greenhouse gases released during construction from drilling, excavation, and equipment used to build the tunnel.

Exposing excavated spoils on the ground surface and transporting it can generate fugitive dust. To the extent that exposed spoils are not wetted or otherwise stabilized, they could generate windblown dust and cause dust deposition in the surrounding area. Fugitive dust deposition is generally not considered to be a health issue; however, excess dust deposition is considered a nuisance as it can increase the soiling of surfaces. Fugitive dust is not anticipated to produce any measurable effect on the overall ambient air quality in the area surrounding a site. Impacts would be low.

8.2.2.2 Operation Impacts

During operation of the new tunnel, no air emissions are expected other than very small amounts potentially emitted by vehicles used during maintenance. Impacts would be low.

8.2.2.3 Mitigation

No mitigation would be required.

8.2.3 Surface and Groundwater

8.2.3.1 Construction Impacts

Groundwater could be affected during construction of the new tunnel if an aquifer is breached by excavation and groundwater pathways are disrupted, in which case it would probably dewater. There is the potential that the existing reservoir could be disturbed by construction, but a new intake is not planned, since the new tunnel would divert from the existing one below the existing intake. Excavation and disposal of excavated material could have short-term impacts on surface water quality because of increased turbidity and siltation.

8.2.3.2 Operation Impacts

No operations impacts would occur; the new tunnel would not result in more water being taken from the existing reservoir. However, the new tunnel could create a preferential pathway for groundwater flow along the tunnel.

8.2.3.3 Mitigation

- Develop temporary and permanent stormwater management systems that incorporate BMPs for pollution prevention.
- Characterize the surface and groundwater hydrology prior to construction, develop an understanding of discharge and recharge relationships, and avoid creating new hydrologic connections through grading and related activities.
- Monitor water quantity and quality conditions if construction activity is to occur near aquifer recharge areas.
- Implement BMPs for use, handling, and storage of fuels, pesticides and other hazardous materials during both construction and operation.

8.2.4 Plants and Animals

8.2.4.1 Construction Impacts

There would be negligible impacts on plants and animals other than those associated with construction (noise, vehicle traffic, soil removal), since most of the work would be done below ground and there would be no change in the way water is removed from the reservoir. Construction impacts that affect ground and surface water could ultimately have adverse effects on aquatic species. Overall, minor habitat disturbance and human activity in the project area would result in low impacts

8.2.4.2 Operation Impacts

No operations impacts are expected.

8.2.4.3 Mitigation

- Where possible, use existing roads and disturbed areas for project development, and minimize the area disturbed for project construction.
- Develop and implement a restoration plan to restore disturbed plant and animal habitat.
- Implement measures to minimize establishment of invasive species.
- Landscape site buffer areas with native plant species

8.2.5 Energy and Natural Resources

8.2.5.1 Construction Impacts

The vehicles and boring equipment used in the construction process would consume relatively small amounts of non-renewable fossil fuels.

8.2.5.2 Operation Impacts

The operation of the project would not use fossil fuel and would not increase the amount of water consumed to produce electricity. The increased output of electricity would reduce the need for other, non-renewable electricity sources to meet City Light load growth.

8.2.5.3 Mitigation

No mitigation would be required.

8.2.6 Environmental Health

8.2.6.1 Construction Impacts

During construction, noise levels would increase due to vehicles and use of boring equipment. No additional corona or electrical-magnetic field effects (EMF) are anticipated during construction.

8.2.6.2 Operation Impacts

During operation, no additional noise, corona, or EMF impacts are anticipated.

8.2.6.3 Mitigation

No mitigation would be required.

8.2.7 Land Use

8.2.7.1 Construction Impacts

Construction impacts would be limited to potential interference with recreation uses or hydropower facility operations, the two primary land uses in the area. Impacts would likely be in the form of increased vehicle traffic for construction staff and materials that could delay traffic flow or limit access to certain areas (thus limiting land use for other purposes). These impacts would be temporary, and would likely be low during most stages of construction.

8.2.7.2 Operation Impacts

Project operation would be compatible with the site's existing use as a hydroelectric project and would not permanently change the use of surface land. The area is within the Ross Lake National Recreation Area; however, there would be no incremental changes in potential impacts on recreation compared to the present. The existing project operates under a federal license that includes requirements for minimizing and mitigating impacts of the hydroelectric plant operations on the National Recreation Area. City Light works closely with the National Park Service in implementing license requirements.

8.2.7.3 Mitigation

- Buffer areas of construction activity from areas frequented by recreationists, if possible.

8.2.8 Aesthetics and Recreation

8.2.8.1 Construction Impacts

Construction activity including vehicle and equipment use and ground disturbance could create contrasts with the existing visual environment and adversely affect the visual experience of motorists. As noted in the *Land Use* section, work will take place in the Ross Lake National Recreation Area, which is part of the North Cascades National Park Complex. The project would be in close proximity to State Route 20, the highway used by all travelers through the area. The area is used for recreation, and increased construction traffic and noise could adversely affect the recreation experience of hikers and others. These impacts would be temporary. They could be mitigated by scheduling construction during periods of low recreation use, but that would primarily be during winter months, increasing risks of other impacts such as increased erosion due to rain. Overall, impacts would be low to moderate.

8.2.8.2 Operation Impacts

Operation would have almost no impacts on aesthetics and recreation, since the new tunnel facilities would be underground and require little routine maintenance.

8.2.8.3 Mitigation

- Schedule construction during periods of low recreation use.
- If possible, provide vegetative or landscape screening to obstruct views of the construction activity from surrounding areas.

8.2.9 Cultural Resources

8.2.9.1 Construction Impacts

The tunnel is not itself listed on the National Register. However, Gorge Powerhouse, the old railroad bridge over the Skagit River between SR20 and the powerhouse, and Ladder Creek Gardens behind the powerhouse are listed on the National Register of Historic Places. Work would have to be planned to avoid impacts to those resources. It is possible but highly unlikely that other resources could be discovered or disturbed during construction activities. The level of impact would depend on the importance of the resource and the degree of disturbance. It is assumed that if resources are discovered, mitigation would be implemented to recover information represented by the cultural resource. Impacts are expected to be low.

8.2.9.2 Operation Impacts

No operations impacts are expected.

8.2.9.3 Mitigation

- Consult with the appropriate State Historic Preservation Officer (SHPO) and area tribes to determine the likelihood of any cultural resources within or near the project area.
- Conduct a cultural resource survey of the area to identify and assess resources that may be present.
- If cultural resources are present and impacts cannot be avoided, prepare a cultural resources mitigation and management plan in consultation with appropriate authorities and negotiate next steps.
- If unanticipated resources are discovered during construction, halt work, notify SHPO immediately, and develop an appropriate mitigation program.

8.2.10 Economy

8.2.10.1 Construction Impacts

There would be a temporary increase in employment during construction and benefits from spending by workers and by the facility for materials, equipment, and supplies.

8.2.10.2 Operation Impacts

There would be a small increase in employment during operation as a result of increased maintenance requirements for the new tunnel.

8.2.10.3 Mitigation

No mitigation would be required.

9.0 Conservation

9.1 General Description (for resources included in 2006 IRP)

Conservation resources include 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.

9.1.1 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, and condominiums. Residential conservation measures can be divided into the following general categories:

- Building envelope
- Lighting
- Water heating
- Space heating

Typical energy efficiency measure installed under a conservation program for existing residences include wall, floor, and ceiling insulation; windows; lighting (bulbs and fixtures); refrigerators; clothes washers; dryers; and heat pumps.

Conservation programs for new residences offer incentives and/or assistance to building owners and developers for building to more efficient standards than required by current energy codes and appliance standards. Energy efficiency measures for new residences, including new multi-family buildings, include all the efficient appliances listed above, along with insulation, windows that are more efficient, efficient lighting and lighting controls, and higher efficiency HVAC systems and controls.

9.1.2 Commercial

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, incentives and or technical assistance are offered to the owner, designer, or developer to build beyond the current energy code. For both existing and new commercial buildings, conservation measures fall into the following end use categories:

- Lighting – efficient lighting measures includes T-8 fluorescent, metal halide, high-pressure sodium lamps, and fixtures; exit signs; occupancy sensors; and day-lighting controls.

- Heating, Ventilation, and Air Conditioning (HVAC) – HVAC measures focus on increasing the efficiency of energy use in heating and cooling systems and optimizing the air movement in buildings. These measures include more efficient chillers, air conditioners, air to air heat pumps, hydronic heat pumps, variable speed drives, and HVAC controls.

- Refrigeration – efficient refrigeration measures include commercial solid-door refrigerators and freezers; pumps, compressors, and chillers; exhaust heat recovery; variable speed drives; and the design and installation of control systems.

- Building Envelope – efficiency measures include insulation and energy-efficient doors and windows.

- Equipment and Appliances – includes more efficient water heaters, data processing equipment, vending machines, and other energy using office equipment.

9.1.3 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.

Among the energy efficiency measures applicable to the industrial customer are:

- Efficiency lighting upgrades including daylighting and occupancy controls.
- Compressed air system upgrades including new compressors, humidity controls, variable speed drive compressors, and cycled refrigerated dryers.
- VSD installations on cooling tower fans and pumps.
- Controls for ventilation fans and industrial processes.
- Heat recovery measures.
- Electric furnace upgrades.
- Premium efficiency motors.

9.2 Environmental Impacts and Mitigation

Energy efficiency measures have a number of potential adverse environmental impacts; all are either insignificant or readily mitigated. On the other hand, implementation of energy efficiency measures would generally result in widespread beneficial impacts because impacts associated with energy development elsewhere would be foregone.

9.2.1 Soils and Geology

Energy efficiency measures would not result in any direct or indirect adverse impacts.

9.2.2 Air Quality

Energy efficiency measures such as insulation, energy efficient windows, caulking and weather-stripping typically reduce the exchange between indoor and outdoor air. Decreases in air circulation may lead to an accumulation of pollutants that either have entered the building from outside or have been produced indoors. Pollutants affecting indoor air quality include cigarette smoke, radon, formaldehyde, asbestos fibers, disease microorganisms; gases released from construction materials, carpeting, and furniture; as well as pollution materials released during normal plant operations. 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. Increased moisture would encourage the growth of mold and mildew and accelerate wood decay and aging of interior paints.

Unsafe concentrations of radon can be 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, increasing ultraviolet radiation from the sun. Thus, atmospheric releases of CFCs could result in increases in ultraviolet radiation.

Mitigation for effects on indoor air quality in residential, commercial, and industrial 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. Overall, impacts would be low.

9.2.3 Surface and Groundwater

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) were 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 per current local, state, and federal laws and regulatory practices for toxic waste removal. Impacts would be low.

9.2.4 Plants and Animals

There are no direct adverse effects on plants and animals; however, some plants and animals, especially amphibians, could be indirectly harmed by increased ultraviolet radiation resulting from atmospheric releases of CFCs caused by energy efficient upgrades of refrigeration and or air conditional systems.

9.2.5 Energy Resources

Conservation equipment and measures indirectly require some expenditure of energy resources in manufacturing. Otherwise, no direct adverse effects to energy resources would result from the installation of energy efficiency measures.

9.2.6 Environmental Health

Some energy conservation measures may pose health risks if they decrease indoor/outdoor air exchange rates leading to excessive concentrations of indoor air pollutants. Long-term effects 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.

Elevated ultraviolet radiation from the sun due to CFCs released to the atmosphere as a result of air conditioning or refrigeration energy efficient upgrades 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.

Effective mitigation of these effects includes indoor air monitoring, adequate ventilation, and following proper installation and maintenance procedures. Impacts would be low.

9.2.7 Land Use

Energy efficiency measures would not result in any direct or indirect adverse impacts.

9.2.8 Aesthetics and Recreation

Energy efficiency measures would not result in any direct or indirect adverse impacts except as the physical appearance of structures could be altered by the measures in a manner than would be aesthetically unappealing.

9.2.9 Cultural Resources

Energy efficiency measures could alter the exterior or interior appearance or integrity of historical buildings. In turn, altered appearances or integrity of historical buildings could decrease their perceived or actual cultural significance. Installation of energy efficient lighting measures also could change the ambience or aesthetic appeal of a building.

Effective mitigation includes not installing energy efficiency measures in historically significant buildings.

9.2.10 Economy

Employment impacts are created through:

1. direct jobs associated with the installation of conservation measures;
2. indirect jobs via businesses who make or supply conservation materials; and
3. induced jobs created via the spending of wages and salaries by the directly and indirectly employed.

The net effect would be an increase in employment ranging from 64 to 196 job-years per megawatt of conservation developed. Most of these jobs would be in communities within or surrounding City Light's service territory.

Increased employment and expenditures would result in increased levels of personal income.

10.0 Market Transactions: Purchases/Sales, Call Options, Exchanges, Hydropower Contract, BPA Contract Changes

10.1 General Description

10.1.1 Market Transactions

In the IRP, City Light is evaluating several different resource options that can be categorized as "Market Transactions". They include Market purchases and sales made directly by City Light; contracts called Call Options, Exchanges, and Hydropower Contracts; and changes made to City Light's existing contract to purchase power from the Bonneville Power Administration (BPA).

For the purposes of this analysis, all of these resources are assumed to result in changes in the amount of electricity purchased from the wholesale power market. Why are Call Options, Exchanges, contracts for existing hydropower resources, and changes in SCL's contract to purchase power from BPA treated as market transactions? All of these resources are based on existing resources. By acquiring some of the energy output of these existing resources, City Light precludes other utilities from using it to meet their loads, forcing them to acquire the energy somewhere else. It is not possible to be sure what resources other utilities would acquire in these circumstances and hence the net environmental impact of City Light's decision. A reasonable assumption is that the resource of choice, at least in the short run, would be the wholesale power market, and to attribute the impacts of the market resource to a decision by City Light to acquire additional energy from existing resources. These impacts are described below.

While it is not possible to know exactly what type of power plant will be providing the electricity served by Market Transactions, Global Energy Decisions has provided estimates of the resources used to supply market purchases over the 20-year planning period (see *Chapter 2* for a description of the planning process). The model specifies the marginal resource by month and year. For the most part this resource is a natural gas combustion turbine, with a small amount of coal power production included (less that 5 percent in all years, almost none in some). The natural gas and coal plants on the margin (i.e., most likely to be turned on or off as load is added or dropped) will in general be older, less efficient, plants. The heat rate for the gas plants is assumed to be in the range of 7,000 to 11,600 btu/kWh.

A more detailed summary of the range of air emission rates for Market Transaction resources is shown in Table C-5 below. The table shows the predicted minimum, maximum, and average heat rate and emissions for the market resource over the 20-year planning period. Emissions data are provided for oxides of nitrogen (NOx) oxides of sulfur (SOx), carbon dioxide (CO_2, the most prevalent greenhouse gas emitted from power plants), mercury (HG), and particulates (PM).

Table C-5. Market Emission Rates - Reference Case

	Heat Rate	NOx	Sox	CO_2	HG	PM
Reference	Btu/kWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh	lb/MWh
average	8,403	0.40	0.05	1,038	7.90E-06	0.20
min	7,516	0.13	0.00	902	2.32E-06	0.01
max	9,992	1.06	0.24	1,193	2.94E-05	1.40

10.1.2 Resource Descriptions

10.1.2.1 Market Purchases/Sales

All utilities face periodic mismatches between the production of their generating resources and their retail demand for power. As a practical matter, it is impossible to match the two every hour of every day. When production is surplus to their needs, utilities typically sell into the wholesale power market and when native production is less than demand, they buy. On an annual basis, City Light is a net seller into the market, even under very poor hydro conditions, but will often buy from the market to meet demand or for economic reasons. For example, City Light routinely buys energy from the market during off-peak periods when it is cheap and saves the water that would otherwise have been used to meet retail demand during the peak periods when power prices are higher.

Assessing the environmental impact of using the wholesale power market as a resource poses a problem because the exact source of the energy is unknown. In practice, the energy is a blend of the energy delivered by all of the generating plants connected to the grid – the interconnected high-voltage transmission system – at the time the energy is consumed. In past planning efforts, City Light constructed a fictitious resource to represent the likely blend of resources running during those periods City Light was purchasing and used it to estimate the environmental impact. In this plan, City Light is relying on information provided to it by Global Energy Decisions, the consulting firm that supplied the model used to do the analysis, and the price forecasts for the various futures used in the IRP.

In developing its price forecasts, Global Energy Decisions runs a sophisticated model that, in effect, mimics the operation of the west coast wholesale power market every hour of the year. It is able, therefore, to say with reasonable confidence which resource will be the marginal resource called into operation in any hour to meet the last increment of demand. This is the resource that is used to assess the environmental impact of buying from the market. Despite the changing mix of resources in the west coast across futures and over time, the marginal resource is some type of gas-fired generation most of the time. This is not surprising given the amount of gas-fired generation in the west coast under all futures and the ability to dispatch such resources rapidly to meet increases in demand.

In light of this, even though it represents somewhat of an approximation, for the purpose of this EIS it is assumed that market purchases have the environmental impacts primarily of a gas turbine with a heat rate in the range of 7,000 – 11,600 MMBtu/MWh.

10.1.2.2 BPA Contract Changes / Hydropower Contract

City Light has an existing contract to purchase energy from BPA. One option considered in the IRP is to negotiate a change to that contract, and to accept a decrease in the total amount of energy received from BPA in exchange for receiving that energy at a time when it is most needed by City Light customers. This could allow City Light to meet demand during the winter more readily, and to reduce the amount of surplus in other parts of the year. While it might also be possible to renegotiate to get more energy from BPA, this is less likely in future years, and was not considered in the IRP.

City Light also considered the option of buying energy from an existing hydropower plant in the Northwest that is not owned by BPA. There are a number of potential hydropower plants to purchase from, and a specific plant was not identified in the IRP. It is assumed that the plant is existing, not new.

One challenge in assessing the likely environmental impacts of resource decisions made by City Light is the impact on air emissions of City Light acquiring additional amounts of the fully subscribed existing hydro base, such as energy from BPA or from an existing hydropower project in the Northwest, to serve load. One possible answer is that since the hydro does not have emissions, then City Light's acquisition has no impact on emissions. However, this is clearly not a reasonable proposition. By acquiring the resource, City Light precludes others from using it to meet load, forcing them to acquire the energy somewhere else. Unfortunately, it is not possible to be sure what resources others would acquire in those circumstances and hence what the net impact of City Light's decision would have on emissions. A reasonable assumption is that the resource of choice, at least in the short run, would be the wholesale power market, and to attribute the emissions impact of the market to a decision by City Light to acquire additional amounts of existing hydro. This analysis uses the market as a proxy for these impacts.

10.1.2.3 Exchanges/Call Options

Exchanges and Call Options are contract options in which City Light would receive a specified amount of electricity at a specified time of year. In these types of contracts, the actual source of the electricity is not always specified. These resources are described in greater detail below. In Call Options and Exchanges, the uncertainty about which power plant the energy is produced by might be eliminated if the counter-party is able and willing to commit to providing the output of a specific plant. However, for long-term planning purposes, Call Options and Exchanges have not been linked to a specific power plant, and are therefore treated in the same way as Market Purchases for the purpose of environmental evaluation.

A call option is a contract that gives the bearer the right to buy a given amount of power at a given price. Call options usually expire by a certain date defined within the contract. Call options can be "physical" or "financial." A physical call option usually defines which generating resources the electric power will come from. If the option is "called," the bearer of the option (the utility) takes delivery of power up to a maximum amount specified within the contract. Financial options are settled with money and do not involve a transfer of electric power. For the IRP, the objective is to ensure resource adequacy. Only physical call options are considered within the context of the IRP.

City Light is interested in evaluating physical call options because of their flexibility as a resource. Call options can ensure the availability of a generating resource if power is needed on a seasonal or temporary basis, without the utility having to bear the full costs of long-term resource ownership. In a sense, it is like an insurance policy that the power will be available at a certain price when needed. Like an insurance policy, the utility must pay a "premium" for the call option. The premium is a fee to the owner of the generating resource for providing this service to City Light. If City Light decides to call the option, it must also pay a pre-negotiated price for the power produced by the generator who sold the option.

The availability and costs of call options vary through time. Factors often affecting the availability and costs of call options are:

1. the balance of supply and demand in the power market;
2. the degree of price volatility (or price risk) in the market;
3. the prevailing prices at the time the option is negotiated; and
4. the expectations of the utility and the option seller about the future of the power market.

The greater the length of time before a call option is purchased, the less information is available about the above four factors. City Light will consider purchasing call options in different years throughout the 20-year planning horizon.

City Light does not view call options as a direct substitute for a generating resource. There is more uncertainty about their long-term availability and cost. In the years post-2012, call options would serve as "bridging" resources in the portfolios. They would bridge the gap in resources for a few years at a time while load grows to a size to merit purchasing or building another generating resource.

There are different types of exchanges including exchanging power in one location for power delivered to another location or exchanging power delivered during one season for power delivered in another, commonly referred to as seasonal exchanges. Seasonal exchanges require identifying another load-serving entity with a need for power that is the opposite of City Light's. Other requirements include transmission. Seasonal exchanges often make the most efficient use of a generator(s) that is lightly loaded during part of a year due to seasonal variations in load. Exchanges can be made using a spe-

cific generating resource or a portfolio of resources. For purposes of the IRP, City Light, a winter-peaking utility, would provide power from its existing resource portfolio from June through August, while City Light's exchange partner, a summer-peaking utility, would provide power from its system between December and February. The most probable location for such an exchange is California, although Idaho is also possible.

City Light is interested in seasonal exchanges because they fill the need for power supply in the winter and reduce the surplus of power in the summer. In addition, they most likely would not require construction of new generating resources and would more effectively use existing resources. However, there is the potential that if existing transmission is insufficient, upgrades may be necessary. Currently, for purposes of the IRP, City Light is planning on using existing transmission.

10.2 Environmental Impacts and Mitigation

10.2.1 Soils and Geology

10.2.1.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.1.2 Operation Impacts

On average, impacts would be slightly greater than new Natural Gas impacts described in Section 3.0 of this Appendix due to the higher heat rate compared to a new natural gas plant, and the consequent requirement for more fuel extraction. Overall, these impacts would be moderate.

10.2.2.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process for natural gas, since the plants that produce the energy have already been built. See Section 3.0 in this Appendix for details on mitigation options.

10.2.2 Air Quality

10.2.2.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.2.2 Operation Impacts

On average, slightly greater than new Natural Gas impacts described in Section 3.0 of this Appendix due to the higher heat rate compared to a new natural gas plant, and the consequent combustion of more fuel leading to higher emissions. Overall, these impacts could be high.

10.2.2.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would install additional mitigating measures in order to meet the incremental demand. See Section 3.0 in this Appendix for details on mitigation options.

10.2.3 Surface and Groundwater

10.2.3.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.3.2 Operation Impacts

Operational impacts to surface and ground water would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due to fuel extraction and the emission of air pollutants that could end up in water sources. These impacts would be moderate.

10.2.3.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would install additional mitigating measures in order to meet the incremental demand. See Section 3.0 in this Appendix for details on mitigation options.

10.2.4 Plants and Animals

10.2.4.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.3.2 Operation Impacts

Operational impacts to plants and animals would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due to fuel extraction and the emission of air pollutants that could end up in water sources, degrading habitat and water quality for plants and animals. These impacts would be moderate.

10.2.4.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would install additional mitigation measures in order to meet the incremental demand. See Section 3.0 in this Appendix for details on mitigation options.

10.2.5 Energy and Natural Resources

10.2.5.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.5.2 Operation Impacts

Operational impacts on energy resources would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due primarily to fuel combustion, and since the Market Transactions have a higher rate of fuel use per unit of energy, compared to a Natural Gas plant, the energy impacts will be greater. These impacts could be high.

10.2.5.3 Mitigation

Mitigation options are limited, since the plants are already built. It is possible that these existing plants could be made more efficient, thus reducing fuel use slightly, but it is unlikely that efficiency projects would be undertaken to meet demand for incremental energy.

10.2.6 Environmental Health

10.2.6.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.6.2 Operation Impacts

Operational impacts on environmental health would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due primarily to fuel extraction, transportation, and combustion, and since the Market Transactions have a higher rate of fuel use per unit of energy, compared to a new Natural Gas plant, the environmental health impacts will be greater. These impacts would be moderate.

10.2.6.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would install additional mitigation measures in order to meet the incremental demand. See Section 3.0 in this Appendix for details on mitigation options.

10.2.7 Land Use

10.2.7.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.7.2 Operation Impacts

Operational impacts on land use would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due primarily to fuel extraction and transportation, and since the Market Transactions have a higher rate of fuel use per unit of energy, compared to a new Natural Gas plant, the land use impacts would be greater. These impacts would be moderate.

10.2.7.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would modify the facilities or uses in order to meet the incremental demand with reduced impacts to land use. See Section 3.0 in this Appendix for details on mitigation options.

10.2.8 Aesthetics and Recreation

10.2.8.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.8.2 Operation Impacts

Operational impacts on aesthetics and recreation would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due primarily to fuel extraction and transportation, and since the Market Transactions have a higher rate of fuel use per unit of energy, compared to a new Natural Gas plant, the impacts will be greater. These impacts would be moderate.

10.2.8.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would modify the facilities or uses in order to meet the incremental demand with reduced impacts to aesthetics and recreation. See Section 3.0 in this Appendix for details on mitigation options.

10.2.9 Cultural Resources

10.2.9.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.9.2 Operation Impacts

Operational impacts on cultural resources would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due primarily to fuel extraction and transportation, and since the Market Transactions have a higher rate of fuel use per unit of energy, compared to a new Natural Gas plant, the impacts will be greater. Overall, these impacts would be moderate.

10.2.9.3 Mitigation

Mitigation options are limited to those that can be applied to the fuel extraction and transportation process, since the plants have already been built, and it is unlikely that these plants would modify the facilities or uses in order to meet the incremental demand with reduced impacts to cultural and historical resources. See Section 3.0 in this Appendix for details on mitigation options.

10.2.10 Economy

10.2.10.1 Construction Impacts

Since almost all Market Transaction energy will be supplied by existing resources, there are minimal incremental impacts. It is unlikely that new plants would be constructed only to meet demand for these Market Transactions.

10.2.10.2 Operation Impacts

Operational impacts on land use would be slightly higher than those for Natural Gas described in Section 3.0 of this Appendix. These impacts are due primarily to fuel extraction and transportation, and since the Market Transactions have a higher rate of fuel use per unit of energy, compared to a new Natural Gas plant, the positive impacts will be greater.

10.2.10.3 Mitigation

No mitigation would be needed.