RESOURCE OPTIONS

An essential step for integrated resource planning is to identify and evaluate a broad range of resources, as required by Washington state law (RCW 19.280), including energy efficiency. This appendix contains information about resources currently available to electric utilities that are considered for the 2016 Integrated Resource Plan (IRP). The resources evaluated include energy efficiency programs, nonrenewable generation resources (natural gas), renewable generation resources (such as wind and solar) and short-term power purchases from the western wholesale energy market.

ENERGY EFFICIENCY RESOURCE

As a low-cost, low-carbon alternative to other types of energy generation, energy efficiency is City Light's first choice resource for meeting growing demand for power. Through the longest running energy efficiency programs in the nation, City Light partners with its customers to use energy-efficient equipment and practices in homes and businesses. These programs offer direct customer value, but also deliver broad benefits to the utility by avoided high-cost generation, deferred transmission and distribution investments, and reduced air pollution and greenhouse gas emissions. Acquiring energy efficiency is also a good policy in a changing energy market because it avoids price risk and availability risk.

Characteristics

Utilities must be able to match resources to load. Dispatchability refers to a utility's ability to control the output of a generation resource in real time. More readily controlled resources, such as gas turbines, have a greater degree of dispatchability. Energy efficiency measures are not dispatchable and their impact is defined by seasonal, daily and hourly usage patterns. The ability to save energy is based on when the energy consuming equipment is in use. Some equipment, like refrigerators, are on constantly. Other equipment, such as washing machines, make an impact during the times they are in use.

Energy efficiency measures can be considered either discretionary resources or lost opportunity resources. Lost opportunity energy efficiency can occur when there is a single decision point where the energy efficiency choice can be made. Lost opportunity energy efficiency must be captured when a new building is built or when a new appliance is installed; if not, the energy efficiency opportunity can be lost. In contrast, discretionary measures can be implemented at any time within practical limits. Discretionary measures are energy efficiency improvements that can occur from equipment replacements and equipment upgrades. Discretionary energy efficiency can be shifted during the study period based on the timing of incentives and programs, while lost opportunity energy efficiency must follow building construction trends.

Conservation Potential Assessment

The 2016 Conservation Potential Assessment (CPA), conducted by Cadmus, Inc., examined energy savings available in the residential, commercial and industrial sectors in City Light's service area. The assessment considered hundreds of potential energy efficiency measures, distinguishing between discretionary resources and lost opportunity resources. The study also incorporated non-energy benefits.

The CPA identified the total 20 year opportunity for energy efficiency and then adjusted the potential based on market conditions. Technical potential refers to the maximum savings that could be achieved if every cost-effective efficiency measure were implemented in every customer facility. Achievable potential is the portion of technical potential that will likely be viable over the planning horizon, given market barriers and an economic screen. The result was an achievable cost-effective energy efficiency potential that totals 205.4 aMW over the 20-year planning horizon.

Modeling Energy Efficiency in the 2016 IRP

In the 2016 analysis, staff modeled different energy efficiency scenarios. The base and high achievement of energy efficiency scenarios were selected as part of the candidate resource portfolios (Figure 1: Cumulative Energy Efficiency by Year). The main difference between base and high achievement of energy efficiency was that although the overall potential was the same, high achievement of energy efficiency shifted forward some of the discretionary measures.

In general, the reported energy efficiency cost structure suggests that the cost of energy efficiency is not a limitation for achievable energy efficiency. The most meaningful constraints to energy efficiency have been physical. In the 2010 IRP, City Light found that it should acquire energy efficiency as quickly as possible, as long as the cost was significantly below the levelized avoided cost threshold.

In estimating the pace of the high achievement of energy efficiency, the model logic does not address practical considerations of energy efficiency program implementation. For the high achievement of energy efficiency, the relevant question was implementation: “How quickly can City Light actually ‘mine’ discretionary energy efficiency from existing buildings?” The answer to this depends on issues such as City Light’s and customers’ budgets, policy-makers’ priorities, customer incentives, staffing, office space, consultants, energy efficiency contractors, and coordination of schedules.

Figure 1: Cumulative Energy Efficiency by Year

YEAR	BASE	HIGH ACHIEVEMENT
2016	12.53	14.35
2017	25.06	28.91
2018	37.60	45.69
2019	50.14	61.09
2020	62.64	78.22
2021	75.18	93.54
2022	87.70	108.28
2023	100.23	121.05
2024	112.80	132.69
2025	125.24	142.80
2026	137.67	152.03
2027	148.48	160.21
2028	157.66	167.38
2029	166.72	175.02
2030	174.42	181.71
2031	181.02	187.56
2032	187.07	192.49
2033	192.41	196.95
2034	197.37	201.15
2035	202.01	205.22

GENERATION RESOURCES

Generation resources produce electrical energy from other forms of energy, such as heat or solar; or potential energy, from wind or falling water. The types of generation resources analyzed for an IRP are proven and commercially available. Generation resources added to City Light's existing portfolio will have characteristics important to City Light's future needs. The most important characteristics to consider when comparing generation resources are costs, dispatchability, transmission requirements, and environmental attributes.

Evaluating the Resources

This section describes the types of generating resources that were candidates for inclusion in the candidate resource portfolios for the 2016 IRP and how those resources were selected from the available technologies.

- Wind
- Biomass
- Geothermal
- Solar
- Natural Gas-Fired Combined-Cycle Combustion Turbine (CCCT)
- Natural Gas-Fired Single-Cycle Combustion Turbine (SCCT)
- Hydro

As research and development continue for new or enhanced types of generating resources, it is difficult to predict future technological advancements and how they will affect resource costs and availability. For this reason, most IRPs identify and monitor promising generating resource technologies that may become technically viable and commercially available, but do not include them in the quantitative analysis. Washington state law governing IRPs states that they should contain commercially available technologies and select resources with the lowest reasonable cost. In keeping with state law and IRP best practices, this IRP does not contain forecasts of new technologies or their costs.

Selecting a Range of Resources

The IRP staff followed a structured process to compare and choose from an array of available resource types. City Light evaluated more types of generating resources than were included in the recommended resource portfolio. Including a broad range of resource types has advantages, including the assurance that the IRP process is objective and does not prematurely narrow the field of resource alternatives. Each type of generating resource has a unique combination of advantages and disadvantages, including costs, benefits, opportunities, and risks. Evaluating a particular resource does not imply a predetermined preference for or against its inclusion in City Light's portfolio.

Analyzing various types of generating resources helps identify which combinations of new resources can best complement the existing resources in City Light's portfolio. A single type of generating resource might not meet all of the utility's long-term needs, while a diversified mix of resources may be more likely to meet the utility's objectives of maximizing reliability and minimizing cost, risk and environmental impacts.

Various types of generating resources have proponents and opponents. 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. Quantitative analysis of candidate resource portfolios that combine a variety of resource types provides the means to incorporate input from many perspectives such as capacity, efficiency, potential availability, dispatchability, environmental emissions, and cost. These inputs can be used for comparisons between portfolios. Quantitative analysis of the candidate resource portfolios with different mixes of resources can produce useful information for selecting a long-term resource strategy.

Based on results from quantitative analysis, City Light's candidate resource portfolios contain resources that are known to be commercially viable at the point the IRP is produced. Some resources were not included in the quantitative analysis because their costs are significantly higher or due to governmental regulations or environmental constraints, they are not viable options for consideration in the resource portfolios - ultimately they are not commercially available to City Light.

Costs of New Generation Resources

City Light conducts in-depth research using many reliable technical sources to determine the outlook of the costs for generation resources during the IRP study period. Due to federal, state, and local environmental policies and regulations[1] as well as governmental incentive programs,[2] renewable generation resource costs, such as wind and solar photovoltaic (PV) have declined. The combination of existing and new environmental regulations and policies, lower electricity demand, and increased natural gas production have led to the reduction of demand for natural gas and lower natural gas costs. As a result of lower natural gas prices, the generation cost for natural gas-fired turbines has been driven down.

Information about the costs of new resources came from many sources, including new existing renewable contracts in WECC, the U.S. Department of Energy, Northwest Power and Conservation Council, California Energy Commission, and Integrated Resource Plans from other utilities in the Pacific Northwest.

Transmission costs for new resources are assumed to be consistent with the BPA's policy for new transmission. The policy is that the BPA will build new transmission as needed by its customers, not to exceed an amount that would increase rates by 5 percent.

Figure 2 provides costs and other assumptions for new generation resource options that were evaluated in the 2016 IRP.

Figure 2: New Generation Resource Options Evaluated in the 2016 IRP

RESOURCE	2014 $/ MWH
CCCT	$ 76.31
SCCT	$ 143.58
Biomass: Landfill Gas	$ 96.40
Biomass: Wood Waste Cogen	$ 101.34
Biomass: CHP Gasification	$ 141.44
BPA Hydro	$ 51.49
Non-BPA Hydro	$ 55.09
Geothermal	$ 144.59
Solar PV	$ 127.14
Solar Thermal	$ 244.59
Wind	$ 76.97

Resources Evaluated in the IRP

As mentioned earlier, the most important characteristics of generation resources added to City Light's current portfolio are costs, dispatchability, potential availability, transmission requirements and environmental attributes. For each new generation resource evaluated, the following basic information was gathered:

- Resource technology and fuel
- Current status and outlook
- Resource characteristics

WIND POWER

The use of wind power has increased rapidly, making it the predominant renewable resource technology in the Pacific Northwest, where the installed capacity of wind power projects has increased from zero to more than 3,000 megawatts in the last decade.

WIND POWER	
TECHNOLOGY & FUEL	Wind power is the process of mechanically harnessing energy from the wind and converting it into electricity. The amount of wind power that can be produced at a given place is dependent on the strength and frequency of wind. Wind velocity and frequency is particularly important because the quantity of power increases as wind speed and frequency of wind increases, up to the maximum capacity of the wind turbine. In general, wind turbine generators are grouped together in order to minimize costs while maximizing output. Wind power has no fuel cost. However, lease payments to landowners are a cost of accessing the wind "fuel".
CURRENT STATUS & OUTLOOK	The Northwest Power and Conservation Council (NPCC) estimates the potential for wind power in the Pacific Northwest exceeds 6,000 megawatts. In the region, wind projects range anywhere from less than 1 MW to 343 MW.
CHARACTERISTICS	Transmission requirements. The cost of transmission for wind power is higher per megawatt-hour than for other generating resources because it has a low capacity factor. Dispatchability. Wind power is not a dispatchable resource. One approach for firming up the intermittent 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). Environmental attributes. Wind power is renewable and does not consume fossil fuels or produce air emissions. Primary environmental concerns are bird and bat mortality and visual impacts.

SOLAR POWER

Solar PV and solar thermal power prices have dropped significantly from $210.7 per MWh (levelized cost of energy) in 2011[3] to $114.3 per MWh in 2015[4] and $311.8 per MWh in 2011 to $220.6 per MWh respectively. Solar PV growth has dramatically increased in the US. Despite having a low solar efficiency rate in many parts of the Pacific Northwest, as a result of the existing and new regulations and policies such as RPS and Federal and State incentive programs, solar power projects have become more commercially available.

SOLAR POWER	
TECHNOLOGY & FUEL	Solar power is generated by transforming solar radiation by converting it into heat and electricity. There are two ways that solar energy can be converted into electricity: Photovoltaics change sunlight directly into electricity and solar thermal generate electricity by concentrating solar energy to heat a fluid to produce steam that is used by a power generator.
CURRENT STATUS & OUTLOOK	The Northwest Power and Conservation Council (NPCC) estimates solar costs will drop to $1 per watt for utility-scale solar PV projects coming online by 2020, representing a 75% cost reduction since 2010. Solar PV projects are still highly dependent on federal incentives. The Federal Investment Tax Credit (ITC) which provides a 30% credit for solar projects has been extended until 2019, then the credit steps down annually to be reduced to 10% by 2022. In the region, solar project capacities range anywhere from less than 1 MW to 14.3 MW.
CHARACTERISTICS	Transmission requirements. The cost of transmission for solar power is much higher per megawatt-hour than for other generating resources because it has a low capacity factor. Dispatchability. Solar power is not a dispatchable resource. Solar power is dependent on daylight and is also impacted by location and cloud cover to produce high amounts of energy. One approach for compensating for the intermittent generation from solar 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). Environmental attributes. Solar power does not consume fossil fuels or produce air emissions. Primary environmental concerns for solar technologies are the hazardous materials used in the manufacturing process.

BIOMASS

Biomass generation is the production of electricity using biomass fuel which is made from organic material that can be burned or converted into a combustible material. Examples of biomass fuels that can be used to generate electricity include waste wood (e.g. residues from forest thinning, logging and mill processes), methane produced at wastewater treatment plants, methane produced from the decomposition of animal manure, agricultural residues, natural degrading and decomposition of municipal solid waste in sanitary landfills, and energy crops.

For the 2016 IRP, wood waste cogeneration, gasification CHP, and landfill gas were used as potential biomass resources.

BIOMASS	
TECHNOLOGY & FUEL	Biomass is converted into fuel using thermochemical or biochemical processes. Biomass plants generate electricity by processing the raw biomass into a combustible fuel and burning it. Conventional steam-electric turbines with or without cogeneration are the chief technology for electricity generation using wood-derived fuels. Generating electricity from biomass requires large quantities of organic material because the raw forms of biomass fuel sources have low energy content.
CURRENT STATUS & OUTLOOK	Biomass type resources are situation-specific. Details vary based on the fuel source and the technological process used to generate electricity from that source. In the region, biomass projects range anywhere from less than 1 MW to 113 MW in capacity. City Light has a contract with King County's West Point Water Treatment Facility and a small contract with Columbia Ridge landfill gas plant.
CHARACTERISTICS	Transmission requirements. Biomass generation is usually sited near transmission or distribution lines. Dispatchability. Biomass generating resources usually operate as base load generation. Environmental attributes. Most biomass fuel is a renewable resource, with low environmental impacts. Biomass generation does not add large amounts of additional carbon dioxide to the atmosphere, but it does emit nitrogen oxides and particulate matter. When using conventional steam-electric turbine technology consumes significant amounts of water – up to 55,000 gallons per megawatt-hour, depending on fuel source and production technology.

GEOTHERMAL

Geothermal is the only large renewable resource that combines base load generation with long-term firm fuel supply and scalability. While other renewable energy resources like wind and solar generate power intermittently, and hydro availability varies from year to year, geothermal can be operated over 95 percent of the time and may operate for 100 years or more.

GEOTHERMAL	
Technology & Fuel	Geothermal energy is derived from heat that originates deep in the earth's crust. There are three basic types of geothermal generating technologies: dry steam, flash, and binary.
Current Status & Outlook	A Western Governors' Association Geothermal Task Force Report estimates nearly 1,300 megawatts of developable geothermal generation in Washington. However, the outlook for development of geothermal generating resources in Washington and parts of the Pacific Northwest is unclear because extensive exploratory drilling has not been done. In the region, geothermal project capacities range anywhere from 12 MW to 28.5 MW.
Characteristics	**Transmission requirements.** Sites with geothermal potential are located near City Light owned or controlled transmission. If geothermal plants are built in those areas in the future, upgrades to the existing transmission system may be necessary. Geothermal is easy to integrate into a hydroelectric system because it has a high capacity factor. **Dispatchability.** Geothermal energy is usually operated as a base load supporting resource but it has some limited dispatchability on-peak and off-peak. **Environmental attributes.** Geothermal energy is a renewable resource. No fossil fuels are consumed, but the potential for release of pollutants, potential impacts to ground and surface water, and land use issues make it difficult to site in wilderness areas.

NATURAL GAS: COMBINED-CYCLE COMBUSTION TURBINES & SIMPLE-CYCLE COMBUSTION TURBINES

Combustion turbine technology has been used to generate electricity for several decades. Natural gas generation technologies considered for the 2016 IRP are CCCTs and SCCTs.

NATURAL GAS	
Technology & Fuel	There are two types of combustion turbines. The 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 SCCT generates power directly, without recovery of exhaust heat. CCCTs are more complex than SCCTs, and have higher capital costs. However, CCCTs are more fuel-efficient, with total running costs lower than for SCCTs. Both CCCT and SCCT projects are primarily fueled with natural gas.
Current Status & Outlook	In the Pacific Northwest, there are approximately 5000 megawatts of CCCT generating capacity. The region also has slightly more than 1,500 megawatts of SCCT generating capacity. Natural gas project capacities range anywhere from less than 1 MW to 689.4 MW. Historically, volatile natural gas prices and surplus generating capacity in the Pacific Northwest slowed the development of new combustion turbine generating projects until recently. New shale gas supplies and much lower natural gas prices created an increase in natural gas-fired generation development.
Characteristics	**Transmission requirements.** Siting requires access to a natural gas pipeline in addition to electric transmission. **Dispatchability.** Combustion turbines are highly dispatchable. SCCT generating units can go from a cold start to full operation in less than 10 minutes. CCCT generating projects can be started up and shut down in a matter of hours. Combustion turbines operate at highest efficiency under full load. 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 resources for system reliability purposes. CCCT generating projects are normally used more for base load and mid-range purposes. **Environmental attributes.** Combustion turbines emit carbon dioxide, small amounts of sulfur dioxide (SO2), nitrogen oxides (NOX), and other air pollutants. Control technologies are used to eliminate most emissions of SO2 and NOX. CO2 production remains a major consideration. Some projects require large amounts of water, and there are other impacts from fuel extraction and transportation.

HYDRO

In previous IRPs it has been assumed that the current BPA contract would be renewed at the end of 2028. City Light's BPA hydro contract averages anywhere from 39% to 41% of the resource portfolio. In this IRP, the BPA contract expires at the end of September 2028, allowing City Light to identify potential options or cost-effective modifications that could impact the resource portfolio.

MARKET RESOURCES

A transmission grid system that serves the 11 states of the Western Region enables City Light to participate in many types of wholesale power market transactions. Seasonal exchanges and short-term energy and capacity purchases can be used to "reshape" power from spring to winter, allowing City Light to sell generation when loads are low or generation is high and to buy generation in the wintertime from other producers when loads are high or generation is low.

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. City Light 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. Exchanges are helpful in meeting the utility's seasonal resource needs since it enables the utilities in different locations to maintain less generating capacity than would otherwise be necessary. City Light's current portfolio includes a seasonal exchange with Northern California Power Agency (NCPA).

Exchanges are often done on a megawatt-hour for megawatt- hour basis, though 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 two 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 occur from November through February, bridging calendar years, while transfers during the summer months occur within the same calendar year.

When assessing seasonal exchanges or short-term energy "reshaping" transactions, City Light first determined whether or not the utility will have sufficient rights to firm transmission capacity available along the transmission path between the winter peaking utility (such as City Light) and the summer peaking utility (such as those in California or the Desert Southwest).

Another important consideration in assessing exchanges is ensuring that the total amount of energy City Light delivers during the summer months does not deprive City Light of the energy needed to meet growing summer loads.

RESOURCE ADDITIONS AND PORTFOLIO DESIGN CONSIDERATIONS

In planning the 2016 IRP and considering new resources, City Light examined the particular characteristics of each resource. The requirements of the Renewable Portfolio Standard (RPS, which was previously known as I-937), the use of Renewable Energy Credits (RECs), and the future need for new transmission for new resources. These considerations are described below.

Renewable Portfolio Standard

I-937, the Energy Independence Act, was passed by Washington voters in November 2006 and became the Renewable Portfolio Standard. Without purchasing any additional resources, City Light meets the renewable resource requirement through 2024 because of wind energy purchased from the Stateline Wind Project and forward purchases of renewable energy credits (RECs). Until then, resource adequacy is the main consideration in renewable resource acquisition choices.

Renewable Energy Credits

Renewable Energy Credits (RECs) are tradable certificates that represent the environmental attributes of one megawatt-hour of electricity generated by a power plant that is a qualifying renewable resource under state law. Evaluation of REC strategies is an important issue in the IRP process. Targets for RPS compliance were established based upon the formula and information stated within the 2006 legislation (RCW 19.285), rulemaking, and City Light's long-range load forecast. RCW 19.285 requires electric utilities to have 15 percent of their energy provided by new, qualifying renewable resources by 2020. Since the 2010 IRP, the utility has acquired renewable resources and sufficient RECs to meet RPS requirements through the year 2024.

REC prices in the Pacific Northwest have fallen precipitously as the result of legislation, regulatory decisions in California, and transmission congestion. In a 2012 decision by the California Public Utilities Commission, the amount of RECs that can be purchased from outside California was capped. California's SBX1-2 increases the requirements for renewable energy under the renewable portfolio standard, but at the same time it limits the use of tradable renewable energy credits (TRECs) to 25 percent of a utility's requirement. Additionally, by 2017 and thereafter, California's cap on TRECs will tighten to 10 percent. In October 2015 California's legislature passed SB 350 which increases RPS requirements to 50 percent by 2030. In 2016, the Oregon legislature passed SB 1547 which increases RPS requirements to 50 percent by 2040 and a total phase-out of coal fired electricity by 2035. Pacific Northwest wind generators are also constrained from selling wind energy (including the associated RECs) in California and Oregon by transmission congestion. The combined effects of regulatory decisions and transmission constraints greatly diminished the Pacific Northwest market for RECs.

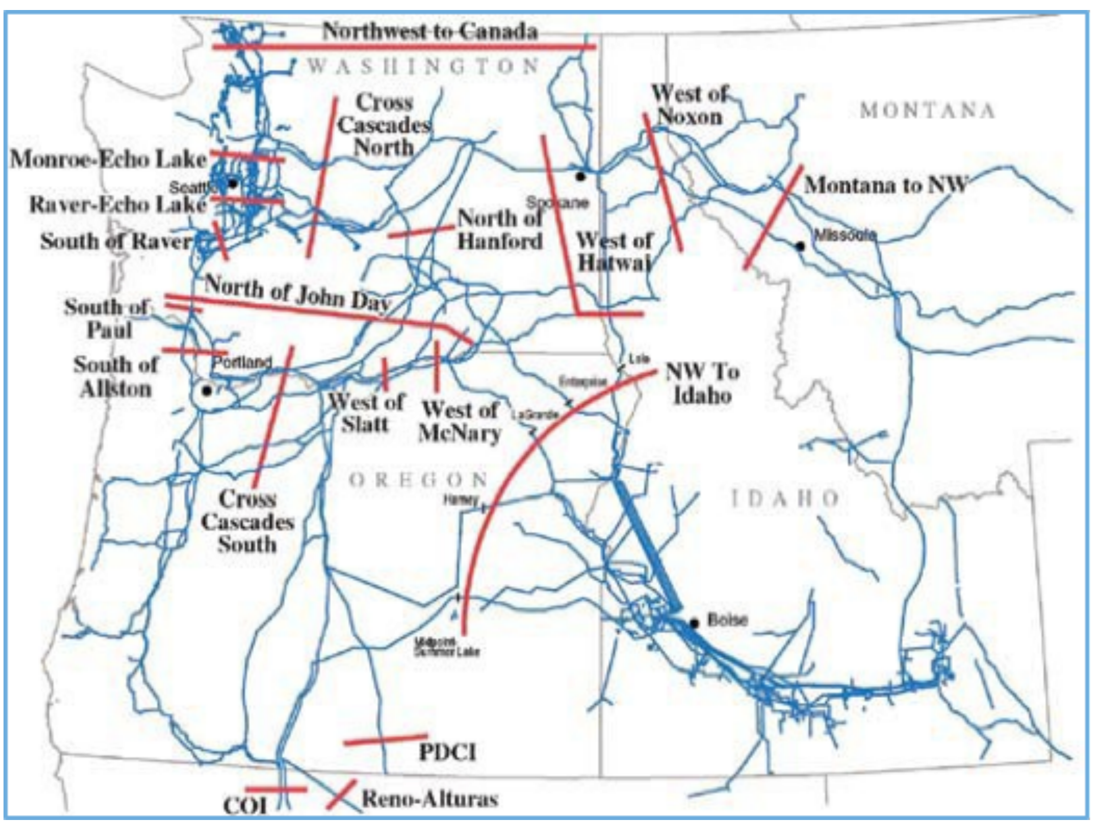
City Light's estimated long-term cost of RECs is expected to be lower for this IRP as a result of regulatory action in the WECC sub-regions, transmission constraints between geographical areas, and an overall regional declining trend in demand largely caused by energy efficiency. REC costs are small in comparison to costs of other resources and have no impact on relative portfolio rankings.

Transmission for New Resources

City Light owns only 657 miles of transmission facilities – primarily from the Skagit Hydroelectric Project to its service area – 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 surpluses and deficits, as well as gaining access to new power supplies in the future. The capacity of the existing regional transmission system – of which approximately 70 percent is owned and operated by BPA – is almost fully subscribed, and available capacity on key transmission paths is extremely limited. The congested transmission paths, or flow gates, in the Northwest are shown in Figure 3.

As congestion in the Western grid continues to increase, existing firm transmission rights become more valuable and acquisition of new transmission capacity from existing transmission providers becomes more difficult. As the transmission system ages, maintenance outages that are more frequent and of longer duration will be needed to maintain system capacities and prevent path deratings. Scheduled outages often cause inefficient management of generation resources. Energy efficiency seems to be the most cost-effective option to avoid the high costs of new transmission lines in addition to the more obvious environmental benefits. The likely upgrade on BPA's transmission system could potentially be the integration of renewable resources by utilities from the area, however given the high costs of integration and new transmission, it is unlikely to occur in the near term. City Light will monitor whether or not new transmission facilities can be permitted and built to see if new generating resources can be delivered to Seattle.

Figure 3: Northwest Constrained Transmission Paths



TRANSMISSION CONTRACTS

City Light has long-term firm transmission contracts that provide point-to-point (PTP) contract demand rights of approximately 2,000 MW. These rights are predominantly purchased from BPA under its FERC-compliant open-access transmission tariff and provide distinct quantities of transmission capacity on a point-of-receipt to a point-of-delivery basis. These rights provide City Light with some flexibility to secure firm transmission for resources located to the east and south of Seattle. City Light also has transmission agreements for lesser quantities of transmission service with PacifiCorp, Idaho Power, Avista and Puget Sound Energy.

City Light has reserved most of this transmission capacity for current operations by designating the plant capacity at the point-of-receipt, thus leaving limited transmission transfer capability available for use in acquiring future distant resources.

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[1] Renewable Portfolio Standard (RPS)

[2] Production Tax Credit (PTC) and Investment Tax Credit(ITC)

[3] EIA Annual Energy Outlook 2011: Table 1. Estimated Levelized Cost of New Generation, 2016. U.S. Average Levelized Costs (2009 $/MWh) for plants entering service in 2016

[4] EIA Annual Energy Outlook 2015: Table 1. Estimated levelized cost of electricity (LCOE) for new generation resources, 2020. U.S. Average Levelized Costs (2013 $/MWh) for plants entering service in 2020