

Chapter 4 – The Choices: Identifying Potential New Resources

This chapter describes the various resources currently available to electric utilities and considered for this Integrated Resource Plan (IRP). They include additional conservation resources based on the 2006 Conservation Potential Assessment; generation resources (landfill gas, an efficiency upgrade to City Light's Gorge plant, biomass, wind, geothermal, natural gas, gasified coal and pulverized coal); and purchases of power from the Western wholesale energy market. Other resources, including solar and wave energy, that may become feasible in the future are also briefly discussed, with more detail provided in Appendix C.

Conservation Resources

Over three decades ago, the City of Seattle established conservation as the first choice resource to meet City Light's energy requirements. This direction has been reaffirmed over the years in a variety of resolutions, ordinances and initiatives, most recently as key element of the Mayor's Climate Action Plan.

As described in Chapter 3, City Light has implemented this direction by operating conservation programs that encourage Seattle homeowners and businesses to use energy-efficient equipment and practices. Investment in conservation resources under City Light's programs has generated significant resource and other benefits for the Utility and its customers in the form of avoided higher cost generation, deferred transmission and distribution investments, reduced air pollution and greenhouse gas emissions, and lower customer bills.

Resource Characteristics

Energy efficiency measures installed under City Light conservation programs are not dispatchable, meaning they cannot be turned off and on as needed on short notice like some generation resources. Conservation measures are more similar to baseload generation, such as coal plants, that produce power at a steady level rather than to a simple-cycle combustion turbine that may be called on only a few times in a year.

Energy savings from many conservation measures do have seasonal, daily and hourly load shapes. For example, an energy-efficient water heater saves more energy in the morning than other times of the day, because hot water use is greatest in the morning. An energy-efficient window installed in a residence with electric space heat will save more energy in the winter, when the need for space heating is greatest.

Conservation measures can be either discretionary or lost opportunity resources – relative to the timing of implementation. Discretionary conservation measures can be implemented at any time within practical limits. For example, an energy efficient window can be installed in an existing residential building now, or five years from now, with little or no effect on the cost effectiveness of the measure.

Lost-opportunity conservation must be captured at the time a new building is built or a new appliance is installed. For example if energy-efficient lamps and fixtures are not installed in a new building at the time of construction, the potential for energy savings and operational efficiency is lost until the building is replaced or, more likely, retrofitted at a much higher cost in the future.

2006 Conservation Potential Assessment

In preparation for the 2006 IRP, City Light engaged the energy analysis firm Quantec to update the assessment of conservation resource potential in City Light's service territory and develop a new CPA (2006 Conservation Potential Assessment). Quantec compiled a wide range of measure-specific, economic and market information. The data included City Light forecasts, customer characteristics surveys and conservation program achievements, along with a variety of data from secondary sources. These included the Northwest Power and Conservation Council Regional Technical Forum, the Energy Information Association and the California Energy Commission's Database for Energy Efficient Resources.

The 2006 CPA analysis considered dozens of possible conservation measures, with hundreds of permutations across segments and construction vintages, distinguishing between discretionary (e.g. shell retrofit) and lost opportunity (e.g. equipment replacement and new construction) resources.

Approach

The approach in the 2006 CPA was to identify all “technical potential” in City Light’s service territory, and then determine how much of this technical potential was “achievable.”

Technical potential assumes that all demand-side resource opportunities may be captured regardless of their costs or market barriers. Achievable potential represents the portion of technical potential likely to be viable over the planning horizon, given prevailing market barriers that may limit the implementation of demand-side measures. For the 2006 CPA, achievable potential was assumed to be 70 percent of the technical potential.

The 2006 CPA examined energy savings available across the residential, commercial and industrial sectors in City Light’s service area. The study also incorporated non-energy benefits using the method employed by the NPCC in developing the 5th Regional Power Plan. For a more detailed discussion of assumptions, approach and methodology used in developing the 2006 CPA, see the link for Conservation Potential Assessment on Seattle City Light’s Conservation Webpage, <http://www.seattle.gov/light/conserve/>.

Summary of Findings

Based on the results of the 2006 CPA, the 15-year achievable conservation potential in City Light’s service area is estimated at 229 aMW of electricity, representing more than 18 percent of the baseline electricity consumption forecast in that year (2020).

Table 4-1 shows this estimate of achievable conservation potential broken out in \$.01 increments based on the “levelized” cost of the resource. The levelized cost is the present value of the total cost of installing and maintaining a conservation resource over its economic life, converted to equal annual payments. As the data show, nearly 75 percent of the achievable potential across all sectors is available at \$.06/kWh or less. Over 95 percent of energy savings potential in the industrial sector is available at \$.03/kWh or less.

Modeling Conservation for the IRP

For the purposes of developing modeling input for the 20-year IRP planning horizon, the CPA results shown in Table 4-1 were extended by five years. Conservation costs were modeled the same way as generation resources, using real levelized costs identified by the Conservation Potential Assessment. In all Round 1 portfolios, the pace of conservation acquisition was modeled at a constant rate of 7 average megawatts (aMW) per year. This constant pace of conservation acquisition was identified as producing the highest net present value through modeling sensitivities. In Round 2, an accelerated pace of conservation acquisition was also modeled (see Chapter 6).

Table 4-1. 15-Year Cumulative Achievable Potential by Cost Group

Cost Group	Residential (aMW)	Commercial (aMW)	Industrial (aMW)	Total (aMW)	Cumulative Percent
A. Up to \$0.01	2.6	11.7	0.7	14.7	6%
B. \$0.01 to \$0.02	5.1	32.8	17.9	48.1	21%
C. \$0.02 to \$0.03	11.2	48.1	34.3	79.1	35%
D. \$0.03 to \$0.04	13.9	52.4	35.2	101.6	44%
E. \$0.04 to \$0.05	18.8	58.7	35.5	113.2	49%
F. \$0.05 to \$0.06	20.3	63.5	36.5	120.5	53%
G. \$0.06 to \$0.07	26.8	67.4	36.5	130.9	57%
H. \$0.07 to \$0.08	31.8	70.0	36.5	138.4	60%
I. \$0.08 to \$0.09	33.2	76.0	36.5	145.8	64%
J. \$0.09 to \$0.10	35.8	78.4	37.1	150.9	66%
K. \$0.10 and Higher	71.3	120.4	37.1	228.8	100%

Generation Resources

Generation resources produce electrical energy from other forms of energy such as heat, potential energy (e.g. falling water, wind), solar or chemical energy. This section begins with an explanation of why types of resources rather than specific projects are evaluated, and the value of considering a broad range of operationally proven, commercially available resources that are likely to be cost-effective.

The following generation resources were analyzed for this IRP:

- Landfill gas
- Biomass (wood-fired)
- Hydro efficiency improvement at Gorge Dam
- Wind
- Geothermal
- Natural gas (simple and combined-cycle combustion turbines)
- Coal (integrated gasification combined cycle)
- Pulverized coal

Any generation resource added to City Light’s existing portfolio will have characteristics that suit the Utility’s future needs. The most important are costs, dispatchability, transmission requirements and environmental attributes. Cost information for new generation resources evaluated in the IRP is summarized, followed by descriptions of each resource type, including information on the other three characteristics.

Other generation resources that may become feasible in the future are summarized at the end of this section, with more detail in Appendix C.

Resource Types vs Specific Projects

Evaluating generating resource types in an IRP rather than focusing on particular generating projects has several advantages. Reliable, verifiable information about the generating technology can be used, making it possible to objectively compare the results of the quantitative analysis of candidate resources. The IRP can be focused on higher-level, long-term strategic issues rather than on the variable details of specific transactions.

In addition, the information about generating resource types that is developed in an IRP can be used as the Utility shifts from planning to implementation (resource acquisition). For example, if the resource strategy adopted in an IRP calls for City Light to acquire a specific type of generating resource, fundamental information about that resource type that was developed in the IRP can be used as a benchmark for evaluating particular generating projects.

If during resource acquisition it becomes apparent that costs or other characteristics of particular generating projects are as good or better than what was used in the last IRP, then acquisition can confidently proceed as planned. However, if costs or other characteristics are substantially worse, analysts can exercise

caution and perhaps reconsider whether that type of resource still fits within the Utility's overall resource strategy.

Selecting a Range of Resources

The IRP evaluated more types of generating resources than were included in the resource recommended resource portfolio. The advantages of analyzing a reasonably broad range of generating resource types include the following:

- Each type of generating resource has a unique combination of advantages and disadvantages, including costs, benefits, opportunities and risks. Including a broad range of resource types helps to ensure that the IRP process is objective and does not prematurely narrow the field of resource alternatives.
- The net impacts of a particular type of generating resource on the Utility's overall resource portfolio are often not obvious and can remain obscured if the resource is only evaluated on a stand-alone basis.
- It is unlikely that a single type of generating resource can best meet all of the City Light's needs over the long-term. A diversified mix of resources is more likely to meet the Utility's objectives of maximizing reliability and minimizing cost, risk and environmental impacts.
- Analyzing various types of generating resources helps to identify which combinations of new resources can best complement the existing resources in the Utility's portfolio.
- Various types of generating resources have proponents and opponents. Quantitative analysis of candidate resource portfolios that combine a range of resource types provides a constructive, organized means to incorporate input from a variety of perspectives.

The IRP provides an open, rigorous and structured process for comparing and choosing from among an array of available resource types. However, evaluating a particular resource does not imply a predetermined preference for (or against) including that resource in the Utility's portfolio.

Quantitative analysis of candidate resource portfolios that mix various types of resources produces results (e.g., impacts on reliability, costs, risks, environmental impacts) that are useful for selecting which types of resources will be included in the Utility's long-term resource strategy. While the preferred strategy will likely include more than one type of resource, several types of generating resources will probably be excluded based on results from the quantitative analysis.

Costs of New Generation Resources

The 2006 IRP has been developed at a time when rapidly rising commodity prices and a devalued U.S. dollar are escalating costs for new resources. Much of this cost escalation can be traced to rising prices for steel and concrete, as global demand for these materials rises. The cost of wind turbines, many imported from Europe, has grown rapidly as a result of a devalued U.S. dollar and scarcity premiums caused by a rush to complete projects before expiration of the federal Production Tax Credit in 2007.

In the next few years, City Light expects to see higher costs for resources than represented in the 2006 IRP. However, it is likely that productive capacity for concrete, steel and wind turbines will expand, causing real prices for resources to moderate. City Light opted to not adjust resource costs in the 20-year study for what are seen as primarily near-term market trends. Table 4-2 shows the resource costs used in the 2006 IRP.

Table 4-2. Costs for New Resources (2006 Dollars)

Cost	Coal	CCCT	SCCT	Hydro	Geothermal	Wind	Biomass	Landfill Gas
Heat Rate	9,282	7,200	9,688				n/a	11,000
Capital (\$/kW)	\$1,575	\$613	\$500		\$3,150	\$1,500	\$2,476	\$1,500
Fixed O&M (\$/kW-yr)	\$28.35	\$10.00	\$12.00		\$171.97	\$20.00	\$219.00	\$134.03
Wheeling (\$/kW-yr)		\$14.33	\$14.33	\$14.33	\$14.33		\$14.33	\$14.33
Transmission Build (\$/kW-yr)	\$85.14					\$20.00		
Fuel	MT/WY \$0.79/mmBtu	GED Gas Price Forecast	GED Gas Price Forecast	\$0.00	Included in Capital	\$0.00	Included in Capital	\$1.00
Variable O&M (\$/MWh)	\$3.24	\$2.85	\$6.00		\$2.90	\$1.00	\$0.00	\$1.00
Integration & Shaping (\$/MWh)						\$7.25		

As shown in Table 4-2, transmission plays a role in estimating costs for new resources. City Light is dependent upon a regional transmission system that is highly constrained. In the IRP, it is assumed that if a new transmission line or transmission upgrade is required to interconnect a distant power resource to City Light, the Utility will have to pay a pro rata share of the transmission line according to the amount of firm capacity it needs. Transmission costs are driven by the distance between Seattle and the generating resources and the amounts of transmission capacity required. These costs are assumed to be financed over time and are incorporated as a cost of the resource. In the absence of new transmission requirements, the BPA transmission tariff is assumed.

Information about the costs of new resources came from many sources, including Global Energy Decisions, U.S. Department of Energy, Northwest Power and Conservation Council, Western Governors Association, American Wind Energy Association, and the Geothermal Resources Council. Not all cost information from these sources was consistent, despite adjustments for heat rates, capacity factors and other factors. In these cases, a cost was selected that fell within the range most frequently reported.

Resources Evaluated in the IRP

This section provides the following basic information on each generating resource type evaluated for the IRP:

- Resource technology and fuel
- Current status and outlook
- Resource characteristics (dispatchability, transmission requirements and environmental attributes)

Landfill Gas

The two forms of bioenergy generation analyzed for the IRP are landfill gas and wood waste. Existing bioenergy generating projects make up about two percent of the Pacific Northwest’s total electric generating capacity, and about one percent of U.S. electricity generation. Wood wastes and landfill gas are the most prevalent fuels because there are few competing commercial uses. For existing projects, costs for these two types of fuel are negligible.

Interest in bioenergy resources has increased in recent years, with active research and development of new forms of bioenergy. The impetus for these efforts reflects growing concerns about the cost and availability of fossil fuels, as well as growing interest in finding new sources of energy that do not produce large amounts of CO2 emissions. Certain types of bioenergy fuels could also be used as a substitute for petroleum-based fuels. In the future, this could lead to competition

between alternative uses of bioenergy fuels, including transportation and electric generation.

The analysis of landfill gas in the IRP is based on costs and other characteristics of a biogas project fueled by methane collected from a solid waste landfill. Other forms of biogas not considered were methane produced at wastewater treatment plants, and methane produced from animal manure.

Resource Technology and Fuel

As organic materials in solid waste landfills decompose, high concentrations of combustible gases are released. Typically, landfill gas is composed of 50 to 60 percent methane; most of the rest is carbon dioxide. At most modern landfills, federal laws require capturing and burning the gas to minimize the risk of explosion and reduce hazardous air emissions. However, it can be put to productive use as a fuel for generating electricity using internal combustion engines or combustion turbines.

The most efficient size and form of generating technology for any particular solid waste landfill usually depend on the amount (and quality) of biogas produced by the landfill, which, in turn depends on factors such as the landfill's size, contents and age. The capacity is generally 10 megawatts or less.

Fixed and variable costs for landfill gas projects depend on the type of generating technology that is used. Smaller projects typically use internal combustion engines, while larger projects often use combustion turbines.

Current Status and Outlook

Landfill gas is used to produce electricity at 380 landfills in the United States. Recently, new landfill gas projects have been developing at a moderate pace, driven by the economics of specific landfill gas project opportunities relative to the cost of competing sources of electric generation.

Landfill gas generating projects use mature technologies. While incremental improvements may occur, significant breakthroughs are not expected. Future availability of opportunities to develop landfill gas generating projects will be influenced by the number and location of solid waste landfills.

Resource Characteristics

Transmission requirements. Most solid waste 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.

Dispatchability. Most landfill gas generating projects are operated as baseload resources, largely to help ensure that all gas produced from the solid waste landfill is burned.

Environmental attributes. Net environmental impacts are relatively small, since landfill gas generating projects consume a fuel source that would otherwise be flared. Unprocessed landfill gas may contain impurities that can create hazardous air emissions unless they are removed either before or after combustion. Depending on where the solid waste landfill is located and the types of neighboring land uses, noise from generating equipment must also be controlled.

Biomass

Resource Technology and Fuel

Biomass can be converted into fuel using thermochemical technologies such as direct combustion, gasification and pyrolysis, or biochemical technologies such as anaerobic digestion (e.g., dairy digesters) and fermentation.

City Light's analysis of biomass generation is based on costs and other characteristics of a conventional steam-electric turbine fueled by direct combustion of wood waste.

Both types of technology generate electricity by processing biomass into a combustible fuel and burning it in an internal combustion engine, a combustion turbine or a conventional steam-electric turbine. In some situations, a biomass-fired conventional steam-electric turbine can be configured to both generate electricity and produce a supplemental supply of steam for use in an industrial process (i.e., industrial cogeneration).

Current applications. Conventional steam-electric turbines with or without cogeneration are the chief technology for electricity generation using wood-derived fuels.

Most existing biomass generating projects have a capacity of 50 megawatts or less, because large amounts of biomass fuels usually are not available near a single location, and long-distance transport of biomass fuels is costly. Most future biomass plants will likely have generating capacities of between 15 and 30 megawatts.

The configuration and costs of biomass generation projects vary dramatically depending on the type and availability of fuel supplies, form of generation technology and geographic location.

Fuel requirements. Biomass fuels are made from organic matter that can be burned as is or converted into a combustible material. Examples include wood waste (e.g., residues from forest thinning, logging and mill processes), agricultural residues and crops planted as fuel for energy. Because the raw forms of many biomass fuel sources have relatively low energy content, generating electricity with biomass requires large quantities of organic material.

Some types of biomass fuels such as wood waste are a byproduct of other activities and are not useful for other commercial purposes, so the cost is generally quite low. However, the amount of fuel that is available may be limited and dependent on other activities, such as timber harvesting or mill operations, that are beyond the control of the fuel user.

For biomass sources that are grown as a fuel source, suppliers must be reimbursed for the costs of production, environmental mitigation (e.g., appropriate disposal of residues), and transportation. Prices will also be affected if there are competing uses for the fuel, such as biodiesel or synthetic fuels for motor vehicles.

Current Status and Outlook

In recent years, biomass fuel production has declined in the forest products industry, been stable in the other natural resources industries and increased for solid waste. The sources and amounts of fuel for current biomass generation technology appear to be finite. Few new opportunities to acquire these types of generating resources are expected, and costs and other characteristics are likely to be highly situation-specific.

In the future, stabilization and possible expansion of the timber supply and logging and mill residues can be expected as forests recover. Also, the supply of forest thinnings could increase from more intensive commercial forest management, forest health restoration efforts and wildfire control. The woody fraction of solid waste in landfills is expected to increase with economic and population growth.

While woody residue is available in large quantities, the high cost of collection and transportation is likely to limit generation development unless cogeneration opportunities are available to

help share costs. Technical difficulties and seasonality of fuel availability are likely to preclude significant use of agricultural field residues for generation. A small, undeveloped potential for energy recovery exists at municipal wastewater treatment plants.

New forms of fuels may become available with the growth of energy crops or increased harvesting of biomass residues. However, some fuels, such as ethanol, could also complement or substitute for fossil fuels used in transportation. Technologies based on biomass fuels that are not well suited to competing energy uses may be the most cost-effective for generating electricity.

Resource Characteristics

Transmission requirements. Biomass generating facilities are usually sited to interconnect at a subtransmission voltage of 69 kilovolts or less, at a substation that feeds the distribution system or at an industrial site. Due to the small size of most biomass generating facilities, major new transmission lines are often not required although line upgrades may be necessary. Integrating biomass resources into the power grid is fairly straightforward for facilities that operate in baseload and have high capacity factors (e.g., cogeneration).

Dispatchability. For biomass generating resources that are more economic to operate in baseload or must do so (as at a cogeneration facility), electrical output is held at a relatively constant level. This means these resources are not normally considered to be dispatchable – that is, their output is not increased and decreased to help balance daily system loads and generation. However, when a biomass facility is located close to electrical loads, it may be able to provide grid support in limited circumstances. Dispatchability would be improved in the future if new forms of biomass generating resources use fuels that support more flexible operation.

Environmental attributes. Biomass is a renewable resource, with relatively low environmental impacts. Perhaps most the most important environmental advantage is that biomass generation does not add large net amounts of carbon dioxide to the atmosphere. By repeating a cycle of growth and consumption of biomass materials, carbon dioxide is captured and then produced again and again, essentially forming a “closed loop” system. In addition, several types of biomass fuels contain much smaller amounts of other pollutants such as sulfur.

Biomass generation based on conventional steam-electric turbine technology consumes significant amounts of water. To produce steam, a biomass project needs a water source that can supply 23,000 to 55,000 gallons per megawatt-hour for a once-through system and 350 to 900 gallons per megawatt-hour for a re-circulating system.

Geothermal

Geothermal is the only reasonably large renewable resource that serves baseload, has a very long-term firm fuel supply, and is scalable. While other renewable energy resources like wind and solar energy generate power intermittently, and hydro availability varies from year to year, geothermal operates over 95 percent of the time, and if well managed, may operate for 100 years or more.

Although suitable sites are often difficult and expensive to find, the technologies used for geothermal generation are well proven. Geothermal generation provides a highly reliable and clean power supply with greater certainty of costs than other types of generating resources, particularly those that consume fossil fuels.

Resource Technology and Fuel

Geothermal energy is derived from heat that originates deep in the earth's crust. The heat rises to near the surface by thermal conduction and by intrusion of molten magma originating from great depth upward into the earth's crust, heating nearby groundwater and/or rock formations. As the groundwater and/or rock are heated, geothermal energy is naturally created. This energy can then be extracted and used to produce electricity.

There are three basic types of geothermal generating technologies: dry steam, flash, and binary. Dry steam technology captures steam (over 455 degrees Fahrenheit) from fractures in the ground and uses it to turn a turbine generator. Flash technology takes extremely hot water (over 360 degrees Fahrenheit) out of the ground, separates the steam from the boiling water, and uses the steam to turn a turbine generator. Binary technology takes moderately hot water (225-360 degrees Fahrenheit) and passes it through one side of a heat exchanger in order to heat an organic fluid in a separate adjacent pipe that is then used to turn a turbine generator. After its heat has been transferred to the organic fluid, the water is returned via an

injection well into the reservoir to be reheated, thereby helping to maintain pressure and sustain the reservoir.

Most geothermal plants are built as 20 to 50 megawatt units, but modular systems as small as 5 megawatts have been developed. Costs vary significantly because they are highly dependent on location, project configuration and other site-specific factors.

Current Status and Outlook

The United States currently has 2,700 megawatts of geothermal generating capacity. Roughly half of the total capacity is at the Geysers projects, which are located in Northern California and use dry steam technology.

The Western Governors Association Geothermal Task Force Report identified over 5,000 megawatts of promising geothermal resource opportunities in the West and nearly 1,300 megawatts of developable geothermal generation in the Northwest. Recent proposals for geothermal development in southern Idaho, if successful, would be the first commercial development of Basin and Range resources in the Northwest.

However, the outlook for broader development of geothermal generating resources in the Pacific Northwest is unclear because extensive exploratory drilling has not been done. The most likely locations are the Basin and Range provinces of southeastern Oregon and southern Idaho and the High Cascades in southern Oregon. While the Cascades have the greatest potential for geothermal resources, feasibility of development in that area is the most uncertain.

Resource Characteristics

Transmission requirements. Transmission needs for geothermal resources vary depending on site location. Some good sites with geothermal potential are located in the vicinity of City Light owned or controlled transmission. While upgrades to the existing transmission system may be necessary to accommodate these resources, project sizes would be comparatively small. A new line would probably not be necessary, except for resources at some locations in Idaho or Oregon.

Operated as a baseload resource, a geothermal resource is relatively easy to integrate into an existing hydroelectric based electrical system. Because it has a high capacity factor (meaning that it operates virtually all of the time), the transmission can be fully utilized, thus keeping the per-megawatt-hour cost low.

Dispatchability. Geothermal energy is usually operated as a baseload resource. However, it could be dispatched when required in certain circumstances, for example to support transmission system needs. Geothermal energy can also serve as a shaping resource.

Environmental attributes. Geothermal energy is a renewable resource. No fossil fuels are required or consumed, so no carbon dioxide is produced. The main environmental impacts associated with geothermal generation are the potential for increased release of gases during extraction of steam or superheated water, and land use issues that would make it difficult or infeasible to locate geothermal generating projects in wilderness areas.

Wind Power

Over the last decade, the use of wind power has increased rapidly, making it the predominant renewable resource technology, with many large-scale installations around the world.

Resource Technology and Fuel

Wind power is the process of mechanically harnessing energy from the wind and converting it into electricity. The most common form of utility-scale wind technology uses rotors with long, slender turbine blades to turn an electric generator mounted at the top of a tall tower.

Because air has low mass, the wind itself has low energy density. The amount of wind power that can be produced at a given place is dependent on the strength and frequency of wind. Wind velocity is particularly important, because the quantity of power increases dramatically as wind speed increases.

Project scale. As of the late 1990s, capacity of individual utility-scale wind turbines was limited to roughly 0.6 megawatts. However, recent advances in materials and design have allowed manufacturers to increase the capacity. For example, in October 2006, General Electric announced that more than 5,000 of its 1.5-megawatt wind turbines had been installed. Turbines with capacities exceeding 2 megawatts are now commercially available and even larger capacities are planned.

Wind power can also be generated on a more modest scale, by using much smaller turbines as a form of distributed resource. Because the potential for such resources in City Light's retail

electric service area is relatively small, the analysis for the IRP focused on larger, utility-scale forms of wind power.

In order to maximize energy output and achieve economies of scale, large numbers of wind turbine generators are often grouped together to form a wind farm project. Today's utility-scale wind farms typically encompass a total project area of several thousand acres or more, although the permanent facilities use no more than 5 to 10 percent of the total acreage.

Costs. As wind turbines have grown in size and large manufacturers have entered the market, costs for wind power projects have declined. Costs are far lower than the late 1990s.

However, declines in the capital cost of wind power projects have stopped and even reversed, in part due to increased global commodity costs (e.g., for steel and concrete), fluctuating currency exchange rates that have diminished the value of the American dollar, and high worldwide demand for wind power equipment. It is difficult to predict when and to what extent these upward pressures on the capital costs for wind power projects will moderate.

Wind power has no fuel cost, per se. However, lease payments to the owner of the land where a wind power project is located may be considered a cost of accessing the wind "fuel".

Current Status and Outlook

Wind power technology has dramatically improved during the past decade. Development of wind power has grown globally, nationally and in the Pacific Northwest. In this region alone, during the last 10 years the installed capacity of utility-scale wind power projects has increased from zero to more than 1,700 megawatts.

Recent adoption of Renewable Portfolio Standards by several states is expected to further increase interest in and development of renewable resources, especially wind power. Initiative 937, approved by Washington voters in November 2006, included requirements for conservation as well as renewable resources.

The net impacts from the increased impetus for development of renewable resources such as wind power are difficult to predict. On one hand, continued growth in development of wind power projects in the Northwest may increase economies of scale and spur innovations that lead to reductions in certain types of costs for wind power. On the other hand, the increased demand for

wind power could cause upward pressure on costs, for example if utilities find it necessary to bid increasing prices for a finite amount of viable wind resources.

The Northwest Power and Conservation Council has estimated that there are approximately 6,000 megawatts of developable wind power in the Pacific Northwest over the next 20 years. The Mid-Columbia area of Washington has been identified as a prime location for new wind generation. Areas suitable for wind power development include Kittitas County, the area from the Columbia River gorge to the Southeast corner of Washington, and the Blackfoot area of north central Montana.

Major uncertainties likely to shape the future outlook for wind power include whether or not the federal Production Tax Credit is extended beyond 2007, and challenges associated with construction of new transmission facilities needed to bring large amounts of new wind power generation from good sites to regional load centers.

Resource Characteristics

Transmission requirements. Transmission is one of the most challenging issues to be addressed when considering wind power resources, for several reasons. First, many of the most favorable sites for locating wind power projects in the Pacific Northwest are in areas where the transmission system is already constrained or where transmission does not exist. To accommodate large amounts of new wind power generating capacity, new long-distance high-voltage transmission facilities will need to be built.

Second, the cost of transmission for wind power is higher per megawatt-hour than for other types of generating resources that have a higher capacity factor. Using currently available technology, the capacity factor for most wind power projects averages 30 to 35 percent, which is much lower than the capacity factor for baseload generating resources. To the extent that each type of resource must pay the full cost of reserving transmission capacity for its peak generating capacity, this means that the unit cost (in dollars per megawatt-hour) of transmission for a wind power project can be double the unit cost of transmission for a baseload generating resource.

Third, integration of wind farms into the transmission grid requires consideration of issues associated with intermittent generation

Dispatchability. The amount of wind energy that can be produced depends on both the frequency and strength of winds. Consequently, wind power is not a dispatchable resource, meaning wind power cannot be increased as needed to meet customer demand for electricity. While the reliability and availability of wind turbine generators is relatively high (over 95 percent), the actual amount of generation from a wind power project varies between zero and 100 percent of nameplate capacity.

One approach for firming up the generation from wind power projects is to coordinate their operation with dispatchable resources (e.g., combustion turbine generation) or with resources that have the ability to shape or store energy (e.g., hydroelectric generation).

Integrating wind output into a large power system is challenging because wind power generation cannot be accurately forecast. As the output of wind farms increases or decreases relative to the system load, the output of other sources of generation, such as hydro, natural gas, or coal plants, must be adjusted. Recent studies indicate that when the wind generation exceeds about 10 - 20 percent of a utility's overall resource portfolio, intermittency of the wind power resources can become a significant issue.

Environmental attributes. Wind power is a renewable resource, and is one of the most environmentally attractive utility-scale generating resources currently available. It does not consume fossil fuels or produce air emissions such as carbon dioxide.

Primary environmental concerns related to wind power are potential mortality to birds and visual impacts from the tall towers and rotating turbine blades.

Natural Gas

Natural gas technologies considered for the IRP are Combined-Cycle Combustion Turbines (CCCTs) and Simple-Cycle Combustion Turbines (SCCTs).

Resource Technology and Fuel

Combustion turbine technology has been used to generate electricity for several decades. A combustion turbine is a rotary engine composed of three basic parts. First, air is taken in through a compressor. Next, natural gas is mixed with the air

and burned in a combustion chamber. The resulting mechanical energy is then used to turn a turbine at a speed of 3,600 revolutions per minute.

Combustion turbine size. Two basic forms of combustion turbines are used to generate electricity. Large “frame” machines are designed for use in stationary applications. Frame machines are currently available in capacities of up to 250 megawatts. Smaller combustion turbines, called “aeroderivatives”, are modified versions of the jet engines used on modern airliners. Aeroderivative machines used to generate electricity typically have capacities between 10 and 50 megawatts, but may be much larger.

Because combustion turbine technology is comparatively flexible, a wide variety of generating project configurations is possible. Smaller applications can be built very quickly and may even be mounted on truckbeds for portability. Combustion turbine technology can also be used to build much larger generating projects at permanent sites.

Combustion turbine technology is comparatively efficient at converting fossil fuels to electricity. Higher efficiencies occur with larger machines and machines that operate at higher combustion temperatures.

Types of combustion turbine technology. There are two types of combustion turbines. The combined-cycle combustion turbine (CCCT) uses the combustion turbine to generate power and then recovers exhaust heat from the combustion turbine to make steam for a turbine generator that in turn produces additional power. The simpler and less fuel-efficient simple-cycle combustion turbine (SCCT), generates power directly.

CCCT generating projects are more complex than SCCT projects, and have higher capital costs. However, because CCCT projects are more fuel-efficient than SCCT projects, total running costs for CCCT projects are lower than for SCCT projects.

Both CCCT and SCCT generating projects are primarily fueled with natural gas. Three interstate pipelines transport natural gas to the Northwest. The Northwest Pipeline from British Columbia runs from north to south through western Washington. The two other pipelines transport gas from Alberta in Canada and from the Rocky Mountains, converging

in Northeastern Oregon, proceeding through Portland and then south.

Current Status and Outlook

For the past 15 years, most new generating projects have used CCCT technology. In the Pacific Northwest, there is over 4,000 megawatts of CCCT generating capacity, most of it brought on line between 1995 and 2004. During that period, many CCCT projects were developed by non-utility generating companies for sale of power into competitive wholesale power markets. The Northwest also has slightly more than 1,500 megawatts of SCCT generating capacity, including projects developed during the 1980s and more recently.

Natural gas-fired CCCT generation became popular for several reasons. Market prices for natural gas were low during the 1990s and early 2000s, and during that period, manufacturers made major improvements in combustion turbine efficiency. Also, CCCT projects were relatively quick and easy to permit and construct. CCCT technology was also attractive because it is reliable and provides operating flexibility.

High and volatile prices for natural gas have dramatically slowed the development of new combustion turbine generating projects. Natural gas prices have recently moderated somewhat, and the natural gas industry is working to bring new sources of supply on-stream.

For example, a number of terminals have been proposed to receive imports of liquefied natural gas (LNG), both nationally and in the Pacific Northwest. Some observers believe these and other new sources of supply will help keep market prices for natural gas at moderate levels. However, the outlook for natural gas prices is a significant source of uncertainty for CCCT and SCCT generating resources.

Resource Characteristics

Transmission requirements. Siting for a new CCCT project requires access to a natural gas pipeline and electric transmission facilities that both have available capacity. Because a number of new CCCT generating projects were developed during the past decade, sites have become scarcer. However, some suitable sites may be available that would not require construction of new high-voltage transmission lines.

Dispatchability. Generating projects based on combustion turbine technology are highly dispatchable, giving them a high degree of operating flexibility. SCCT generating units can go from a cold start to full operation in less than 10 minutes. CCCT generating projects can be started up nearly as quickly, although the steam cycle takes hours to start up and shut down. However, combustion turbines operate at highest efficiency under full load. Their efficiency falls off significantly when they are operated below 75 percent of capacity.

Because SCCT generating projects have higher operating (fuel) costs than CCCT generating projects, SCCTs are usually used to meet peak load requirements and provide standby for system reliability purposes. CCCT generating projects are normally used more for baseload and mid-range purposes.

Environmental attributes. Combustion turbine generation consumes natural gas and emits pollutants such as carbon dioxide (CO₂), sulfur dioxide (SO₂) and nitrogen oxide (NO_x). Control technologies are used to eliminate most, but not all emissions of SO₂ and NO_x. However, CO₂ production remains a major consideration in developing generating projects based on natural gas-fired combustion turbine technology. Projects that consume large amounts of water can also be a concern.

Pulverized Coal

Coal has been used to generate electricity in the United States for more than a century. Pulverized coal generation technology was developed in the 1920s and since then has been the most common form of coal-fired generation.

Resource Technology and Fuel

Pulverized coal power plants are fueled by coal that is either extracted from an on-site mine or delivered via railroad or truck. The generation process begins by feeding pieces of coal into the power plant and crushing them into a fine powder. The coal powder is then blown, along with heated air, into a large furnace where it quickly burns. The resulting thermal energy is used to heat water in boiler pipes, creating steam. Next, the steam is used to turn a turbine generator, which produces electricity.

The combustion process produces two forms of ash. Roughly one fourth of the ash is coarser, heavier “bottom ash” that falls to the base of the combustion chamber and is removed. The

other three fourths of the ash is finer, lighter “fly ash” that exits the combustion chamber with the exhaust heat and is passed through a particulate collection system. Many plants use scrubbers and other types of emission control systems to reduce the amount of pollutants that are released.

Pulverized coal power plants can be constructed in unit sizes from less than 50 megawatts to more than 700 megawatts. Some projects use multiple large units, with total plant generating capacity exceeding 1,000 megawatts at a single site. Economies of scale generally enable larger projects to produce power at a lower cost per megawatt-hour.

Fuel characteristics. Coal is a fossil fuel, available in massive amounts in several regions of the United States. Large reserves of coal are available and mines are operated in several Western states, including Montana and Wyoming. The quality of coal varies depending on the source. For example, coal from one location may have higher heat content by weight, while coal from another location may have lower sulfur content.

Compared to most other types of fuels, coal has comparatively low energy density by weight. Also, pulverized coal power plants are not able to convert the energy contained in coal to electricity as efficiently as generating resources that use other fuels.

The fuel characteristics of coal have several implications. Coal is more costly to ship across long distances than other fuels such as natural gas. As a result, in the West it has often been more cost-effective to build pulverized coal generating plants close to the mine, rather than close to where the electricity is consumed.

Costs. Fixed costs are high for pulverized coal generation, especially compared to natural gas-fired combustion turbine generation. Both the capital cost in dollars per megawatt of capacity and the fixed operating costs are higher for a pulverized coal plant. However, the cost of fuel in dollars per megawatt-hour is typically lower for a pulverized coal plant than for a natural gas-fired combustion turbine plant.

During the last several decades, air emission control costs have increased, primarily for equipment to reduce emissions of pollutants such as particulates, sulfur oxides and nitrogen oxides.

There is a significant possibility that costs will be imposed for emissions of carbon dioxide. Pulverized coal generation emits a proportionally large amount of CO₂ per megawatt-hour generated, so if costs for future CO₂ emissions must be paid in

dollars per ton of CO₂ produced, they could become a large proportion of total costs and shift the balance of fixed and variable costs.

Current Status and Outlook

In 2005, 50 percent of the electricity generated in the United States was produced in coal-fired power plants, with about 90 percent of those using pulverized coal.

Pulverized coal power plants are less common on the West Coast. In the Pacific Northwest, coal-fired generating resources serve about 15 percent of total electrical loads. In Washington, one large coal-fired generating plant near Centralia has two 700-megawatt units that began operating in the early 1970s and until recently were supplied by an onsite surface coal mine. The plant is now fueled by coal transported from Wyoming.

Many pulverized coal generation projects in the United States have been in service for 30 years or more. While many plants have been upgraded and modernized, others have not. In the past 15 years, natural gas-fired combustion turbines have been used instead of new coal-fired generation capacity.

However, during the past several years, more than 150 new coal-fired generating units have been proposed in the U.S. One company recently announced that it intends to build 11 new pulverized coal power plants in Texas, plus as many as a dozen or more in other states.

In the West, plans to develop new coal-fired generating plants are drawing strong negative reaction and opposition from environmental organizations, consumer groups and other stakeholders. Meanwhile, some utilities have begun to scale back recent plans to build new coal plants. It is difficult to predict whether or when significant numbers of new pulverized coal generating projects will be built.

Examining the outlook for pulverized coal generation in the United States reveals sharply contrasting considerations. On one hand, pulverized coal generation is a proven, reliable technology that has relatively low direct costs and uses a domestic fuel supply that is readily available in large quantities. On the other hand, it produces larger and more damaging environmental impacts than most other generation resources.

In the future, advances in pulverized coal generating technologies may become commercially successful. For example, supercritical combustion technologies are being

developed that operate at higher temperature and pressure conditions, allowing higher thermal efficiency. However, future costs for carbon dioxide emissions represent a large source of future risk and uncertainty.

Resource Characteristics

Transmission requirements. In the past, long-distance transmission lines have been constructed to bring power from coal plants near the mine to urban load centers. The cost of transporting coal long distances is relatively high, and it is less difficult to site pulverized coal generating facilities in rural areas where coal reserves are available than in highly populated areas where large amounts of power are consumed.

The Pacific Northwest electric transmission grid does not have available capacity to accommodate construction of large new pulverized coal plants in areas such as Montana to serve electrical demands in Western Washington. It is also unlikely that a new pulverized coal power plant could be permitted in Western Washington. Therefore, new long-distance transmission facilities would almost certainly be needed in order to make power from new pulverized coal resources available to this area. However, siting and permitting new transmission facilities for such a purpose may present significant challenges.

Dispatchability. Pulverized coal generating plants operate most efficiently at high capacity factors, often as high as 85 percent, so it can take from 24 to 36 hours to bring a pulverized coal plant from cold start up to full output. As a result, pulverized coal plants are usually operated as baseload resources and are not highly dispatchable.

In limited circumstances such as seasonal periods of high hydroelectric generation and low regional electric demand, pulverized coal plants may be shut down for economic reasons.

Environmental attributes. The most significant drawback of pulverized coal plants is their environmental impacts. Pulverized coal generation is a major source of carbon dioxide emissions and other greenhouse gases and pollutants, emitting more CO₂ per megawatt-hour than most other forms of fossil-fueled generation. There is currently no commercially viable technology for capturing the CO₂. At new pulverized coal generating plants, control technologies are used to remove most but not all emissions of sulfur oxides and nitrogen oxides. Other emissions from coal plants include mercury and carbon monoxide.

Pulverized coal generation also consumes large amounts of water, and coal mining has number of significant impacts on land, water and wildlife.

Coal – Integrated Gasification Combined Cycle (IGCC)

Coal processed with integrated gasification combined cycle (IGCC) technology is a new type of electric generation that is entirely different from conventional pulverized coal electric generation.

Resource Technology and Fuel

The IGCC process begins by partially combusting coal with oxygen and steam under pressure to form an energy-rich synthetic gas called “syngas”. During the gasification process, ash from the coal is removed. Next, the syngas is cooled and processed to remove particulates, mercury and sulfur. The processed syngas is then used to fuel a combined-cycle combustion turbine (CCCT) generation system. The CCCT portion of an IGCC power plant is very similar to the technology used in natural gas-fired CCCT generating projects.

IGCC technology combines the efficiencies of combined-cycle combustion turbines with the relatively low cost and abundant supply of coal. It has a high degree of modularity and improved emissions control over conventional pulverized coal technology. It also has the potential to be used along with another new form of technology designed to convert carbon monoxide in the syngas into carbon dioxide and then sequester it underground.

Current Status and Outlook

Two IGCC plants are operating in the United States. One IGCC project has been proposed in the Pacific Northwest. Energy Northwest has announced that it intends to build a 600-megawatt IGCC project in Cowlitz County Washington, with commercial operation scheduled to begin in 2012.

IGCC technology is currently in the advanced stage of development. The federal government has identified IGCC as a promising new type of generating resource and has provided incentives to spur commercial development of new projects. The prospects for IGCC generation depend on further progress in making the technology reliable and commercially successful.

Using a modular design that incorporates well-proven combined-cycle combustion turbine generating technology has allowed researchers to focus on improving the gasification component of IGCC technology. The technology is expected to become commercially available in unit sizes of 250 megawatts or larger, with total generating plant sizes of 1,000 megawatts or larger.

Carbon sequestration. Compared to the other two primary components of an IGCC plant (CCCT and gasification), carbon sequestration technology is the least mature and requires the most development. As a result, some recent IGCC project proposals include a design that is “sequestration-ready”. This approach may not prove acceptable, due to the risk of relying on carbon sequestration technologies whose future availability, performance and cost are uncertain.

Costs. Coal prices vary in response to fluctuations in market prices for other fossil fuels such as crude oil and natural gas. However, coal prices have historically tended to be less volatile than market prices for natural gas.

Fixed costs represent a larger proportion of total costs than for pulverized coal generation. However, variable costs are expected to be proportionally lower, largely due to the comparatively low cost of coal.

Carbon sequestration would add costs above those for a stand-alone IGCC generating project. These include the direct costs of sequestration plus a reduction in the net amount of electricity generated due to the use of power by the carbon sequestration process.

Resource Characteristics

Transmission requirements. The transmission issues associated with IGCC generation are similar to those for new pulverized coal generation. Lower emissions from IGCC generating technology may make it somewhat less difficult to site IGCC projects nearer to highly populated areas, which may mitigate the need for construction of new long distance transmission facilities. However, sites suitable for carbon sequestration may not be located in areas where transmission capacity is available.

Dispatchability. The CCCT portion of an IGCC generating project has dispatch capabilities similar to a natural gas-fired CCCT power plant. However, the gasification process and lower costs for fuel make it likely that an IGCC generating project would be operated as a baseload resource.

Environmental attributes. Compared to pulverized coal generation, IGCC generation offers several environmental advantages, mostly because particulates, mercury and sulfur are removed prior to the combustion process, rather than after it. The prospect of carbon sequestration represents another potential environmental advantage, compared to other forms of generation that consume fossil fuels. Also, IGCC technology uses about half the water consumed by pulverized coal generation.

Market Resources

The wholesale power market in the 11-state Western region is served by a transmission grid system that allows City Light to participate in many types of transactions. Seasonal exchanges and seasonal capacity contracts are two types of market transactions of interest for this IRP, in addition to long-term power purchases. (See Chapter 3 for details.)

Seasonal Exchanges

A seasonal exchange is a power transaction that takes advantage of the seasonal diversity between Northwest (winter peaking) and Southwest (summer peaking) loads. Utilities can transfer firm power from north to south during the Southwest's summer load season and from south to north during the Northwest's winter load season, allowing both utilities to maintain less generating capacity than would otherwise be necessary.

City Light's existing portfolio includes a seasonal exchange with utilities in Northern California. Exchanges are an ideal solution for meeting the Utility's seasonal needs, provided that both parties can benefit and transmission is available.

Often exchanges are done on a megawatt-hour for megawatt-hour basis. The actual delivery schedules of firm energy in the exchange may vary. For example, one utility could deliver 25 aMW for four months of the year while the other utility delivers 50 aMW for 2 months of the year.

In modeling exchanges, energy transfers were not megawatt-hour for megawatt-hour on a calendar year basis, since winter transfers to Seattle could occur from November through February, cutting across calendar years, while transfers during the summer months all occur within the same calendar year.

When assessing exchanges in the modeling process, a key consideration was having enough firm transmission capacity available at the correct times. Staff analysts first determined whether or not City Light has sufficient rights to firm transmission capacity available along the transmission path between the winter peaking utility (City Light) and the summer peaking utility (in California or the Desert Southwest). If there was not sufficient firm transmission capacity, it was assumed that new transmission capacity would need to be constructed, but a minimum of seven years was allowed before the exchange began. Any new transmission capacity required for the exchange was assumed to be a pro rata portion of an upgrade or new transmission line. This was ultimately considered as a cost of the exchange.

Another important consideration was ensuring that the total amount of City Light energy delivered during the summer months did not grow so large as to make City Light short of energy to meet growing summer loads in later years.

Seasonal Capacity Contracts

A seasonal capacity contract (also known as a physical call option) is a contract that gives the bearer the right to buy a given amount of power at an established price. The contract usually defines which generating resources the electric power will come from, and expires by a certain date. If the option is "called," the bearer of the option (the utility) takes delivery of power up to a maximum amount specified in the contract. By contrast, a financial option is settled with money and does not involve a transfer of electric power. Since the objective of this IRP is to ensure adequacy of resources, only physical call options are considered.

City Light is interested in seasonal capacity contracts because of their flexibility as a resource. They 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 cost or risk 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." 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 amount of power produced by the generator who sold the option.

The availability and costs of seasonal capacity contracts vary over time. Factors often affecting the availability and costs are:

- Balance of supply and demand in the power market
- Degree of price volatility (or price risk) in the market
- Prevailing prices at the time the option is negotiated
- Expectations of both 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. In modeling these contracts, City Light considered purchasing call options in different years throughout the 20-year planning period, mostly as a tool for balancing resource requirements. For planning purposes, the cost of the premium is estimated as the fixed costs of a simple-cycle combustion turbine for the time period covered by the contract, plus a return on investment for the turbine owner.

City Light does not view seasonal capacity contracts as a direct substitute for a generating resource, because there is more uncertainty about their long-term availability and cost. When planning for the years after 2012, these contracts only serve as “bridging” resources in the candidate portfolios. They 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.

Transmission for New Resources

City Light owns only 657 miles of transmission facilities from the Skagit Project and a share of the Third AC Intertie. The Utility is dependent upon access to transmission systems owned by others to reach the Western power market for balancing its seasonal power supply and demand, and gaining access to new power supplies in the future. As congestion in the Western grid continues to grow, utilities that do not own transmission may find it increasingly more difficult to access regional power markets.

Of utmost importance to City Light’s long-term resource planning is whether new transmission facilities can be permitted and built, and whether or not the energy can be transmitted to Seattle. This section identifies issues associated with acquiring long-term firm transmission.

Transmission Contracts

City Light has long-term firm transmission contracts that provide point-to-point contract demand rights of approximately 2,000 MW. These rights are predominantly purchased from the BPA under its FERC-compliant open-access transmission tariff (OATT). These rights provide City Light with some remaining flexibility to secure resources to the east and south.

City Light also has transmission agreements for lesser quantities of transmission service with PacifiCorp, Idaho Power, Avista and Puget Sound Energy. City Light uses most of this transmission capacity for current operations, leaving limited transmission transfer capability available for use in acquiring future distant resources.

In the Pacific Northwest, BPA has convened its stakeholders to assess transmission adequacy and seek solutions to the problems posed by the construction of new transmission lines. These problems include determining how much transmission is needed and when, where transmission needs to be sited, who will own and control transmission facilities, and what measures might forestall the need for construction. The Transmission Adequacy Work Group of the Northwest Power Pool’s Northwest Transmission Assessment Committee is also working to address transmission adequacy for the region.

Issues

City Light does not expect to directly site and develop transmission outside of the Utility’s service area. Transmission facilities required for new City Light generation resources probably will be built by someone else; however, it is in City Light interest to participate in resolving issues such as:

- Lack of available transmission capacity over the long-term.
- Lack of clear responsibility for planning and constructing transmission facilities.
- Time required from planning to construction (averages two to seven years).
- Uncertainty about who will finance, build and pay for needed transmission.
- Uncertainty about costs and rates for new transmission.
- Multi-jurisdictional siting and permitting issues.
- Lack of coordination between transmission and resource planning and development processes.

- Ultimate form of FERC regulations and the future of a regional transmission organization.

City Light may need to build more new generating resources if it cannot take advantage of seasonal diversity of power demand, importing from California or the Desert Southwest during the fall and winter to meet peak requirements. An overbuilt power market may be depressed due to the surplus of Northwest power during the summer and lack of ability to export to high demand regions.

Having a low-priced wholesale market for power during much of the year may be beneficial to industrial customers who can directly access that market. However, utilities hoping to keep costs low for their customers could suffer if adequate transmission is not available.

Anticipated Need for New Transmission

City Light may need new or upgraded transmission facilities to transmit power from any additional resources to its service area or to the existing regional transmission grid. New transmission also may be needed to improve reliability, redundancy or otherwise increase the capacity of the system to reduce or defer the need for new generation sources.

Actual transmission requirements cannot be known until the size, location and operating characteristics of proposed new resources are identified. In general, resources farther from load centers and from existing transmission lines would require more transmission construction than resources close to load centers and existing transmission lines. Table 4-3 shows assumptions about general transmission line requirement for potential new generation resources considered in the IRP.

Table 4-3. Transmission Facility Requirements

Resource Type	Miles of New Transmission Lines Needed*	Upgrade of Existing Transmission
Conservation	None	None.
City Light-Owned Hydropower	None	Uses existing transmission.
Contracts/Exchanges	None	Uses existing transmission when available.
Natural Gas - Combined Cycle	50	
Natural Gas - Simple Cycle	None	Assumes some upgrades to BPA transmission may be necessary, but because the generating capacity would be small, the upgrades would be less than BPA's rate. Therefore uses BPA's rate.
CHP (Combined Heat and Power)	None	0
IGCC Coal - after 2012 (Montana)	950	0
Pulverized Coal (Montana)	950	0
Wind (Northwest)	225	0
Geothermal (Idaho, Oregon, Western Washington)	None	Assumes some upgrades to BPA transmission may be necessary, but because the generating capacity would be small, the upgrades would be less than BPA's rate. Therefore uses BPA's rate.
Hydro Contract	None	Assumes some upgrades to BPA transmission may be necessary, but because the generating capacity would be small, the upgrades would be less than BPA's rate. Therefore uses BPA's rate.
Wind (Montana)	950	0
Biomass, Wood (Western Washington)	None	Assumes some upgrades to BPA transmission may be necessary, but because the generating capacity would be small, the upgrades would be less than BPA's rate. Therefore uses BPA's rate.
Biogas, Landfill Gas	None	Assumes some upgrades to BPA transmission may be necessary, but because the generating capacity would be small, the upgrades would be less than BPA's rate. Therefore uses BPA's rate.

*Miles from the point where the resource interconnects with the grid to Seattle.