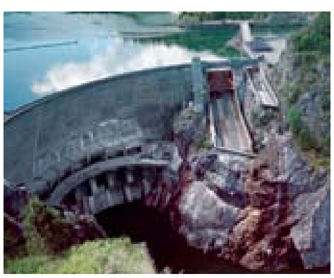
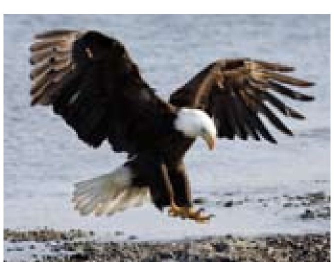
2008 Integrated Resource Plan





Seattle City Light

Seattle's municipal electric utility

2008 Integrated Resource Plan

Seattle City Light

Resource Planning

700 Fifth Avenue, Suite 3200
P.O. Box 34023
Seattle, Washington 98124-4023
www.seattle.gov/light/news/issues/irp/
206/684-3564

Acknowledgements

IRP Stakeholder Group

Stakeholders

Vita Boeing, Residential Customer
Steve Butler, City of Seatac
John Chapman, University of Washington
Stuart Clarke, Bonneville Power Administration
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Tom Eckman, Northwest Power and Conservation Council
Craig Gannet, Davis Wright Tremaine LLP
Steve Grose, Virginia Mason Medical Center
Rod Kaufman, Building Owners and Managers Association
Steven LaFond, Boeing
Mike Morris, Building Owners and Managers Association of Seattle
John Schelling, City of Seatac
Dr. Jennifer Sorenson, Seattle University

Staff Participants

Don Eder, City Council Staff
Alec Fisken, Mayor's Office of Policy and Management
Tony Kilduff, Seattle City Council Staff

Seattle City Light IRP Team

SCL Staff

David Clement, Resource Planning Director
Sarang Amirtabar, Resource Planning
Beth Blattenberger, Science Policy
Carsten Croff, Financial Planning
Corinne Grande, Science Policy
Paula Laschober, Financial Planning
Steve Lush, Energy Management Services
Marilynn Semro, Wholesale Contracts
Don Tinker, Power Marketing
Mary Winslow, Resource Planning

IRP Consultant

Charlie Black, CJB Energy

Cover photographs:

Wind Generation
Sockeye Salmon
Boundary Dam on the Pend Oreille River
Bald Eagle

Table of Contents

List of Figures

List of Tables

2008 Integrated Resource Plan – Executive Summary

The Recommended Resource Strategy

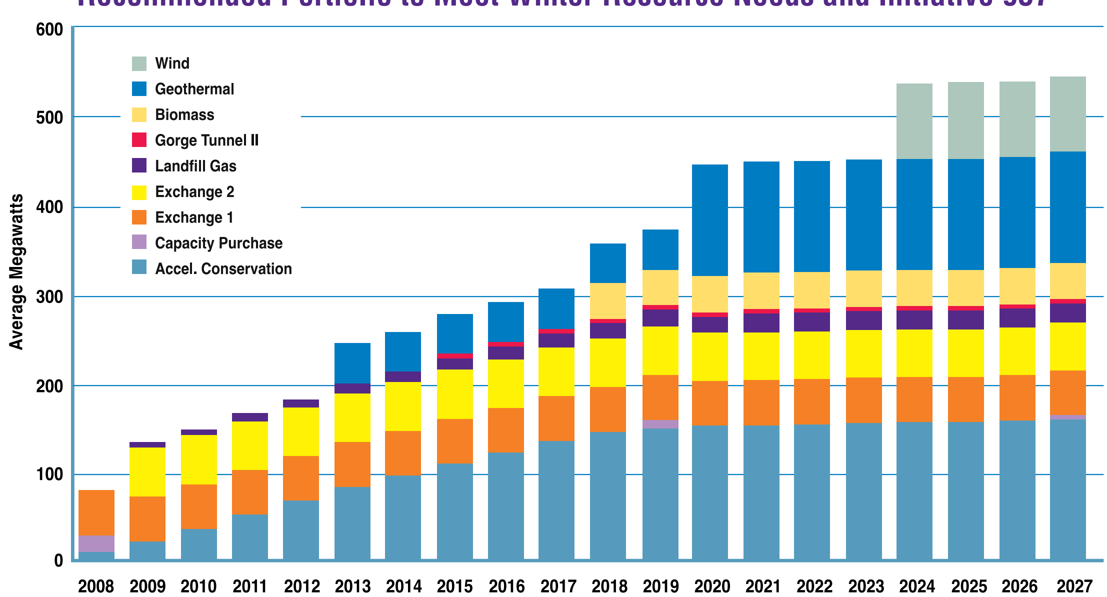
Seattle City Light's 2008 Integrated Resource Plan (IRP) identifies how much additional power the utility needs in the winter (when highest demand occurs) through 2027. It demonstrates how the utility plans to meet growing resource demand within a policy context. It evaluates candidate resource portfolios against four criteria - reliability, cost, environmental impact and risk - balancing these criteria with public input from a wide range of perspectives.

To meet winter resource needs, City Light's 2008 IRP recommends a long-term conservation and power resource strategy and a short-term action plan. The recommended long-range resource acquisition strategy recommends these steps:

- Accelerating the acquisition of cost-effective conservation.
- Instituting cost-effective seasonal power exchanges designed to increase available winter energy, beginning in 2009.
- Exercising City Light's preference rights for the purchase of low-cost power from the Bonneville Power Administration (BPA) in a new contract beginning in 2011.
- Planning for the near- to mid-term purchase of output from low-cost renewable resources such as a small, new landfill gas project.
- Acquiring output from other renewable resources such as geothermal, biomass, and wind beginning in 2012, to meet resource adequacy requirements and in compliance with Washington state Initiative 937.

The recommended resource strategy is a continuation of the utility's policy of obtaining low-cost power with low environmental impacts for its ratepayers/owners (see graph below) while making the most of its existing resources. Conservation is the first choice resource, followed by seasonal exchanges that help shape resources to load. City Light expects its access to low-cost federal power via BPA will be locked in for 20 years, beginning in 2011. Market-based purchases take place when a resource need exists without enough justification to acquire new resources. When new resources are needed, the lowest-cost renewable resources are acquired first, followed by higher-cost renewable resources.

Recommended Portfolio to Meet Winter Resource Needs and Initiative 937



Integrated Resource Planning Process

The two-year planning process that culminated in City Light's preferred portfolio included these steps:

- Public Involvement of citizens and stakeholders with diverse perspectives.
- Recruiting expertise from inside and from outside the utility.
- Licensing and installing a sophisticated computer model, the AURORAxmp® Electric Market Model, for power planning.
- Calibrating the model for the characteristics of City Light's complex hydroelectric operations and purchase power contracts.
- Thoroughly assessing conservation resource potential in the service area.
- Forecasting customer demand for power each month through 2027.
- Developing a resource adequacy measure, crucial for defining the timing and amount of future need.
- Developing costs and characteristics of alternative resources to be included in the candidate resource portfolios.
- Constructing and modeling Round 1 candidate resource portfolios for evaluation against four criteria: Reliability, cost, risk and environmental impacts.
- Constructing and modeling Round 2 candidate resource portfolios, based on findings and comments in response to Round 1.
- Updating an Environmental Impact Statement (EIS) for new resource portfolios.
- Recommending a resource strategy and near-term resource action plan.

Public Involvement

The IRP stakeholder committee represents residential, commercial and industrial customers, environmental organizations, power resource developers and energy-related government agencies. This committee guided resource planning efforts during five meetings with comments, questions and suggestions throughout the process. Members of the public also attended IRP public meetings and offered suggestions that helped to shape the analyses used in the planning process.

The IRP was developed in two phases. Phase 1 identified proposed assumptions, including projected peak demand, forecasts of future energy prices, availability of spot market purchases, resources to consider, resource costs, performance measures and a wide range of potential resource portfolios that could meet the projected demand.

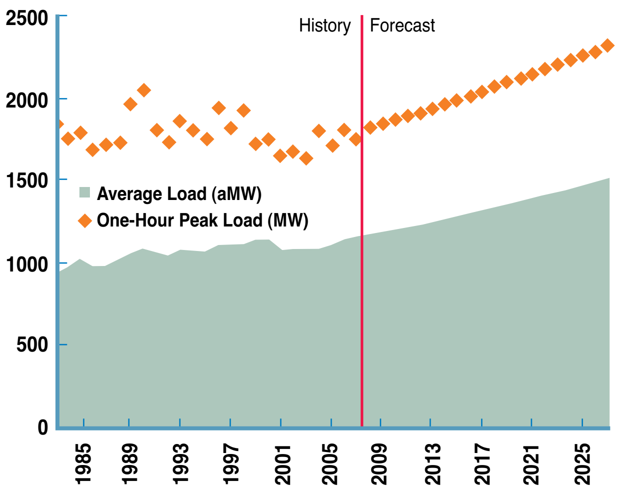
These assumptions were adjusted in response to public input. The operations of the alternative resource portfolios were then simulated using a sophisticated computer model. The results of the computer modeling of power operations were evaluated for performance, using the four criteria of reliability, cost, risk and environmental impact.

In phase 2 of the IRP process, lessons learned from the first phase were used to construct a different set of resource portfolios, in order to improve their performance based on the four criteria. After this analysis, a recommended resource portfolio was identified.

Load Forecast and Resource Adequacy

A first step in assessing the need for additional resources is a forecast of future need, taking into account the load forecast and the desired level of resource adequacy. The utility's long-range forecast projects continued load growth for the service area. The IRP treats conservation as a resource and evaluates it in the same way as it evaluates other resources. The graph below shows the load forecast assuming no new programmatic conservation.

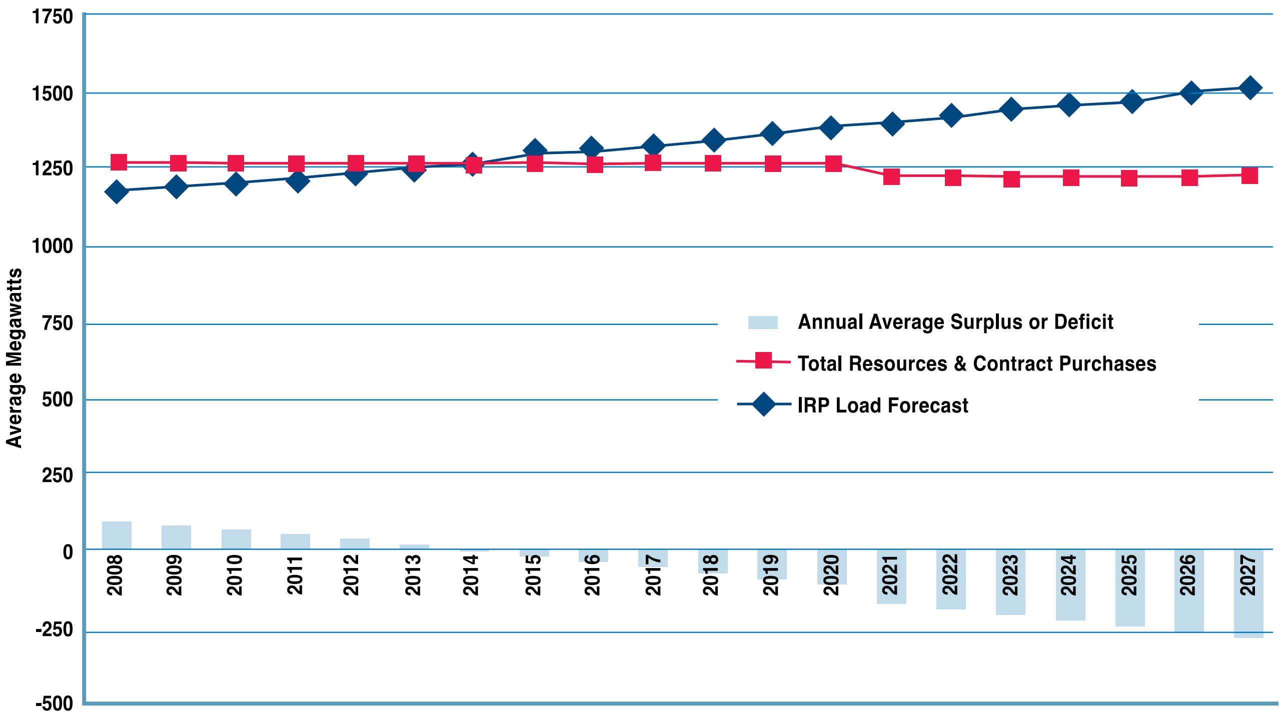
System Annual Load History and Forceast (with no new conservation resources)



City Light provides a high level of resource reliability, including the ability to serve load even when hydro generation capability is low. In an average water year and with normal temperatures, City Light has substantial surplus power available to sell in the wholesale power market, even during the winter. Under critical water, however, City Light would be short of firm resources on an annual basis in 2014, as seen in the following graph.

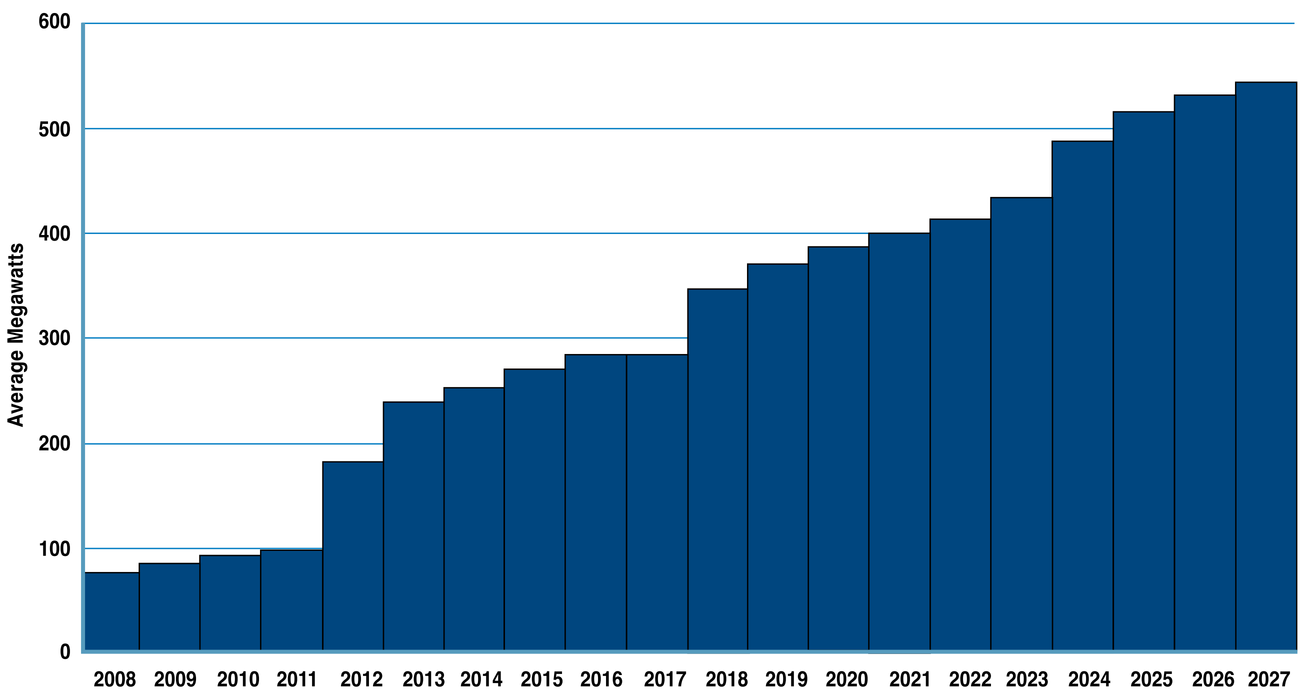
In addition to an annual average basis, City Light must also have sufficient resources on a monthly, weekly and hourly basis. Since City Light is a winter peaking utility, the winter months are of most concern. City Light's annual peak demand most often occurs in January. The 2008 IRP relies on a measure of resource adequacy that ensures that the utility has a 95% confidence level of meeting loads in any given January. Low generation capability is usually due to drought conditions in the Pacific Northwest. High customer demand is usually due to extremely low temperatures in the winter. The greatest threat to City Light's resource reliability is the combination of low water and high customer demand for power.

IRP Load Forecast and Existing Firm Resources



Using the 95% resource adequacy measure and assuming that 100 average megawatts of power can be purchased from the spot market even under the most extreme conditions, modeling the operation of City Light's existing resource portfolio shows that the utility needs additional winter resources in January 2009. This winter need in 2009 increases through time as load grows and as existing contracts expire. By 2027 the need for power in the winter grows to 544 average megawatts in the winter and 200 average megawatts in the summer. The timing and amount of winter resources needed for a combination of resource adequacy and Initiative 937 requirements is shown below.

New Resources for Winter Resource Adequacy



Seattle City Light's Generation Resources

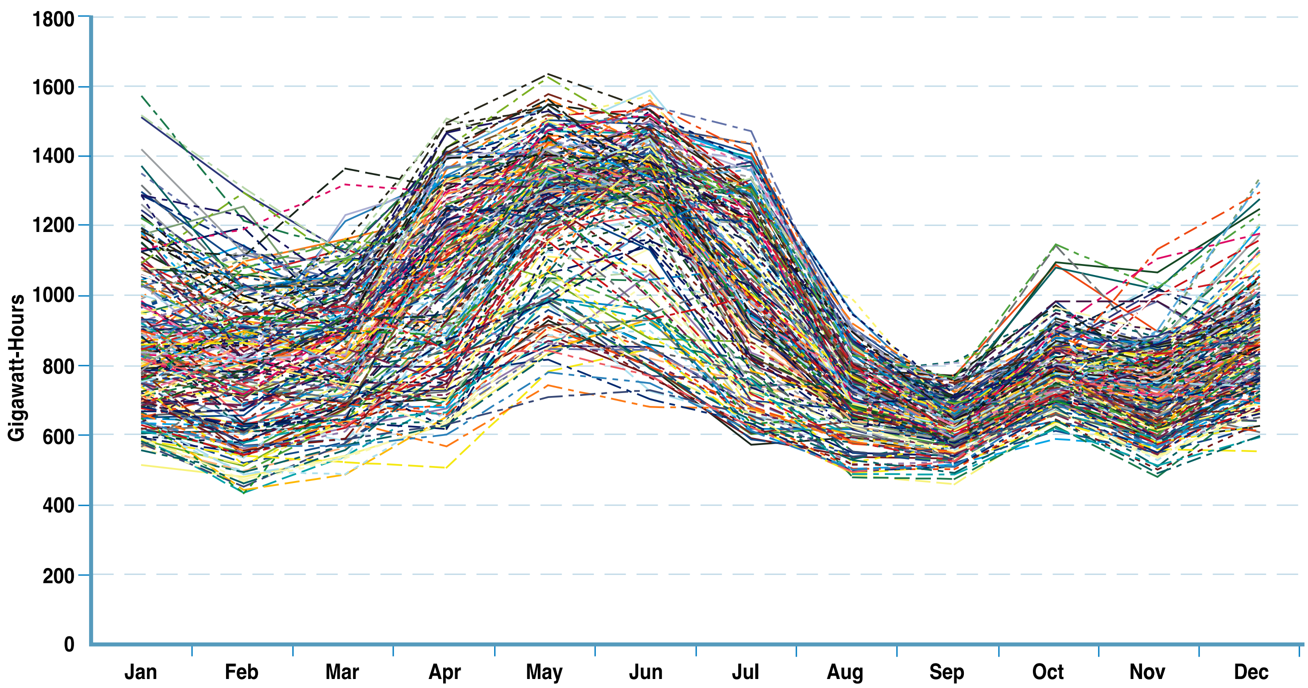
Existing Resource Portfolio

City Light's existing portfolio includes conservation, generation resources and market resources. City Light policy makers have been committed to conservation as the resource of first choice for over 30 years. Generation resources include low-cost City Light-owned hydroelectric projects, power purchased at preference rates from BPA, and contract purchases from other entities. The utility supplements these resources with power exchange agreements and purchases made in the wholesale power market. Much of City Light's power is generated by its own low-cost hydroelectric facilities, located mainly in Washington State. In 2002, City Light added wind power to its portfolio when it signed a 20-year contract to purchase output from the Stateline Wind Project in eastern Washington and Oregon.

Characteristics of the existing resource portfolio influence the choice of resource additions. The two dominant characteristics are hydro variability and monthly shape. The monthly shape of generation from the existing portfolio is not in synch with service area load. Load is highest in winter, but generation is highest in late spring. This suggests the use of strategies that in effect reshape generation to winter load. Properly constructed seasonal exchanges can accomplish this.

Hydro variability refers to the very broad range of generation capability determined by precipitation and can be very challenging to manage. The graph on the following page illustrates hydro variability, based on historical weather conditions and current river regulation. City Light must ensure that sufficient winter resources are available to provide the power needed by its customers under drought conditions, even when winter temperatures are very low. Conversely, the utility must also make the effort not to acquire too much surplus power, thus avoiding the risk of not being able to sell surplus power at prices that cover costs.

Hydro Generation Variability



Policy Direction

The policies that most affect City Light's Integrated Resource Plan are Washington state Initiative 937, the Seattle City Council Resolutions 30144 and 30359, and the Mayor's Climate Action Plan. Resolution 30144 (2000) and the Mayor's Climate Action Plan direct the utility to meet load growth with conservation and renewable resources. Resolution 30144 also directs City Light to mitigate greenhouse gas emissions from any fossil fuel use, and sets a long-term goal of "Net Zero" annual greenhouse gas emissions. City Light first achieved Net Zero in 2005 and has remained Net Zero.

The Greenhouse Gas Mitigation Strategy Resolution 30359 (2001) sets standards for calculating greenhouse gas emissions and mitigation projects. The climate change policy does not prohibit City Light from acquiring electricity from resources that produce greenhouse gas, but does require the utility to fully offset those emissions. Initiative 937 requires utilities with more than 25,000 customers to acquire cost-effective conservation and to serve load with increasing percentages of renewable power. The intent of the initiative is consistent with existing City policy, though specifics of the legislation will likely have an impact on the timing and exact amount of conservation and renewable resource acquisition. Seattle City Light's preferred resource strategy complies with the City's interpretation of the initiative.

The IRP contains a preliminary analysis of the potential impacts of climate change on hydro operations in the Pacific Northwest and for City Light. Various new research efforts are underway to analyze the impact of climate change on the region, most notably an effort at the University of Washington's Climate Impacts Group (CIG) to combine the latest versions of global climate models with new regional models and detailed sophisticated local watershed models. The results of this new work were not available for the 2008 IRP.

Using 2004 estimates of climate change impacts from the CIG and the Northwest Power and Conservation Council, City Light examined how its own hydro system and its power purchase agreements with other hydroelectric generators, most notably BPA, may be affected. The impacts to electricity demand from warming temperatures are also evaluated. With the limited downscaling data available at this time, City Light is only able to estimate partial financial impacts of climate change on its hydro system. However, this analysis has helped focus on a number of specific questions that will guide future efforts to better understand the impacts of climate change on operations. City Light continues to work with the CIG and other climate change researchers to examine these questions and is hopeful that in future IRPs better information will be available at the watershed level.

The work to-date has provided a better understanding of the direction of local change than of the rate of change, and a better understanding of temperature changes than precipitation changes. The work has identified important information gaps in existing research. So far, the CIG analysis does not incorporate changes in glaciers and the impact of those changes on flows and water temperature. Further scientific research is needed on the pace of melting of North Cascade glaciers. The current research does not allow for predicting how potential impacts may change the habitat for critical species, like salmon and bull trout, which, in turn, may change how City Light and others manage watersheds to meeting federal and state stewardship responsibilities. Finally, the research does not predict the possible changes in the frequency of severe storms and flooding. All of these changes could affect protection of fish populations and hydroelectric generation potential, presenting additional uncertainties about the full impacts of climate change for City Light.

BPA and the Northwest Power and Conservation Council may pursue more detailed studies for the Columbia River System. City Light recommends further research on climate change impacts to the Columbia, Pend Oreille, and Skagit rivers as important hydroelectric resources for Seattle. City Light is working directly with CIG and the Lawrence Livermore National Lab, with the goal of having better information available for the next IRP.

Resource Choices

The three main categories of resources are conservation, generation and the wholesale power market. Generation resources can be further categorized as renewable and nonrenewable.

Conservation City policy guidance and State Initiative 937 require the acquisition of cost-effective conservation. Certain conservation measures can improve load shape because their greatest effect is in the winter when the weather is colder and nights longer, requiring greater electricity use. Conservation also has the benefit of avoiding transmission costs. Conservation as a resource was the mainstay in both rounds of portfolio analysis, which examined both constant and accelerated paces of acquisition.

Market The wholesale power market provides opportunities for seasonal exchanges and market purchases. Seasonal exchanges are low in cost and can help shape resources to load. Capacity contracts are useful for meeting a high demand that has a low probability of occurring. Both exchanges and capacity contracts are low cost ways to meet seasonal demand without the expense of acquiring new generation.

Renewable Generation Renewable resources satisfy the need for power and avoid air and water pollution that endangers the environment and human health. Renewable resources could become even more advantageous with the eventual imposition of a carbon tax.

Initiative 937 mandates the development of such resources. The availability of transmission could be a problem. The cost of transmission for wind resources is especially high because transmission must be available even when the wind is not blowing. Other renewable resources likely to be available in the near term to City Light are landfill gas and biomass.

Non-Renewable Generation Non-renewable resources are generally fossil fuels such as coal, oil and natural gas. Their emission of greenhouse gases and air pollutants has significant impacts on the environment and human health, and the necessity of mitigation makes them costly. Natural gas resources can be sited close to load and would require little in the way of transmission upgrades, while resources remote to load, such as coal, would require significant transmission, further increasing their cost.

Most fossil fuel resources have an advantageous generation profile that allows them to meet utility customers' base energy requirements and frees up the hydroelectric resources to follow load. The only fossil fuel resource that can effectively follow load is the natural gas simple cycle combustion turbine that can be used to meet peak load requirements or to operate during the hours proceeding the peak hour, thus saving hydro power to meet the peak requirements. Such a resource was examined.

Methodology for Analyzing Portfolios

The candidate portfolios were tested within the AURORAxmp® Electric Market Model developed by EPIS, Inc. City Light utilized forecasts of natural gas prices from Global Energy Decisions, Inc. (recently renamed "Ventyx") in its modeling. The Aurora model contains installed capacity and customer load in the Pacific Northwest electricity market, which is used to forecast electricity prices. The interplay of these four factors defines the power market in which City Light is likely to be operating over the next 20 years.

The Aurora model used for analyzing the portfolios simulated their operation based on the operating characteristics of each resource and its total cost, including fuel, operations and maintenance, and transmission. The amount of greenhouse gas emissions and air pollutants was also calculated. Costs were assigned to these emissions and considered along with other portfolio costs. At any particular point in time, the least-cost resource was picked first, followed by the next least-cost resource, and so on, until load for that point in time was met. The portfolios were then evaluated using the four criteria:

- Reliability. All portfolios were designed to meet the 95% resource adequacy measure for winter, but they vary in the degree of their reliance on total market purchases over 20 years.
- Cost. The net present value (NPV) of cash flows over 20 years for both capital and operating costs were calculated and compared.
- Risk. The sources of risk are uncertainty about hydro generation, level of demand, fuel prices and the market price of power, whether buying or selling. The portfolios varied in their exposure to these sources of uncertainty.
- Environmental impact. A thorough analysis of potential changes in environmental impacts from Round 2 resource portfolios was completed, and an update to the Environmental Impact Statement was prepared. Carbon dioxide emission impacts were assigned costs that were taken into account in the evaluation of each candidate resource portfolio. Total greenhouse gas and other air pollutant emissions over 20 years were calculated and compared for all portfolios. These included carbon dioxide, nitrogen oxides, sulfur dioxide, mercury and particulate.

Summary of Round 2 Portfolios
Net Present Value in Millions of Dollars

	Portfolios in Round 2	Net Power Cost	5% Chance of Higher Cost	Direct Emissions Cost	Overall Rank
P1	High Biomass, Geothermal	$188	$2,460	$2.1	2
P2	High Exchange, Geothermal, Biomass	$226	$2,470	$1.4	3
P3	High Wind, Geothermal	$214	$2,480	$1.4	4
P4	High Exchange, Wind, Geothermal	$331	$3,079	$0.9	5
P5	High Biomass, Geothermal, Wind	$201	$2,450	$1.6	1

In the 2006 IRP, City Light hypothesized that accelerating discretionary conservation might reduce the costs of complying with Initiative 937. The initiative requires purchases of eligible renewable energy as a fixed percentage of retail load. If the pace of acquiring conservation is accelerated, retail load is reduced, delaying the need for future resource additions. The necessary cost data to perform this analysis was unavailable. However, in the 2008 IRP, the update of the conservation resource potential assessment included the increased cost requirements for accelerating conservation. Despite these additional costs, accelerating conservation proved to be cost-effective on a societal basis, even without including non-energy benefits.

Key Findings and Conclusions

- To meet a 95% reliability standard for winter power supply, new resources are needed for 2009.

The IRP evaluates the challenges faced in maintaining reliability from a resource perspective (resource adequacy). A high degree of reliability is important because adequate electricity is needed to serve the economic activity, health, comfort and safety of the community.

A resource adequacy standard of having 95% confidence of meeting loads in any given January (the highest demand month) was established. This standard is defined in terms of "energy" requirements instead of "capacity" requirements because City Light's hydro system provides large amounts of capacity, but can run short of energy under sustained high demand conditions and low water.

The IRP team analyzed and modeled the hydro resources of the City Light hydro plants at Skagit and Boundary, hydro contracts with the Bonneville Power Administration, and other City Light hydro contracts. Year-to-year hydro generation can vary widely depending upon the amount of precipitation. In general, the West experienced less-than-normal precipitation and stream flows from 2001 until 2008. Higher levels of electricity demand that can occur with winter cold fronts also contribute to risk. The City Light system is most stressed by extended cold spells, when electricity demand for heating is highest.

The combined risks of low hydro generation and high winter demand are analyzed. The analysis indicates that under City Light's assumptions, the need for new resources will increase from 76 megawatts in the winter of 2008 to 544 megawatts in the winter of 2027. The existing need for resources in the out years is due to the combination of continued load growth and the expiration of power contracts in the existing portfolio.

- Seattle City Light can address an increasing proportion of energy demand by accelerating the pace of conservation.

As part of the 2008 IRP, conservation resource potential was re-assessed using more accurate costs for an accelerated pace of conservation. This assessment led to the conclusion that conservation acquisition activities can be accelerated while still attaining a high benefit-to-cost ratio on a societal cost basis, even without considering non-energy benefits. Accordingly, City Light staff began developing a comprehensive conservation 5-year plan to be released for public consideration in 2008.

- The seasonal balance of existing resources can be improved through increased seasonal exchanges with other utilities.

Resource needs are greatest in the winter months of November through February. January is the defining month for adequacy of resources, since this is when the winter peak demand usually occurs. The target amounts of energy to be acquired are driven by the January needs. At the same time, summer loads are substantially lower than in winter, due to Seattle's maritime climate.

City Light's lower summer loads provide an opportunity to conduct seasonal exchanges of power with electric utilities that have the reverse situation (higher loads in summer than in winter). The potential for City Light to conduct new seasonal exchanges is constrained by available electric transmission transfer capability and by reserves needed to assure sufficient resources for future summer loads.

In addition to seasonal exchanges, another opportunity exists for City Light to minimize the need to purchase or construct new resources. City Light can enter into capacity contracts with generators who have surplus generating capacity in winter months. Such capacity contracts serve to maintain a reserve, which can be called upon as needed. The delivery price of the power is pre-negotiated, so City Light would not be forced to pay exorbitant sums for purchased power if it takes delivery. Because the utility would rarely call upon this resource, it is a highly cost-effective alternative to building new resources or buying power under long-term contracts to ensure reliability.

- Reliability can be ensured for the next four years with a strategy of accelerated conservation, exchanges and the acquisition of a small new renewable resource.

A 95% probability of being able to meet the highest winter loads can be ensured for the next four years with the acquisition of less than 10 average megawatts of new generating resources. However, this requires other measures in the plan to be fully implemented on schedule, without fail.

This approach has relatively low costs.

- The preferred portfolio meets Initiative 937 requirements for conservation and renewable energy.

The preferred resource portfolio, complies with all future conservation and renewable resource requirements for Initiative 937. In the early years of the plan, existing resources will be used more efficiently through new cost-effective conservation, seasonal exchanges with other utilities and the seasonal capacity contracts described above. When City Light has exhausted the potential to improve the seasonal balance between supply and demand, renewable resources will be added in relatively small increments to meet the targeted reliability requirement.

Recommended Resource Portfolio (Average Megawatts)

Resource	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027
Accel. Conservation	10	22	37	52	68	84	97	110	122	135	146	149	152	153	154	155	156	157	158	159
Capacity Purchase	20											10								5
Exchange 1	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Exchange 2		55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55	55
Gorge Tunnel II								5	5	5	5	5	5	5	5	5	5	5	5	5
Landfill Gas		6	6	9	9	11	11	14	14	16	16	18	18	21	21	21	21	21	21	21
Geothermal						45	45	45	45	45	45	45	125	125	15	125	125	125	125	125
Wind																	85	85	85	85
Biomass											40	40	40	40	40	40	40	40	40	40
Total	80	134	148	166	182	245	258	278	291	306	357	373	446	449	450	451	537	538	539	545

The first generating resource addition in the recommended portfolio is 6 MW of landfill gas in 2009. Landfill gas grows to over 20 MW by 2027. The second is geothermal energy added at 45 MW in 2013. The geothermal resource is also scaled up during the planning period, so by the end of 2027 there is 125 MW of geothermal capacity. A 40 MW biomass resource is added in 2018, followed by 85 aMW of wind in 2024.

The Integrated Resource Plan was constructed using practices common throughout the electric utility industry. The recommended portfolio provides balance of reliability, cost, environmental impact and risk. It is flexible and cost-conscious. It seeks to get the most from existing resources before looking to new resources. The recommended portfolio will be re-evaluated for the 2010 IRP and can be adjusted if needed before large purchases of new resources are necessary.

- Another IRP will be completed by the end of 2010, allowing for more study of resource needs and options for supplying needs.

Energy markets are dynamic and volatile. Changes in supply, demand, resource technologies and costs are inevitable. Resource plans must be flexible and should be routinely updated for new information to stay relevant and useful. City Light's IRP is formally updated every two years, with substantial public input. A plan is filed bi-annually with the Washington Community, Trade, and Economic Development Department. However, work on improving the resource plan is ongoing at City Light.

The 2008 IRP includes short-term actions to begin implementing the long-term strategy. This action plan is among the most important outcomes of the planning process. These actions will pave the way for improving the seasonal balance of existing resources, acquiring new resources in the future and improving information and analytical capabilities developed during the 2008 IRP.

IRP Action Plan, 2008-2009

Actions	2008	2009
Conservation Resources		
Pursue accelerated conservation in the targeted amounts	8.4 aMW by end of 4th Qtr	12 aMW by end of 4th Qtr
Generation Resources		
Pursue full BPA contract rights	Finalize negotiations and elections for 2011	
Complete a power purchase agreement with a landfill gas supplier by mid-2009	Negotiate contract by end of 4th quarter.	Plant to begin construction and testing.
Investigate future capacity versus energy needs as the region grows shorter on capacity	Begin data collection	Complete analysis in time for 2010 IRP
Market Resources		
Investigate and acquire seasonal exchanges and/or capacity contracts to offset near-term reliability risk	Additional 50 aMW as needed	Additional 50 aMW as needed
Other New Resources		
Evaluate results of the distributed generation market study and pursue any cost-effective opportunities with customers	Engage in discussions with appropriate customers by year end	Decision on go or no go with appropriate customers by 2010
Collect and update information on costs of a wide range of new resources commercially available by June 2008	Ongoing	Ongoing
Continue investigating the development status, costs and commercial availability for geothermal, solar, and demand response. Acquire these resources as appropriate	Ongoing	Select technologies for inclusion in 2010 IRP.
Transmission		
Continue to participate in and support the development of Columbia Grid	Ongoing	Ongoing
Provide comments to the U.S. Department of Energy and Federal Energy Regulatory Commission on transmission issues of importance to City Light	Ongoing	Ongoing
Future IRPs		
Continue to refine assumptions, forecasts and modeling	Ongoing	Ongoing
Support research on the impacts of climate change to North Cascade glaciers and water temperatures in the Skagit, Pend Oreille, and Columbia Rivers	Ongoing	Ongoing

Introduction

City Light staff has been engaged in the planning process for the 2008 Integrated Resource Plan since the summer of 2007. This introduction gives a brief overview of Seattle City Light, a description of the development process and the organization of the 2008 Integrated Resource Plan.

Seattle City Light

Seattle City Light's Mission: Seattle City Light is dedicated to exceeding our customers' expectations in producing and delivering environmentally responsible, safe, low-cost and reliable power.

Seattle City Light is a municipal electric utility that owns and operates generating, transmission and distribution facilities for electric power. The citizens of Seattle created City Light in 1902 when they approved bonds to build a hydroelectric power plant on the Cedar River. Since the Cedar River power plant first began to supply electricity to Seattle in 1905, City Light has delivered reliable, low-cost power to its ratepayer-owners.

The utility's service area covers roughly 131 square miles between Puget Sound and Lake Washington west to east, and between Snohomish County and Renton and South 160th Street north to south. The utility serves the city of Seattle, all or part of the cities of Shoreline, Lake Forest Park, Mountlake Terrace, Tukwila, Seatac, Burien, Renton and Normandy Park and parts of unincorporated King County.

Integrated Resource Planning

The term integrated resource planning refers to how electric utilities go about acquiring a combination of conservation and generation resources in order to meet their customers' long range power needs. City Light's Integrated Resource Plan (IRP) demonstrates how the utility plans to meet its customers' energy requirements within the context of its mission to provide environmentally responsible, safe, low-cost and reliable power.

Integrated resource planning is seen increasingly as a way of reducing risks to both electric reliability and financial stability. City light provides integrated resource planning at the direction of the Seattle City Council, and legislation from the state of Washington, HB 1010. This legislation directs electric utilities to develop and file comprehensive plans that explain the mix of generation and demand side resources they plan to use to meet customers' short- and long-term power needs. Legislation and policy that creates the planning environment for the 2008 IRP is discussed more fully in Chapter 3. As required by HB1010, integrated resource plans are submitted to the Washington Community, Trade, and Economic Development Department every two years beginning with 2008.

City Light's Mission and the IRP

The overall objective for this IRP is to determine strategies for the type, amount and timing of new resource acquisitions in order to meet electrical load through 2027 in keeping with City Light's mission. The IRP process is designed to do this by:

- Ensuring stable and reliable power resources through the resource adequacy requirement.
- Looking for least-cost and lower-risk solutions within the context of other goals.
- Updating the 2006 environmental impact statement that recognizes and evaluates any environmental implications of the IRP.

Once City Light evaluates combinations of new resources that could be added to its existing portfolio, it charts a resource strategy that ensures there is enough power to meet customers' long-term load. The process guides City Light staff in selecting a mix of resources that controls supply cost and risk, meets the resource adequacy requirement and fulfills its obligation to environmental stewardship. City Light avoids or mitigates environmental impacts in accordance with City Resolutions 30144 and 30359.

Differences between the 2006 and 2008 IRPs

The 2008 IRP updates pertinent information in the 2006 IRP, but also differs from the earlier plan in a number of ways.

- The AURORAxmp® was acquired and calibrated to assess portfolios, replacing the Global Energy Decisions Model used for the 2006 IRP.
- The acquisition of conservation is accelerated.
- With the strong likelihood that Federal legislation designed to discourage the production of CO2 by electric utilities will be passed within the next two years, a cost of carbon dioxide emissions is included in all candidate portfolios rather than addressed as a scenario as it was in the 2006 plan.
- Rather than using scenarios that represent alternative market conditions to the utility, as was done in the 2006 IRP, scenarios in the 2008 IRP represent specific external changes, based on issues raised by stakeholders and policymakers, that would have a direct impact on loads and/or resources.

Changes in the 2008 plan reflect developments since the 2006 IRP. State Initiative 937, which addresses conservation and renewable resources acquisition, limits the new resources considered for this planning period. The decision to accelerate conservation has resulted in a decrease in acquisition of other resource types. Coal plant technology was excluded as a choice this time. With fewer choices, fewer portfolios were analyzed.

The Resource Strategy

The overall resource strategy calls for going after possible lost opportunities in conservation and certain generation resources, and seeking low-cost ways to improve resource shape. The former can be accomplished by accelerating the acquisition of conservation, and the latter with relatively low-cost seasonal exchanges, capacity purchases, and hydroelectric efficiency improvements at Gorge and Boundary Dams. New generation resources featured in the candidate portfolios are wind, geothermal energy, landfill gas, biomass, and simple cycle and combined cycle combustion turbines. They are detailed in Chapter 4.

Portfolio design took into account availability and sizing of projects by technology. There were two rounds of analysis of candidate portfolios, each of which combined new resources with the utility's current holdings. All portfolios were evaluated against the four criteria - providing reliable service, minimizing costs to customers, managing risk and minimizing environmental impacts.

Steps in the Process

This IRP's objective is to determine the strategies for the type, amount and timing of new resource acquisitions to meet electrical load for the 20 year period between 2008 and 2027. Along with the generation resources mentioned above - wind, geothermal energy, landfill gas, biomass, hydro efficiency and simple cycle and combined cycle combustion turbines - new resources considered for this planning period are accelerated conservation, hydroelectric efficiency improvements, seasonal exchanges and capacity purchases. For the purposes of analysis, these resources were combined into potential resource portfolios that, together with the utility's existing resources, could meet anticipated future needs.

The 2008 integrated resource planning process included these steps:

- Public involvement: inviting citizens, stakeholders and representatives of many organizations to participate. (See Appendix A - Public Involvement.)
- Recruiting team members from both inside and outside the utility to work on the plan.
- Licensing and installing a sophisticated computer model, the AURORAxmp® Electric Market Model (supplemented by post-processing tools), for assessing portfolio performance.
- Calibrating the AURORAxmp® for the characteristics of City Light's hydroelectric operations and purchase power contracts.
- Revisiting the 2006 assessment of conservation resource potential in the service area.
- Forecasting hourly demand for electric power through 2027.

- Determining when additional resources will be needed and how much, taking into account variable hydro conditions and the resource adequacy measure.
- Developing candidate resource portfolios as part of a resource strategy to meet customers' power needs.
- Updating the environmental impact statement that was prepared for the 2006 IRP.
- Evaluating and comparing a Round 1 of alternative portfolios based on cost, risk, reliability and environmental impacts.
- Measuring the effect of certain scenarios on portfolio performance.
- Preparing and evaluating a Round 2 set of more refined resource portfolios.
- Recommending a resource strategy along with a preferred portfolio to the Mayor and City Council.

Public Involvement

As a municipally owned utility, City Light has a long history of public involvement. Ratepayer-owners and stakeholders are invited to contribute ideas and opinions in various forums. For the 2008 IRP process, community members were invited to contribute their comments and ideas about public preferences in planning for power supplies through 2027. Representatives of stakeholder groups advised City Light during the planning process. City Light also received many comments at public meetings and on the IRP website.

Conducting two rounds of analysis allowed for meaningful public input. After the first round, the utility gathered feedback about IRP assumptions, methodologies and resources that were evaluated. The IRP team incorporated that information into a second round of analysis used to develop a resource acquisition strategy and construct a preferred portfolio.

The 2008 IRP'S Organization

Chapter topics parallel the planning process of the 2008 IRP:

Chapter 1 describes power demand through 2027 based on forecast of customer load.

Chapter 2 describes City Light's existing resource portfolio. It also describes the resource adequacy measure that is used to determine how much power will be needed from additional resources to meet expected load.

Chapter 3 describes the ways in which policy guides resource acquisition through requirements for meeting load, protecting the environment and containing power costs - local, state, regional and federal laws, policies and guidelines.

Chapter 4 identifies commercially available resource types.

Chapter 5 reviews the methodology City Light staff uses to evaluate the ability of candidate resource portfolios to meet expected load growth. The chapter gives an overview of the AURORAxmp(r) Electric Market Model used to assess the portfolio performance. The chapter also describes the scenarios used to evaluate Round 2 portfolios.

Chapter 6 presents the results of two rounds of portfolio analysis, showing their relative ability to meet City Light's anticipated power needs and satisfy the four evaluation criteria. The chapter also presents the results of the scenario analysis.

Chapter 7 presents City Light's recommended long-term strategy and two-year action plan.

A **Glossary** of technical terms and abbreviations used in the 2008 IRP appears at the end of this document.

Appendices are published separately. The topics covered are a) public involvement, b) electric generating resources, c) tidal and wave energy, d) distributed generation opportunities, e) demand response assessment, f) the IRP risk measure, and g) climate change in the 2008 IRP.

Chapter 1 – Energy Requirements & Reliability

This chapter discusses City Light's load forecast through 2027.

About 380,000 customers rely on City Light to provide reliable, low-cost and environmentally sound electricity to their homes and businesses. Power generated by City Light's hydroelectric facilities, purchased under contract and purchased on the wholesale power market are sufficient to meet power needs for the utility's service area under most circumstances. However, in order to ensure power delivery under adverse conditions, for example a winter cold spell during drought conditions, the utility must acquire additional resources. Growing demand and policy changes are two drivers in why and how the utility must obtain new resources over the long term.

Forecasting long-term load growth in City Light's service area was the first step in developing this Integrated Resource Plan (IRP). The IRP team also evaluated the ability of the utility's existing resources to serve future load at a predetermined level of reliability, described in Chapter 2. This level of reliability is called the resource adequacy standard. Because the purchase of resources to guarantee 100% reliability cannot be justified, the utility chose a 95% level of reliability that load will be served, implying a 5% risk that load will not be served.

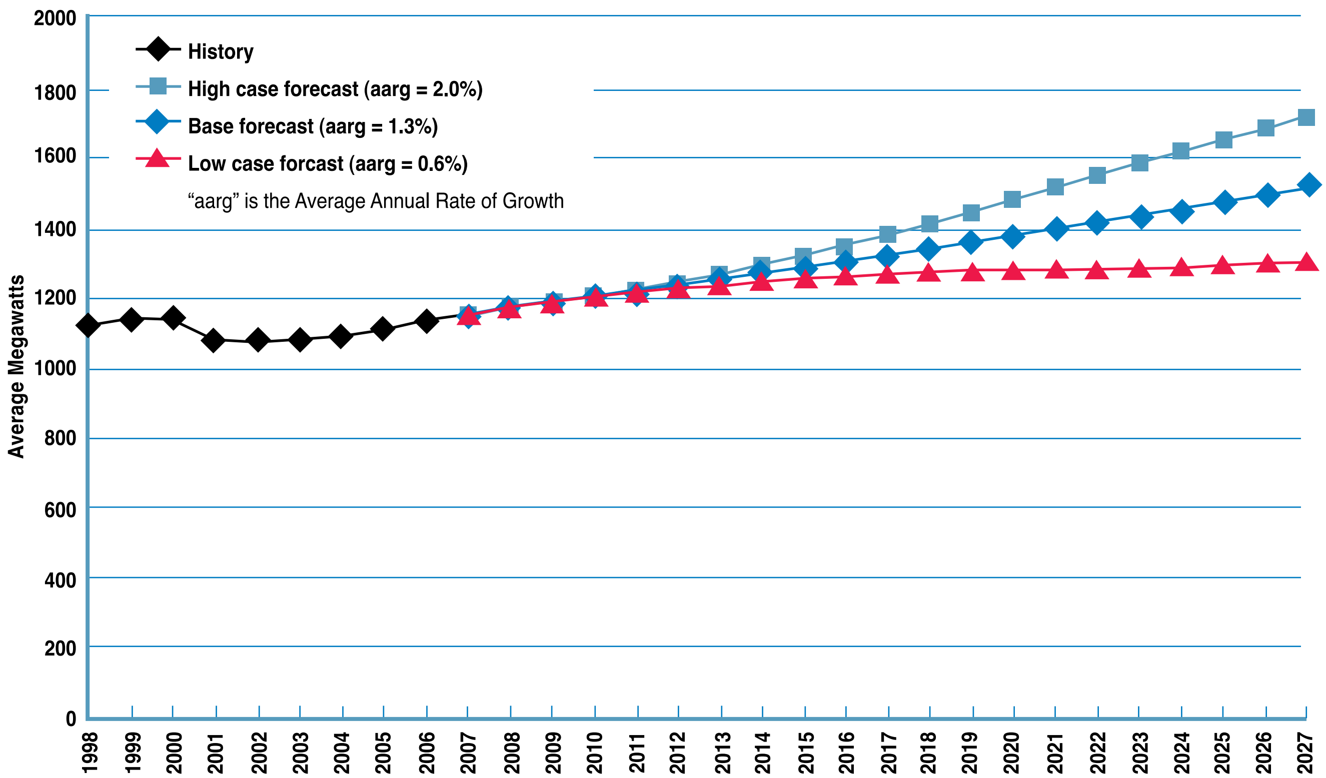
Load Forecast

Since the 2006 IRP was issued, City Light has produced a new long-range load forecast. Compared to the earlier forecast used for the 2006 IRP, the 2007 long-range forecast predicts slower load growth in the near-term and slightly higher growth farther out. The near-term load was reduced because the growth of the regional economy is expected to slow over the next two years, but not fall into recession. The building boom fueled by high levels of economic activity in the service area during 2005-07 has started to slow in response to the economic downturn. A severe recession is one of the scenarios used for testing candidate portfolios in the 2008 IRP.

Load Forecast Range

Figure 1-1 shows the utility's 20-year base forecast of annual average load, with high and low forecasts that reflect uncertainty about the future. These forecasts define the range in which actual load will most likely fall for each year into the future. None of these forecasts reflect the effect of any future programmatic conservation. The exclusion of future utility-sponsored conservation from these forecasts allows conservation to be treated the same as a generating resource in our modeling. The high forecast is one of the scenarios that will used to test the candidate portfolios.

Figure 1-1. Base, High and Low Forecast (no new programmatic conservation)

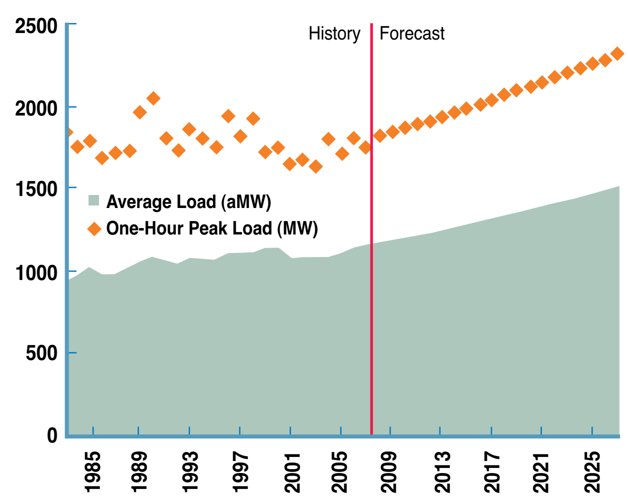


Peak Load Forecast

Figure 1-2 shows the average load history from 1983 through 2007 and the forecast through 2027, as well as the one-hour peak load (average load over a one-hour period). The historical data is actual consumption and reflects the impact of conservation programs in the past. As in Figure 1-1, the forecast does not reflect the effect of any future programmatic conservation. Programmatic conservation is evaluated along with other types of resources included in City Light's portfolio, described in Chapter 4.

Because of the prohibitive cost of acquiring enough resources to serve one-hour peaks of infrequent occurrence, the measure of resource adequacy was devised. This measure is described more fully in Chapter 2.

Figure 1-2. System Annual Load History and Forecast (no new programmatic conservation)

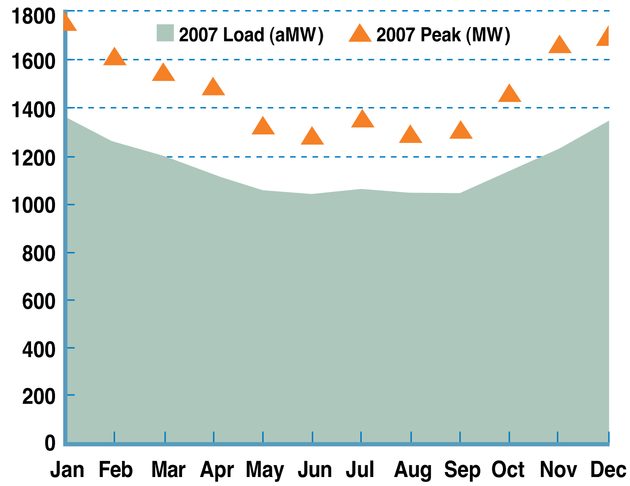


Load Shape

In planning for resource acquisition, City Light requires more information about future load than just average annual consumption provided by the long-range load forecast. The utility must also consider load shape throughout the year. Consumption in the winter is greater than in the summer because of greater customer need for winter heating and lighting. Average monthly variability in load is fairly predictable; usually about 20% higher in December and January than in July and August.

The utility needs sufficient resources to serve its customers during times of peak consumption. The one-hour peak load in any month can be many megawatts greater than the average load. Figure 1-3 shows the monthly load shape and monthly one-hour peaks for 2007. In January, the one-hour peak was nearly 400 megawatts higher than the January average; in August the one-hour peak was nearly 250 megawatts higher than the August average. The range of variability in peak loads for November through February is much greater than in other months. The highest historical peak of 2,055 MW occurred on December 21, 1990, when the temperature dropped to 12 degrees Fahrenheit.

Figure 1-3. 2007 Monthly Average Load and Monthly Peaks

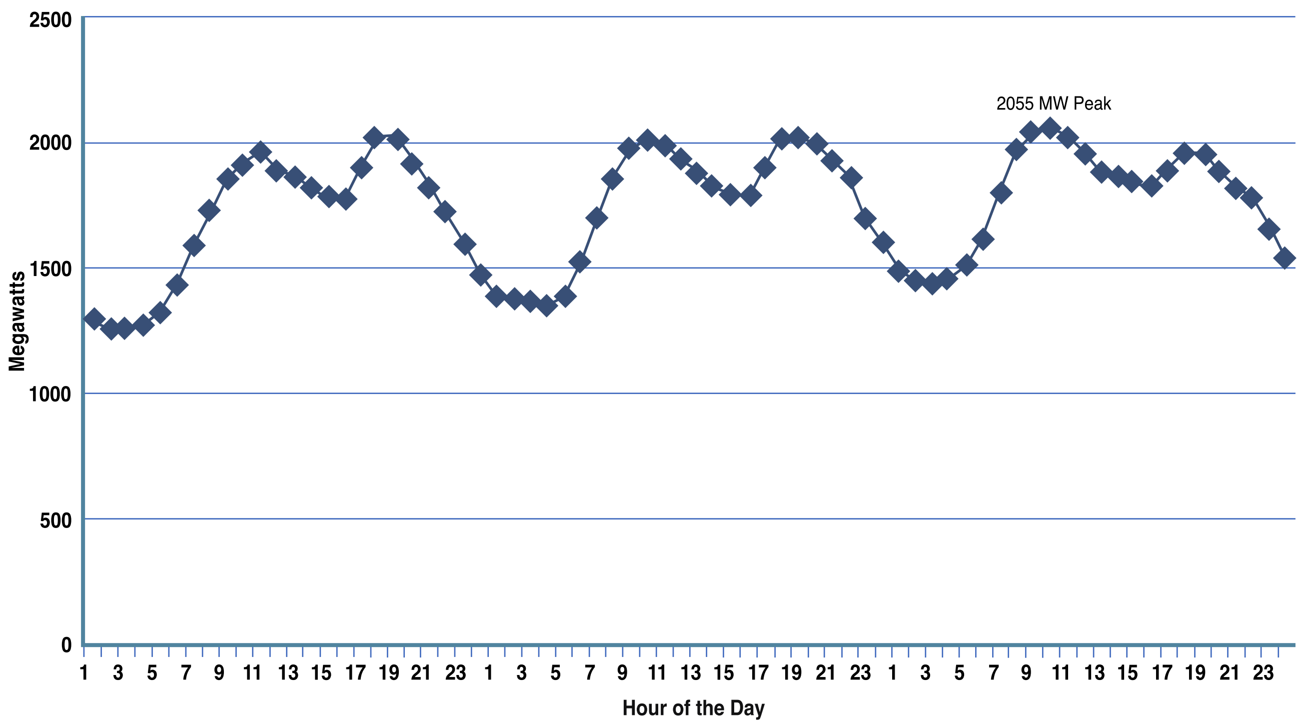


Extreme Weather

In order to assure resource reliability, City Light must be able to serve peak loads under extreme conditions, such as severely cold weather that usually occurs every few years with little warning. Very cold weather can push the one-hour peak load nearly 50% higher than the average load for the month. Such peaks are short-lived, and cold snaps rarely last much longer than three days. Figure 1-4 shows the hourly load shape for December 19-21, 1990, when peak load exceeded 2,000 megawatts for three consecutive weekdays.

Future peak load is only part of the equation to assess the need for additional resources necessary for a high level of reliability. In addition to understanding how much power might be needed under the stress of very cold weather, City Light needs to understand how existing resources operate under stress. The system is most stressed during periods of drought because almost all of the utility's resources are hydroelectric. Existing resources combined with very low hydro (1 in 20 years) were modeled against forecasted electricity demand.

Figure 1-4. Peak Hourly Load – Cold Snap December 19-21, 1990



Chapter 2 – Existing Resources

This chapter describes City Light's existing resources and its power supply. Also described is the resource adequacy standard, the primary driver of the Integrated Resource Plan.

Seattle City Light uses a combination of resources to meet its power needs. The utility's current resource portfolio includes conservation, owned generation resources and long-term contract resources, supplemented with power exchange agreements and near-term purchases made in the wholesale power market. In 2002, City Light augmented its portfolio with a contract for the purchase of power from the Stateline Wind Project, a renewable energy resource. City Light depends primarily on Bonneville Power Administration (BPA) for electric transmission to its service area.

The following sections discuss existing conservation, generation and market resources City Light uses to meet its customers' power demand.

Conservation

Seattle City Light meets the power needs for its service area with a high degree of reliability. Conservation was introduced into the resource mix over 30 years ago and has remained the resource of first choice for the utility to meet load growth. The conservation partnership between the utility and its customers has successfully deferred acquisition of expensive new resources, especially those that negatively affect the environment.

Chapter 3 provides information about conservation policy and legislation that guides City Light in its conservation programming. Chapter 4 focuses on the assessment of future conservation resource potential for the 2008 IRP.

As the Pacific Northwest moves from a period of energy surplus to deficit, conservation programs will continue to encourage customers to use power more efficiently and to defer the acquisition and expense of new resources. Conservation is low-cost and has low environmental impacts, including no greenhouse gas emissions. It is integral to Seattle City Light's Integrated Resource Plan, the Mayor's Climate Action Now Campaign, and to meeting the requirements of I-937. It has also been good policy in a transforming energy market because it reduces price risk and availability risk.

Programs are designed for all customer classes: residential, commercial, and industrial. Conservation programs address specific energy end-uses such as efficient lighting, water heaters and laundry appliances, HVAC, motors and manufacturing equipment, and encourage weatherization and high-efficiency construction methods. Monetary incentives to utility customers include rebates, loans or outright purchase of savings for installed energy efficient measures.

Energy Saved by Conservation Programs

From 1977 through 2007, City Light's conservation programs saved over 10 million megawatt-hours by increasing the efficiency of electricity use in Seattle homes, businesses and industries. Ten years ago, the average Seattle City Light residential customer used 10,739 kilowatt-hours of electricity per year, 500 kilowatt-hours more than the national average. Today, the average City Light residential customer uses 8785 kilowatt-hours, about 1000 kilowatt-hours fewer than the national average.

Seattle City Light's new conservation measures saved about 7 average megawatts of power in 2007. Credit for avoided transmission and distribution losses and savings from participation in the regional market transformation efforts of the Northwest Energy Efficiency Alliance boosted the total savings for the year to about 75,000 MWhs. These savings prevented 45,000 tons of carbon dioxide emissions from entering the atmosphere, which is roughly equivalent to removing 10,000 automobiles from Seattle streets.

Conservation programs at City Light underwent a comprehensive analysis in 2007, when utility conservation staff teamed with conservation experts from Energy Market Innovations, who provided project management and subject-matter expertise. The result of this collaboration is a plan to incorporate conservation industry best practices as the utility strives to meet much of its load growth through conservation measures.

Generation Resources

Over 90% of City Light's power is generated by hydropower, including its own low-cost hydroelectric facilities mostly located in Washington state. As a municipal utility, City Light enjoys preferential status in contracting for the purchase of additional low-cost power that the Bonneville Power Administration (BPA) markets. The utility has contracts with several other owners of hydroelectric projects in the region. In 2002, City Light signed a 20-year contract with the Stateline Wind Project. These resources and their locations are shown on the map below. See Table 2.1, following the descriptions of City Light resources, for the amounts generated by City Light resources over the period 1999-2007.

Figure 2-1. Seattle City Light's Generation Resources

City Light Resources

Boundary Dam is City Light's largest resource with a peaking capability of 1055 MW and average generation of about 490 aMW annually. Under the Federal Energy Regulatory Commission (FERC) license, part of Boundary output must be sold to Pend Oreille County Public Utility District No. 1 to meet the PUD's load growth. In addition, about 5 aMW of energy must be delivered to the PUD in compensation for Boundary Project's encroachment on its Box Canyon Dam. Energy from Boundary is wheeled to consumers over BPA's transmission grid.

Skagit Project includes the Ross, Diablo and Gorge projects, which have a combined one-hour peak capability of 690 MW. City Light transmission lines carry the power generated from the Skagit Project to Seattle

Newhalem is located on Newhalem Creek, a tributary of the Skagit River. City Light-owned transmission lines deliver its two megawatts of power.

South Fork of the Tolt has a one-hour peaking capability of less than 17 MW. Project costs are offset by BPA billing credits. Power from this project is delivered over a line owned by Puget Sound Energy.

Cedar Falls dam has capacity of 30 MW. Power is transmitted by Puget Sound Energy.

Contracted Resources

Bonneville Power Administration City Light's largest power purchase contract is with BPA. The contract allows the utility to receive power from 29 hydroelectric projects and several thermal and renewable projects in the Pacific Northwest. A Block and Slice Power Sales Agreement with BPA allows City Light to purchase over a 10-year period, beginning October 1, 2001. Energy is delivered through BPA's transmission grid.

Under the contract, power is delivered in two forms: a shaped Block and a Slice. Through the Block product, power is delivered in monthly amounts shaped to City Light's monthly net requirement, defined as the difference between City Light's projected monthly load and the resources available to serve that load under critical water conditions. Under the Slice product, City Light receives a fixed percentage of the actual output of the federal system and pays the same percentage of the actual costs of the system. Power available under the Slice product varies with water conditions, federal generating capabilities, and requirements for fish and wildlife protection and restoration.

City Light is scheduled to sign a new 20-year contract with BPA by October 2011. BPA is involved in structuring contracts that will fairly apportion its least expensive base system generation among its customers. All other BPA power will be available as variously designed products. Power will be sold primarily at two rate levels - one for the base system generation and the other, a market rate for power from other resources. Decisions affecting the marketing of BPA power can significantly affect City Light's resource portfolio cost, risk and reliability.

High Ross Agreement In an 80-year agreement with the Canadian Province of British Columbia, City Light abandoned plans to raise the height of Ross Dam in exchange for power purchases from British Columbia Hydro (Powerex). Power delivery and price is similar to the generation and costs City Light would have experienced had construction taken place. Through 2020, the power City Light receives from the contract has a relatively high cost. In 2020, the cost reduces to a few dollars per MWh because the cost portion, equivalent to debt service that would have been issued to build the High Ross Dam, will terminate. BPA delivers the power over their transmission lines.

Lucky Peak Because of its location near Boise, Idaho, Lucky Peak can sell power to all major western trading hubs (Mid-C, COB, PV, Mead, and Four Corners) without encountering normal transmission constraints. City Light has the option to sell to the highest market. City Light has contract rights to Lucky Peak's power for about 30 more years.

Priest Rapids Project City Light purchases power from this project under a 2002 agreement with Grant PUD, who owns and operates the project. Seventy percent of Priest Rapids Project's output has been allocated to Grant PUD, and City Light's share is expected to be about two to three average megawatts in 2008-2009, with a small increase in 2010, followed by gradual reduction as Grant PUD's load increases.

Grand Coulee Project Hydroelectric Authority City Light has 40-year contracts to buy half of the output, or about 27 aMW, from five Columbia River Basin hydroelectric projects. City Light's contracts expire over the period 2022-2027. Electric generation is mainly in the summer months and is transmitted to Seattle by local entities and BPA.

Northern California Power Agency Under its exchange agreement with the Northern California Power Agency (NCPA), City Light delivers 60 MW of capacity and 90,580 MWh of energy to NCPA in the summer. In return, NCPA delivers 46 MW of capacity and 108,696 MWh of energy to City Light in the winter. Deliveries to NCPA started in 1995 and will continue until the agreement is terminated.

Stateline Wind Project City Light has an agreement with Iberdrola to purchase wind energy and associated environmental attributes from the Stateline Wind Project on the Washington and Oregon border. City Light receives wind energy with an aggregate maximum delivery rate of 175 MW per hour through December 2021. Energy delivered under the contract is expected to average about 45 aMW. City Light has also entered into an agreement through 2011 to purchase integration and exchange services from PacifiCorp.

Burlington Biomass Facility City Light has a 10-year power contract (2007-2016) with Sacramento Municipal Utility District (SMUD) to deliver 15 MW of the output of a 23 MW capacity biomass generating plant (Sierra Pacific Industries' sawmill and co-generation plant in Burlington, Washington) to the California-Oregon border. City Light purchases energy and environmental attributes equal to the difference between the plant output and the 15 MW SMUD delivery obligation. The amount is expected to average about 3 MW over the course of the year. City Light will also receive energy from SMUD from unspecified resources during December, January, and February, in exchange for City Light's delivery service.

Power from Existing Generation Resources

Table 2-1 shows the recent history of annual power production from each of the generation resources described above, as well as some no longer part of City Light's portfolio. The table demonstrates how the portfolio has changed in recent years and illustrates power production variability caused by weather.

Table 2-1. Power Generated Annually from Existing Resources in Average Megawatts

	1999	2000	2001	2002	2003	2004	2005	2006	2007
OWNED GENERATION									
Boundary	508.1	431.7	267.1	452.2	408.1	398.8	395.1	493.1	414.6
Skagit - Gorge	135.4	109.3	70.4	117.0	106.3	105.2	88.7	99.6	122.9
Skagit - Diablo	116.7	92.7	54.5	102.8	84.9	8.5	74.8	85.1	95.3
Skagit - Ross	109.9	84.4	44.9	95.6	83.1	77.6	64.3	73.2	98.1
Newhalem		0.4	1.1	1.1	0.9	1.4	0.7	1.0	0.6
South Fork Tolt	8.0	5.0	4.6	8.9	5.6	6.9	5.1	6.1	6.4
Cedar Falls	8.1	5.7	7.4	9.1	7.3	7.0	4.2	8.6	7.6
Centralia (sold 2000)	78.7	31.5							
TOTAL OWNED GENERATION	965.1	760.8	449.9	786.7	696.2	685.3	633.0	766.7	745.5
PURCHASE CONTRACTS									
Bonneville Power Administration	180.6	193.7							
Bonneville Power Administration Block			200.7	152.3	147.1	137.8	109.4	174.4	242.2
Bonneville Power Administration Slice			71.5	322.4	390.9	392.8	385.1	451.1	411.3
High Ross (B.C. Hydro)	35.2	33.8	5.1	33.9	36.0	34.8	35.4	36.1	35.8
Boundary Encroachment (BC Hydro)	1.7	2.0	0.9	1.2	1.6	1.5	1.7	2.6	1.9
Lucky Peak	48.6	38.8	21.5	33.0	33.4	31.3	25.8	46.5	31.2
Priest Rapids (Grant County PUD)	47.1	41.4	29.9	37.3	35.5	36.0	32.9	2.8	2.9
Grand Coulee Project Hydroelectric Authority	28.6	27.2	30.9	28.3	26.9	28.9	28.5	27.6	29.1
Stateline Wind				12.2	24.7	39.7	37.4	43.9	44.0
Klamath Falls (expired 2006)			37.2	81.0	74.7	81.8	66.4	11.4	
Pend Oreille PUD (expired 2005)	8.1	6.6	4.9	5.0	5.4	6.7	3.0		
Metro CoGeneration (expired 2004)	0.9	0.8	1.4	1.7	1.6	0.7			
Columbia Storage Power Exchange (expired 2003)	16.1	12.1	11.6	11.3	3.0				
TOTAL PURCHASE CONTRACTS	366.9	356.5	445.8	719.5	780.8	792.0	725.6	796.4	798.4

Since City Light's current resource portfolio is over 90% hydro, its hydro storage capability has the advantage of operational flexibility but the disadvantage of being significantly affected by weather conditions. The amount of water available for power generation is affected by the amount and the timing of precipitation, run-off from snow melt, and regulations governing the recreational use of lakes, irrigation, protection of fish habitat and other environmental concerns.

Operational flexibility allows the utility to meet peak load easily most of the time, but the ability to serve peak load can be greatly diminished when water levels are low. Prior to 2006, the West experienced six consecutive years of drought conditions, with 2001 as the most severe. Thus, City Light's resource portfolio must be able to serve load under prolonged drought conditions that do occur in the region.

As shown in Table 2-1, the amount of power produced from owned generation in 1999 was about twice the amount produced in 2001, illustrating the risks associated with hydropower production. To make up the shortfall in 2001, City Light increased its purchases from Bonneville Power Administration (BPA), but was still forced to make purchases from the market. By 2002, City Light had signed a new contract with BPA that nearly doubled its purchases. Wind power from Stateline came online in 2002, and power from that source increased over the next two years to its current level.

Future Outlook for Current Generation Resources

Over the next 20 years, not all of the generation resources described above will remain as they are in the existing portfolio. City Light's license to operate Boundary Dam expires in 2011, but with Boundary's relicensing process underway, the utility is confident of the license's renewal. Some contracts will expire or be modified over the planning period. The Stateline wind contract that provides for about 45 aMW expires in December 2021. City Light's share of Priest Rapids generation output gradually declines over the 20-year planning horizon at the rate of Grant County PUD's load growth. City Light's contracts with the Grand Coulee Project Hydroelectric Authority begin to expire in 2022.

Possible changes in the BPA contract have a potentially greater impact. City Light's current power contract with BPA expires in 2011. A new 20-year contract is scheduled to be in place in October 2011. Features of new contracts between BPA and its clients are currently under discussion. The 2008 IRP assumes City Light will continue to purchase power from BPA near present levels after 2011.

BPA has developed a new policy (Long-Term Regional Dialogue record of decision) to address the Pacific Northwest utilities desire to restore and protect low-cost regional power for the post-2011 power contracts. This new policy describes what the new 20-year contracts will look like and how power purchases under the contracts should be priced. As of March 2008, BPA proposed that new long-term contracts be signed in late 2008 for service that begins in October 2011 and terminates in November 2028.

BPA's new policy will include a two-tier pricing system. Tier 1 priced power will be based on the cost of the existing Federal Base System resources. Tier 2 priced power will be based upon either the actual or marginal price of new resources. The amount of power priced at Tier 1 (High Water Mark) that a public power customer will be eligible to purchase will be equivalent to the customer's actual 2010 loads placed upon BPA. To the extent a public power customer is eligible to place loads on BPA above the quantity it may purchase at the Tier 1 price, the customer will be required to purchase such power at the Tier 2 price. Many uncertainties remain with respect to the quantity of power (High Water Mark) that Seattle will be eligible to purchase, the price for Tier 1 power, and the price for Tier 2 power.

In the future, the resource portfolio will include more renewable resources, consistent with policy direction from the City Council (Resolution 30144) and Initiative 937. The accelerated conservation resource will also have a substantial impact as City Light continues to fund programmatic conservation.

Market Resources

The wholesale electric power market in western North America plays an important role in meeting Seattle's power needs by balancing City Light's energy surpluses and shortages.

Surplus power can be sold and power shortages can be made up with purchases both seasonally and over a period of years. Power can also be obtained from the wholesale market through seasonal capacity contracts, although City Light currently has no such contracts. (See Chapter 4 for potential use of market resources in the IRP.) In order to ensure winter reliability, the 2008 IRP allows a maximum of 100 aMW of energy to be purchased in the wholesale power market to meet short-term winter needs. Any needs above 100 aMW in the plan must be met by new conservation and new firm resources.

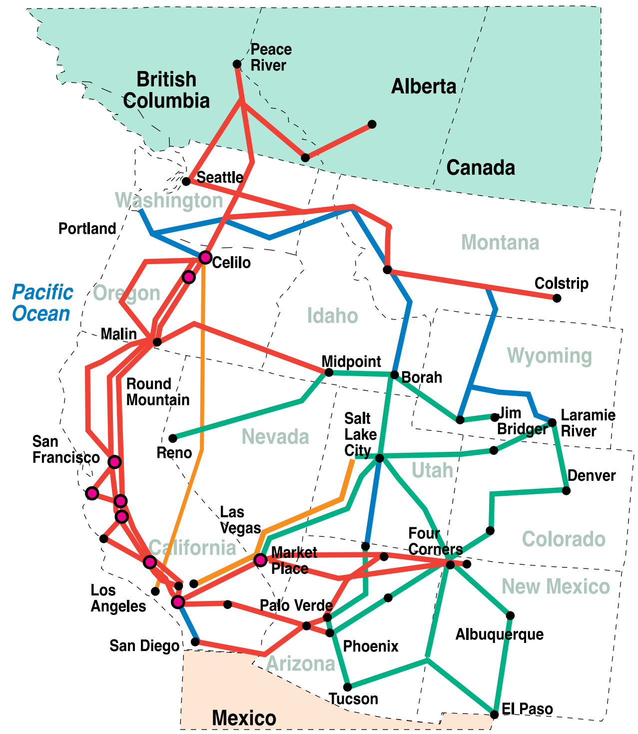
With colder winter temperatures driving Seattle's power demand to peak in November through February and the spring snow melt driving hydropower production to peak in April to June, a seasonal mismatch exists between demand and supply of power. Keeping sufficient power generation capability to meet winter demand leads to excess generation capability the rest of the year. In addition to seasonal variation in supply and demand, precipitation may vary substantially from year to year, making it difficult to predict the supply of hydropower.

City Light actively manages its portfolio of power supply resources by purchasing and selling power in the wholesale markets and transacting seasonal exchanges of power. These transactions lower the rates charged to the utility's retail customers by generating revenues from sales of surplus energy and allowing purchases of lower cost power.

Western States Transmission System

The Western electric transmission system physically defines the wholesale market for electricity in western North America. This market is broadly made up of 11 western states, two Canadian provinces, and northern Baja California, Mexico, as shown in Figure 2-2.

Figure 2-2. Western Electric Transmission System



Constructed primarily in the 1950s and 1960s, the high-voltage transmission system is owned by a number of both private and public utilities. In the Pacific Northwest, the Bonneville Power Administration (BPA) operates about 75% of the transmission system, with other large transmission owner/operators, including PacifiCorp, Puget Sound Energy, Avista, Idaho Power, British Columbia Transmission Company and Portland General Electric, operating the rest. The high voltage transmission system is near capacity in many parts of the West, including the Pacific Northwest.

Market transactions are facilitated by City Light's ownership share of transmission capacity rights on the Third AC Intertie. This ownership share was acquired in 1994, when City Light signed an agreement with BPA for rights to 160 MW of transmission capability over BPA's share of the Third AC Intertie. The Third AC Intertie is an alternating current line that connects the Northwest region with California and the Southwest.

Resource Adequacy

An electric utility's ability to meet its customers' energy requirements is called resource adequacy. The 2008 IRP's essential purpose is to meet City Light's resource adequacy target for the 20 year planning horizon. In addressing this purpose, the IRP team sought a high level of probability that load will be served without acquiring expensive resources that will not be needed.

In the Pacific Northwest, the regional capacity planning reserve margin is typically above 20% because of the high degree of variability in hydro resource, both seasonally and annually. Four regional organizations have estimated regional resource adequacy and have arrived at different conclusions based on differences in their measures and assumptions, including such items as the amount of power available from outside the region and the amount of hydro flexibility in the region's hydroelectric system.

The regional view that power supply is tightening coincides with City Light's perception and experience. City Light is somewhat insulated from the planning risk of a tighter regional market by its assumption of limited availability of energy from the market under critical conditions. The 2008 IRP assumes that 100 aMW of electricity will be available for City Light to purchase in the market under the most extreme temperatures and shortage conditions of the planning period.

While there are concerns about summer resource adequacy for the Northwest region as a whole, City Light has more than adequate summer resources, and its focus is on winter resource adequacy. City Light's peak demand occurs typically in January. To enhance reliability in the winter months at very low cost to the utility, City Light has proposed increasing summer-for-winter energy exchanges. For the 2008 IRP, City Light used an energy resource adequacy measure as opposed to a capacity resource adequacy measure. This is because City Light's existing resource portfolio is 90% hydropower. For up to several days, City Light has substantial amounts of generation capacity available. The larger risk is running out of water, or in City Light's case, "energy." Hence the focus is on an energy resource adequacy standard.

City Light has experienced a wide range of water conditions over 50 years and has that record upon which to make assumptions. As mentioned above, City Light's peak demand typically occurs in January. The years of lowest water conditions for January have been 1978, 1937 and 1944. However, City Light restates the historical record of water conditions in order to accommodate the effects that regulations have on City Light water resources for public and environmental purposes: preservation of fish populations, irrigation, flood control, and recreational use.

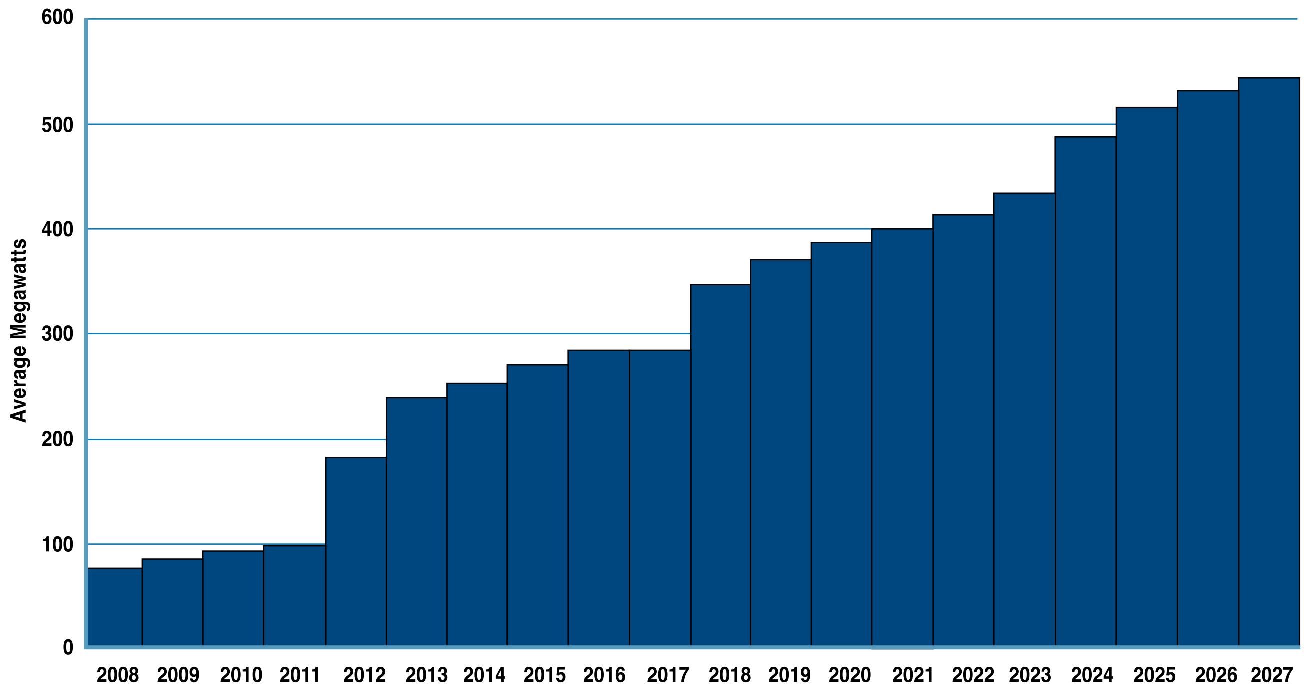
After evaluating several methods of calculating resource adequacy, City Light elected to use the 5th percentile (lower tail of the distribution) of hydropower generation for integrated resource planning in 2008. The level of reliability selected for the 2006 IRP with stakeholder and public input was 95% confidence of no unserved energy (5th percentile). This is the average of the second and third worst water years of record. The utility assumes the risk that on average, it could potentially be short of power once in 20 years. Applying the lowest 5th percentile of hydropower generation in the model provided an estimate of unavailable energy that would be needed to supply demand on an hourly basis for January of each year. This amount was reduced by the assumption that 100 aMW, as mentioned above, could be purchased from the market in every hour.

In producing targeted resource additions, these factors were considered:

- The 1 in 2 (50:50) one-hour peak demand forecast for City Light
- The lowest 5th percentile of hydropower generation
- Assumptions about continuing operation of existing resources (e.g. Boundary relicensing, BPA contract renewal)
- Expiration of existing contracts on schedule
- The need for new renewable resources to meet the requirements of the Washington Energy Independence Act (I-937)

These considerations led to the estimated resource requirements by year shown in Figure 2-3.

Figure 2-3. New Resources for Winter Resource Adequacy



New Resources to Meet Resource Adequacy

Over the 20-year planning period, load is expected to continue to grow as some of the power purchase contracts expire. The amount of load not served at the 95% level increases as the difference between load and resources grows. The resource adequacy requirement is calculated to account for the risk of variation in hydro generation and loads, and to replace the resources of expired contracts. After the Stateline Wind contract expires in 2021, resources are estimated to be insufficient in late summer and early fall, as well as in winter. In order to reduce the risk of unserved energy demand below the 5% level, approximately 76 aMW of additional energy must be available in 2008. As load increases through the 20-year planning period, the amount of additional resources required grows to 544 aMW by the year 2027.

The resource adequacy study was the starting point for developing a portfolio of additional resources for the 20 years from 2008 to 2027. As described in Chapter 6, new resources, including conservation, were added to the existing portfolio, in amounts and at points in time when the resource adequacy study indicated they would be needed. This methodology produced candidate portfolios that each met the same level of resource adequacy.

Chapter 3 – The Planning Environment

This chapter describes the local, state, regional, and federal laws, policies and guidelines that most affect City Light's integrated resource planning process.

Seattle City Light's resource decisions are made within a policy context that includes state and federal laws, internal policies established by the mayor, city council and the utility, and the policies and guidelines of regional power planning agencies and organizations. Over the years, the utility industry has become increasingly regulated. Climate change is the most transformational challenge that faces the energy industry today, and though not yet enacted, federal legislation to reduce and cap carbon emissions could be the biggest policy challenge that faces the energy sector, penetrating every aspect of the industry. Washington state has partnered with other states and Canadian provinces to develop a greenhouse gas trading framework by August, 2008, called the Western Climate Initiative.

In 2006, carbon constraint took center stage in Washington state with the passage of Initiative 937. The initiative requires electric utilities to have 15% of their energy provided by new, renewable resources by 2020. Ninety percent of City Light resources comes from existing hydropower, which does not count toward I-937's renewable resource requirements, effectively limiting City Light's resource choices to conservation and renewable resources for the integrated planning process.

Since I-937 requirements are largely independent of how much energy a utility actually needs, the regulatory requirement can drive resource acquisitions that would not otherwise be made. I-937 can also affect the timing of resource acquisitions. Over time, City Light borders between being driven by renewable resource requirements and by resource adequacy requirements.

The requirements and timing of targets of I-937 put many utilities into the renewable energy resource market at the same time, driving demand for renewable resources in Washington. Similarly, renewables portfolio standards in other states (Oregon, California) will cause out-of-state utilities to compete with City Light for the supply of available renewable resources.

With so many organizations' laws and policies affecting the planning environment, there is considerable uncertainty about the rules and environment in which City Light plans to meet the electricity demand of its customers. Those that have the most impact on resource planning are described in this chapter.

The most recent federal legislation, the Energy Policy Act of 2005, includes a range of provisions pertaining to energy efficiency, generating resources and fuel supply, energy research and development, transmission and climate change.

- The Western Governors Association adopted an initiative to develop renewable resources and build transmission.
- The Pacific Northwest region is developing resource and transmission adequacy standards and engaging the Bonneville Power Administration (BPA) in a dialogue about long-term delivery of power from the federal Columbia River power system.

State legislation includes Initiative 937, described above. A recent Washington state law requires large utilities to perform integrated resource plans. Another state law designates the Washington State Energy Facility Site Evaluation Council as the state authority behind siting transmission facilities under federal energy legislation. SB 6001 establishes a greenhouse gas performance standard of 1,100 pounds per megawatt-hour for all new, long-term baseload power generation.

City of Seattle and City Light's long-standing policies encourage energy conservation, the use of renewable resources, prudent financial policies and the utility's basic mission of providing reliable service. The City has launched an initiative to reduce greenhouse gas emissions. Climate Action Now and City Light's greenhouse gas neutrality goal form a key element in meeting Seattle's community reduction goal. Table 3-1 summarizes the types of resource planning issues that various policies impact as described in this chapter.

Table 3-1. Policies Affecting Resource Planning

Policy/ Issue	Energy Efficiency	Renewable Resources	Planning Methods	Transmission	Resource Adequacy	Power Supplies	Tax Credits	CO2 Offsets	Climate Change
Resolution 30144	❍	❍						❍	❍
Resolution 30359								❍	❍
Initiative 937	❍	❍	❍						
ESHB 1010			❍						
HB 1020				❍					
RCW 80.60		❍							
SSB 5101		❍					❍		
BPA Regional Dialogue						❍			
NPCC Policies	❍		❍		❍				
WGA Resolution 06-10	❍	❍		❍			❍		
EPACT 2005	❍	❍	❍	❍			❍		❍
ESSB 6001						❍			❍

The City of Seattle

City of Seattle and City Light's policies guide the utility's planning and operations as they relate to the environment and to greenhouse gas emissions. City Light has also developed policies to manage the risks of being short or long on resources and strategies to deal with energy surpluses and deficits.

Environmental Policy

City of Seattle and City Light's environmental policies help guide the resource planning and acquisition process in order to protect natural resources and to minimize environmental impacts while serving Seattle's electricity needs. City Light's Environmental Policy Statement calls for City Light to avoid, minimize or mitigate impacts to the ecosystems that it engages with and to consider environmental costs, risks and impacts when making decisions.

City Light's Vision, Mission, Values Statement reaffirms that minimizing environmental impacts and enhancing, protecting and preserving the environment are key parts of the utility's goals. Minimizing environmental impacts is one of the four criteria used to evaluate the IRP candidate portfolios.

Conservation and Renewable Resources

In 2000, the Seattle City Council passed Resolution 30144, which states that City Light should "use cost-effective energy efficiency and renewable resources to meet as much load growth as possible," as part of a goal to meet Seattle's electrical power needs with Net Zero greenhouse gas emissions.

City Light has continued its long-term practice of acquiring conservation through its programs at an annual rate of 7 aMW, and contracted for the purchase of approximately 45 aMW of wind power (175 MW of capacity) from the Stateline Wind project. The city council monitors utility compliance with Resolution 30144 as part of the annual reporting of Council Metrics.

City Light's conservation plans are consistent with the City of Seattle's 2006 Climate Action Plan, the Northwest Power and Conservation Council's Fifth Power Plan (2005), and the Kyoto Protocols. These plans are expected to significantly exceed I-937's requirements. Conservation resource and plans for accelerated conservation are detailed in Chapter 4.

Greenhouse Gases and Climate Change

Resolution 30144 also directs City Light to mitigate greenhouse gas emissions from any fossil fuel use and to set a long-term goal of "net zero" annual greenhouse gas emissions. City Light achieved net zero in 2005 and has continued each year since. The Greenhouse Gas Mitigation Strategy Resolution 30359 was passed in 2001. It sets standards for calculating greenhouse gas emissions and mitigation projects. Climate change policy does not prevent City Light from acquiring electricity from resources that produce greenhouse gas, but does require that the utility fully offset those emissions.

In February 2005, the Mayor proposed that the City achieve reductions in greenhouse gas emissions based on the Kyoto Protocol goal for the United States - a 7% reduction in greenhouse gas emissions compared to 1990 levels, to be achieved by the year 2012.

In 2007, the Mayor's Climate Action Now was launched to promote reduction in greenhouse gas emissions on a community-wide basis. The program requires City Light to meet load growth with conservation and renewable resources and to offset greenhouse gas emissions. This program features City Light's Net Zero Greenhouse Gas emissions by taking actions that avoid, reduce or sequester greenhouse gas as a key component of meeting the City-wide goal and of helping the community meet its goal. The plan also identifies other actions, including the coordination of efficiency services between the gas and electric utilities that serve Seattle.

In order to meet the requirement to offset greenhouse gas emissions, City Light purchases offsets based on estimates of its emissions each year. At present no federal or state laws determine how offsets are defined, created, and sold. City Light, however, has tracked guidelines developed by non-profit and state government organizations. With the assistance of external stakeholders, the utility has established its own guidelines for counting emissions and selecting offsets. Some states, including California and several in the East, plan to put a cap on greenhouse gas emissions from power plants and other sources, and are planning for a market-based trading system for greenhouse gas offsets. City Light's sales to California utilities could be affected by these regulations.

In the IRP analysis, the amount of greenhouse gas emissions of various resources and alternative portfolios has been calculated. The cost of offsetting those emissions will be calculated based on CO2 allowance prices under potential federal legislation.

The Lieberman-Warner Climate Security Act, S2191, which appeared to be the most likely bill to move forward at the federal level, failed during its June 2008 hearing before the Senate.

State of Washington

Washington's Energy Independence Act (I-937)

The Energy Independence Act requires utilities in Washington with more than 25,000 customers to acquire all cost-effective conservation at a prescribed pace and to acquire "qualifying" renewable resources at a rate of a) 3% of retail load by 2012; b) 9% of retail load by 2016; and c) 15% of retail load by 2020.

Qualifying renewable energy must either be sourced from within the Pacific Northwest, or be purchased outside the Pacific Northwest but delivered into Washington on a firm transmission path, real-time, without integration services. Hydroelectric power is not qualifying renewable energy, unless it is the direct result of qualifying hydro efficiency improvements made after March 31, 1999. The requirement for qualifying renewables can be met with renewable energy credits (RECs), which represent the environmental attributes of qualifying renewable resources at the rate of one REC per megawatt-hour.

Three City Light resources are eligible for meeting the target: the Stateline Wind project, at approximately 3% of current load; the Burlington Biomass facility; and efficiency upgrades completed after March 31, 1999 (such as Gorge Tunnel II) that result in additional power output at City Light hydropower plants.

Integrated Resource Planning

ESHB 1010 (Chapter 195, Laws of 2006) passed by the legislature in 2006, requires certain Washington utilities, including City Light, to regularly prepare Integrated Resource Plans (IRPs). Under statute, IRPs must describe the mix of energy supply resources and conservation needed to meet current and future needs at the lowest reasonable cost to the utility and its ratepayers, using available technologies. Utilities must also consider and include in their planning cost-effective conservation and a wide range of commercially available generation technologies, including renewable technologies.

Facilities Siting

HB 1020 (Chapter 196, Laws of 2006) designates the Energy Facility Site Evaluation Council (EFSEC) as the State's authority for siting transmission facilities under the federal Energy Policy Act of 2005. The law extends EFSEC jurisdiction to electrical transmission facilities that operate in excess of 115 kilovolts within national interest transmission corridors and also to electrical transmission lines in excess of 115 kilovolts that connect a power plant to the grid.

Net Metering

Net metering measures the difference between the electricity supplied by a utility and electricity generated by a customer. If the customer generates more than needed, the excess power is sold to the utility's system. Under RCW 80.60, Washington state requires utilities to provide net-metering service to encourage development of renewable and distributed resources. The maximum allowable generating capacity for net metering systems is 100 kilowatts. The list of qualified generating sources for net metering includes solar, wind, water, fuel cells, and biogas from animal waste. In 2014 the cap on the total amount of net metering generation allowed in a utility's system will grow to 0.5% of its peak demand in 1996. City Light's 1996 peak load was 1950 MW, so it will be allowed 9750 kilowatts of net metered load on its system in 2014.

Incentives for Renewables

SSB 5101, passed in 2005 by the legislature, is an investment cost recovery incentive to support certain renewable energy projects. Customers who generate electricity from a renewable energy system may seek annual incentive payment from their participating electric utility up to $2,000 annually. Utility participation is voluntary. Participating utilities, such as City Light, are allowed a credit against their public utility tax equal to the incentives paid to customers.

Governor's Executive Order on Climate Change

In February 2007, Governor Christine Gregoire issued Executive Order 07-02, the Washington Climate Change Challenge. The greenhouse gas reduction goals in order include:

- By 2020, reduce overall emissions of greenhouse gases in the state to 1990 levels;
- By 2035, reduce overall emissions of greenhouse gases in the state to twenty-five percent below 1990 levels;
- By 2050, the state will reduce overall emissions to fifty percent below 1990 levels.

Power Plant Greenhouse Gas Performance Standard

In 2007, the Washington state legislature passed ESSB 6001. This bill entered the Governor's Executive Order 07-02 into law. It also established a greenhouse gas emissions limit, called the performance standard, for new power plants. The limit is 1,100 pounds of CO2 per MWh of power, roughly equivalent to an existing natural gas plant emission rate. Greenhouse gas that is captured and sequestered is not counted toward the emission limit; however, the technologies for achieving capture and sequestration are in early development stages. The law also prohibits electric utilities in Washington state from renewing or entering into new contracts longer than five years for power plants that emit above the limit. This law has already impacted new power plant development in Washington state. Two proposals for new power plants were withdrawn over questions about their ability to meet the new requirement.

2008 Legislation

In the Washington state 2008 legislative session, a bill passed related to greenhouse gas and climate change that may have impacts for utilities and power generation. ESSHB 2815 directs the state to design an inventory process to track progress toward meeting reduction goals, describes goals for participation in regional or multi-state registry processes, and directs the state to work with the Western Climate Initiative. Of specific interest to electrical utilities, the bill requires a report to the legislature on how electrical infrastructure can be provided in urban and rural areas to promote plug-in hybrid vehicles and how electricity or alternative fuel from landfill gas or anaerobic digesters could be used in a market system for greenhouse gas reductions, and energy generators must report greenhouse gas emissions to the Energy Facility Site Evaluation Council.

Washington State Climate Action Team

In 2007, the Washington State Climate Action Team (CAT) was formed to evaluate ways to meet Governor Gregoire's climate change reduction goals and to make recommendations. The report, "Leading the Way, A Comprehensive Approach to Reducing Greenhouse Gases in Washington State," was released in February 2008. The electricity industry was one of the focus industries.

In 2008, the CAT process will continue, with the goal of taking the recommendations from the report and working with the Washington legislature to create laws to implement them. They will focus on a subset of the recommendations that can be implemented quickly.

Regional

Regional policies and guidelines relevant to utility resource planning are summarized below, including those of the Bonneville Power Administration, Northwest Power Planning Council and the Western Governors' Association.

Bonneville Power Administration

Bonneville Power Administration (BPA) is the power-marketing agency for electricity generated from projects owned and operated by the Army Corps of Engineers and the Bureau of Reclamation. City Light purchases approximately 40% of its power supply from BPA, and decisions affecting the marketing of this power at the federal level can significantly impact City Light's resource portfolio cost, risk and reliability. City Light also relies heavily on purchases of significant amounts of transmission from BPA to transfer power from City Light's remote generating resources to its load.

BPA customers, including City Light, have joined to promote long-term, cost-based contracts to restore and protect low-cost regional power in the face of periodic attempts to divert the benefits of BPA from the Pacific Northwest.

After many years of discussions, Pacific Northwest utilities have concluded that BPA should only sell the output of the Federal Base System (federal hydropower plus the Energy Northwest nuclear power plant). All publicly owned utilities should be responsible for acquiring new resources to meet any of their loads in excess of what is allocated to them from BPA. Investor owned utilities should get a financial settlement of their residential exchange rights. Other significant issues have yet to be resolved.

BPA is preparing a Policy Proposal about what new long-term contracts will look like. BPA proposes that contracts be signed for service that begins in October 2011 and terminates in November 2027.

Northwest Power and Conservation Council

The Northwest Power and Conservation Council (NPCC) is a public agency created by the Pacific Northwest Electric Power Planning and Conservation Act of 1980. The agency's three major functions are to:

- Develop 20-year electric power planning for the Northwest that guarantees adequate and reliable energy at the lowest economic and environmental cost.

- Develop programming to protect and rebuild fish and wildlife populations affected by hydropower development in the Columbia River Basin.
- Educate and involve the public in the Council's decision-making processes.

Power Planning

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

Regional Resource Adequacy Standard

In 2006, the NPCC adopted a new regional standard intended to ensure an adequate supply of electricity for the Pacific Northwest. The regional standard is also expected to be included for the Northwest region within the broader West-wide efforts on resource adequacy by the Western Electricity Coordinating Council (WECC).

NPCC's regional adequacy standard is intended to address the unique characteristics of the Pacific Northwest, including the region's winter-peaking loads, compared to summer-peaking loads across most of the West, and heavy dependence on hydroelectric generation. The Pacific Northwest energy aim is to have resources equal the expected annual load.

Western Governors Association

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

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

In 2006, the Western Governors adopted Resolution 06-10, agreeing to provide production tax credit for all renewable energy technologies and energy efficiency investments, raise the cap on the residential investment tax credit to $10,000 for renewable energy or distributed generation systems, and support improvements in national appliance efficiency standards.

In June 2007, the Western Governors adopted Resolution 07-17, making recommendations for renewable portfolio standards that were largely satisfied in Washington state by I-937.

Resolution 07-17 supports:

- Hydropower research and emerging hydrokinetic/ocean technologies.
- Long-term reauthorization of renewable production tax credits.
- Achieving energy efficiency savings from new and existing residential and commercial/public buildings.
- Transmission to accommodate the integration of large amounts of renewable generation in the Western power system.
- Effective utilization of existing hydropower facilities and more effectively using small hydro potential.
- Implementation of national renewable portfolio standards.

Western Climate Initiative

The Western Climate Initiative (WCI) was launched in February 2007 by the governors of the states of Washington, California, Oregon, Arizona, and New Mexico. Its goal was to develop regional strategies to address climate change. Subsequently, the governors of the states of Utah and Montana, and the Premiers of British Columbia, Manitoba, and Quebec have joined. Other western states and provinces are participating as observers, including Alaska, Idaho, Nevada, Colorado, Wyoming, Kansas, Ontario, Saskatchewan, and six Mexican states.

In August of 2007, WCI announced a regional goal of reducing greenhouse gas emissions to 15% below 2005 levels by the year 2020.This goal is consistent with goals set by the partner states.

By August 2008, WCI is to complete the design of the market-mechanism based system partners will use to meet the goal. Reports of greenhouse gas emissions will be done at the state or province level, every two years, and will be submitted to WCI. All six of the greenhouse gases covered in the Kyoto Protocol will be included in the reports.

Currently WCI has drafted recommendations on principles to guide the development of the design covering the following areas: allocation of greenhouse gas emission allowances, the use of greenhouse gas offsets to meet the goal, and reporting requirements. The reporting requirements will likely follow those being developed by The Climate Registry (see below).

States and provinces will report electricity emissions based upon the sources used to supply end-use load inside their borders, even if the power is generated outside their borders. This will pose a challenge to electric utilities to determine the sources of imported and short term market electricity purchases.

The Climate Registry

Building on the work done by the California Climate Action Registry, a multi-state greenhouse gas emissions registry called The Climate Registry (TCR) was formed in 2007. Its development has moved quickly, and as of spring 2008, membership included 39 states, seven Canadian provinces, six Mexican states, and three Native American Tribes. Although voluntary, it is being discussed as the platform for federal legislation for reporting and reducing greenhouse gas emissions.

The City of Seattle is a founding member of TCR, and City Light will likely report its greenhouse gas emissions through this registry. General Reporting protocols have been finalized, and more specific guidelines for electric utilities will be developed.

Federal

The primary federal statutes relevant to energy resource planning are the Clean Air Act, Clean Water Act and Energy Policy Act of 2005.

Environmental Regulations

At the federal level, recent EPA regulations (the Clean Air Interstate Rule and the Clean Air Mercury Rule) have set tighter limits for emissions of common air pollutants from power plants: oxides of sulfur and nitrogen, and mercury. Other regulations will further limit emissions of particulate matter. These regulations may become more restrictive during the planning period of the IRP, and states may set their own more restrictive standards as well. Meeting these limits can be a significant technical challenge, as well as a significant additional cost, for power plants that burn fossil fuel.

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

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

Energy Policy Act of 2005

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

Energy Efficiency

Several provisions related to energy efficiency may influence the acquisition of conservation resources within City Light's service area. The Energy Policy Act of 2005 authorizes $50 million in funding annually between 2006 and 2010 for state-administered energy efficient rebate programs for residential Energy Star products. These include appliances, heating and cooling systems, home electronics, lighting, and windows, doors and skylights. The legislation establishes financial grants for state-run programs to achieve at least 30% efficiency improvements in new and renovated public buildings.

Generation Resources and Fuel Supply

Hydroelectricity

The Act authorizes $100 million for hydroelectric efficiency improvements at existing dams and modernizes the hydropower laws to allow increased production. It creates a 10-year tax credit that will apply to "qualified hydropower production" if placed in service prior to January 1, 2008. Relicensing provisions are amended to allow applicants or other parties to propose alternatives to conditions set by the agencies.

Natural Gas

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

Coal

The Act authorized $200 million per year from 2006 to 2014 for a federal government cost-share program to conduct demonstrations of commercial-scale advanced clean coal technologies. It also authorized $3 billion in the form of loans, cost sharing or cooperative agreements to encourage new sources of advanced coal-based power generation, and to upgrade existing sources of coal-based generation to improve air quality to meet current and future obligations of coal-fired generation units regulated under the Clean Air Act. The Act authorized a total of $1.095 billion over three years in funding for the Department of Energy (DOE) clean coal research and development program, and $75 million over three years for a DOE program to develop carbon capture technologies that can be applied to the existing fleet of coal units.

Innovative Technologies

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

Nuclear Energy

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

Transmission

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

DOE is directed to study of electric transmission congestion and possible designation of "national interest electric transmission corridors." The designation of such corridors could have a significant impact on the development of new electric transmission facilities. Congress has given FERC "backstop" authority to grant permits for the construction or modification of electric transmission facilities within these corridors in certain situations, including where the state siting authority has withheld approval. (In Washington state, HB 1020 in designates the State EFSEC to prevent a FERC backstop.)

Climate Change

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

Amendments to the Public Utility Regulatory Policy Act (PURPA)

The Act amended PURPA to repeal the requirement for mandatory purchase from qualifying facilities by electric utilities if a competitive market exists, and established new criteria for qualifying cogeneration facilities.

The Act amended PURPA to require state regulators and certain non-regulated electric utilities to consider five new standards based on the purposes of PURPA: net metering, fuel sources, fossil fuel generation efficiency, smart metering, and interconnection. Washington state's IRP law and City Light's IRP process meet the consideration and determination requirements required under PURPA. City Light does not anticipate the need for substantial discussion on the fuel sources and fossil fuel generation efficiency standards, since they are covered by existing state law.

Chapter 4 – Resource Options

This chapter identifies and describes commercially available resources and addresses transmission issues that can impact market purchases and seasonal exchanges.

An essential mission for integrated resource planning is to identify and evaluate a broad range of resources (as required by Engrossed Substitute House Bill 1010), including conservation and generation resources. This chapter contains information about resources currently available to electric utilities considered for this Integrated Resource Plan (IRP). These include additional conservation resources; nonrenewable generation resources (natural gas); renewable generation resources (wind, geothermal, biomass, and landfill gas); hydro efficiency improvements; power purchase contracts; and spot power purchases from the Western wholesale energy market. Utility-scale resources that may become cost-effective in the future, such as solar and wave energy, are detailed in Appendix B - Electric Generating Resources and Appendix C - Assessment of Tidal Energy Resources in Puget Sound and Wave Energy Resources in Grays Harbor, Washington. In Appendix D - Assessment of Distributed Generation Opportunities, the potential for small-scale generation at the customer site is explored, and in Appendix E - Demand Response Assessment, customer load control is considered.

Conservation Resource

Conservation is Seattle City Light's first choice as a resource to meet growing demand for power. Through its conservation programs, City Light partners with its customers to use energy-efficient equipment and practices in homes and buildings. Investment in conservation is advantageous for the utility and its customers, and delivers other benefits as well, such as avoided higher-cost generation, deferred transmission and distribution investments, reduced air pollution and greenhouse gas emissions, and lower customer bills. As a low-cost, low-carbon alternative to other types of energy generation, conservation is the foundation of Seattle City Light's Integrated Resource Plan, the Mayor's Climate Action Now Campaign and the utility's plan to meet the requirements of I-937. Acquiring conservation is also a good policy in a transforming energy market because it avoids price risk and availability risk. Seattle City Light has provided highly effective conservation programs for over 30 years.

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 simple cycle combustion turbines, have a greater degree of dispatchability. Energy efficiency measures are not dispatchable.

Conservation resources have seasonal, daily and hourly load shapes. 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 home with electric heat will save more energy in the winter, when heating is used the most.

Conservation measures can be either discretionary or lost opportunity resources. Discretionary conservation measures can be implemented at any time within practical limits. Discretionary conservation usually involves ad hoc energy efficiency improvements by an existing City Light customer, whereas lost opportunity conservation must be captured when a new building is built or when a new appliance is installed; if not, the conservation benefit can be lost. 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 retrofitted in the future at a much higher cost.

2006 Conservation Potential Assessment

The Conservation Potential Assessment (CPA), conducted by energy analysis firm Quantec, examined available energy savings in the residential, commercial and industrial sectors in City Light's service area. It considered dozens of conservation measures, with hundreds of permutations across segments and construction vintages, distinguishing between discretionary and lost opportunity resources. The study also incorporated non-energy benefits. Information gathered in the CPA was used to prepare both the 2006 and the 2008 IRPs.

Technical potential refers to the maximum savings that could be achieved if every cost effective efficiency measure were implemented in every customer facility - residential, commercial and industrial. Achievable potential is the portion of technical potential that will likely be viable over the planning horizon, given market barriers that could limit implementing demand-side measures.

To determine the achievable conservation potential available to meet resource needs, the CPA first attempts to identify all technical or demand-side resource opportunities from conservation that could be captured regardless of costs or market barriers.

Achievable potential was assumed to be 70% of the technical potential for the CPA and the 2006 IRP. In order to comply with Initiative 937 requirements, the percentage for achievable potential assumptions was revised to 85% for all discretionary measures (existing buildings and equipment) and 65% for all lost opportunity measures (new buildings and equipment) for the 2008 IRP. The result was an achievable cost-effective conservation potential that totals 159 aMW over the 20-year planning horizon. Only the discretionary portion of the total 20-year cost-effective potential of 159 aMW was accelerated for the portfolios.

Table 4-1 shows the total amount of conservation potential estimated to be achievable over the 20-year planning period. The table shows the amounts of conservation potential that could be achieved across a series of levelized cost groups. The data shown in the table constitute a "supply curve" for conservation resources.

Table 4-1. 20-Year Cumulative Achievable Potential by Cost Group 2006 IRP vs. 2008 IRP

Cost Group ($/MWh)	2006 IRP (aMW)	2008 IRP (aMW)
Up to 10	18.4	16.3
10 to 20	46.6	57.1
20 to 30	45.2	47.4
30 to 40	13.8	19.7
40 to 50	7.9	8.7
50 to 60	8.8	10.0
Cumulative < $60 /MWh	140.7	159.2

The 2006 IRP identified acceleration of conservation programs as a promising resource strategy and recommended that the costs, benefits and feasibility of accelerating conservation be examined in the 2008 IRP.

Modeling Conservation in the 2008 IRP

One of the outcomes of analysis for the 2006 IRP was a strong recommendation to identify the costs of accelerating conservation in City Light's service territory. To that end, Conservation staff retained consulting assistance to update the Conservation Resource Potential Assessment in 2007 for the 2008 IRP. Conservation costs were reassessed based upon two significant changes: 1) the increase in costs for accelerating conservation; and 2) the changes required in order to use assumptions for achievable conservation potential resulting from I-937 requirements. The new rules for implementing I-937 require a change in assumptions for calculating achievable conservation potential.

In I-937, the target for renewable resources is a percentage amount based on the average load of the previous two years. To the extent that conservation reduces load, it also reduces the need to purchase expensive new renewable resources. Thus, results of this information gathering and reassessment demonstrated that even with the additional costs of accelerating conservation, total costs remained well below the cost of new generating resource alternatives.

In the 2006 analysis, staff modeled alternative levels of conservation in the various portfolios and then compared them in order to identify the most cost-effective level. In 2007, however, the new conservation costs were modeled relative to the 2006 levelized portfolio (avoided) cost of $60/MWh for new resources. City Light staff used the avoided cost approach for several reasons: First, the avoided cost already incorporated a thorough analysis completed for the prior IRP; second, conservation potential was unlikely to have changed significantly in the relatively short period of time between the 2006 IRP conservation analysis and the 2007 update; last, and most important, the updated conservation cost structure suggested that the $60/MWh was not a meaningful constraint. Under these circumstances, the impact to the targets established for accelerating the pace of discretionary conservation acquisition far outweighed any small, positive or negative adjustments arising from the use of a different methodology. The targets for at least the first decade of the planning period would not change, since the constraints were not theoretical, but physical. In short, City Light found that it should acquire as much conservation as it can, as quickly as possible.

In estimating the pace of accelerating conservation, the model logic does not capture practical considerations. For accelerated conservation, the question does not concern theoretical modeling but implementation: "How quickly can City Light actually 'mine' discretionary conservation from existing buildings?" The answer to this depends on issues such as budgets, customer incentives, staffing, office space, consultants, conservation contractors and schedules.

In Round 1 portfolios, City Light modeled a lower rate of accelerated conservation than in Round 2 portfolios, (well beyond the rate required by I-937), based upon what was then the highest estimate for the pace of acquiring the discretionary conservation. After closely reviewing the numbers, Conservation staff set a more aggressive pace to obtain the discretionary conservation. City Light increased the accelerated conservation used in the Round 2 portfolio analysis, which resulted in lower overall portfolio costs.

A cost effective threshold of $60 per MWh (used in the 2006 IRP) was applied to the Conservation Potential Assessment. The figure was updated by the new achievable potential assumptions-85% of all discretionary resources and 65% of all lost opportunity resources.

Two different series of accelerated conservation were used for the Round 1 and Round 2 portfolio modeling. Table 4-2 reflects the accelerated conservation path used in all Round 1 portfolios.

Table 4-2. Accelerated Conservation in Round 1 Modeling, Annual and Cumulative

	Annual (aMW)	Cumulative (aMW)
2008	8.4	8.4
2009	9.5	17.9
2010	11.0	28.9
2011	12.9	41.9
2012	12.9	54.8
2013	12.9	67.8
2014	12.9	80.7
2015	12.9	93.7
2016	12.9	106.6
2017	12.9	119.6
2018	11.0	130.6
2019	9.5	140.1
2020	8.4	148.5
2021	1.5	150.0
2022	1.5	151.6
2023	1.5	153.1
2024	1.5	154.6
2025	1.5	156.2
2026	1.5	157.7
2027	1.5	159.2

For Round 2 modeling, the degree of conservation acquisition was accelerated further, as shown in Table 4-3.

Table 4-3. Accelerated Conservation in Round 2 Modeling, Annual and Cumulative

	Annual (aMW)	Cumulative (aMW)
2008	10.2	10.2
2009	12.1	22.3
2010	14.4	36.7
2011	15.6	52.3
2012	15.8	68.1
2013	15.6	83.7
2014	12.9	96.6
2015	12.9	109.5
2016	12.9	122.4
2017	12.8	135.2
2018	11.0	146.2
2019	3.0	149.2
2020	3.0	152.2
2021	1.0	153.2
2022	1.0	154.2
2023	1.0	155.2
2024	1.0	156.2
2025	1.0	157.2
2026	1.0	158.2
2027	1.0	159.2

Subsequent to Round 2 modeling, the annual conservation goal for 2008 was scaled back to 8.4 aMW after City light did not receive supplemental budget authority.

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 being costs, dispatchability, transmission requirements and environmental attributes.

Evaluating the Resources

In considering resources, the IRP team evaluated generation resource types rather than specific projects. The exception to this is a hydroelectric efficiency improvement, the Gorge Tunnel project. Reliable and verifiable information about the each generating technology can be used for the analysis of candidate resources with this approach, which allows an objective and consistent comparison of the results. The process benefits when the IRP focuses on higher-level, long-term strategic issues rather than on the details of specific transactions. Further, if a resource strategy adopted in the IRP calls for City Light to acquire a specific type of generation resource, the information about the resource developed for the IRP can be used as a benchmark to evaluate specific generation projects.

This section provides descriptions of the types of generating resources that were included in candidate resource portfolios and evaluated for the 2008 IRP.

- Hydroelectric Efficiency (Gorge Tunnel II)
- Wind Power
- Biomass
- Landfill Gas
- Geothermal
- Natural Gas-Fired Combined Cycle Combustion Turbines (CCCTs) and Simple Cycle Combustion Turbines (SCCTs)

As research and development continue for new or enhanced types of generating resources, it is difficult or impossible to predict future technological advancements and how they will affect cost, availability and other characteristics of such resources. Thus, 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 IRPs should contain commercially available technologies and select resources with the lowest reasonable cost. In keeping with state law and IRP best practices, the IRP does not contain forecasts of new technologies or their costs.

Selecting a Range of Resources

The IRP Team followed an open, rigorous and structured process to compare and choose from an array of available resource types, and 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 including it in City Light's portfolio.

Analyzing various types of generating resources helps to identify which combinations of new resources can best complement the existing resources in City Light's portfolio. A single type of generating resource is unlikely to meet all of the utility's long-term needs, while a diversified mix of resources is more likely to meet the utility's objectives of maximizing reliability and minimizing cost, risk and environmental impacts. 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.

Various types of generating resources have proponents and opponents. Quantitative analysis of candidate resource portfolios that combine a range of resource types provides the means to incorporate input from a variety of perspectives. Quantitative analysis of candidate resource portfolios that mix types of resources can produce the information City Light requires in order to select the types of resources included in 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 costs that are verifiable at the point the IRP is produced. Some resources were not included in the quantitative analysis because their costs are significantly higher than alternative renewable resources or they are not commercially available to City Light. (See Appendix B for detailed descriptions of existing and potential resources.) In the future, City Light may conduct Request for Proposals (RFPs) in order to provide more complete information on resource costs and availability. However, even RFPs are not always reflective of the true cost of a resource due to local market constraints and the bidding strategies of participants in the RFPs.

Costs of New Generation Resources

Rapidly rising commodity prices and a devalued U.S. dollar are driving escalating costs for new resources. Much of the escalation is traceable to rising prices for steel and concrete, as global demand rises for these materials. The cost of wind turbines, many imported from Europe, has grown rapidly as a result of transportation costs and a weak U.S. dollar.

In the next few years, City Light expects to see higher capital costs for resources than represented in this IRP. However, the possibility exists that productive capacity for concrete, steel and wind turbines will increase, causing resources prices to moderate. City Light chose not to adjust resource costs upward for what are seen as primarily near-term market trends. Table 4-4 shows the resource costs used in the 2008 IRP.

Information about the costs of new resources came from many sources, including the U.S. Department of Energy, Northwest Power and Conservation Council, California Energy Commission, and Northwest Utility Integrated Resource Plans. 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 middle of the range most frequently used.

Transmission costs for new resources are assumed to be consistent with the BPA's policy for new transmission. This 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%.

Table 4-4 provides costs and other assumptions for new generation resource options that were evaluated in the 2008 IRP.

Table 4-4. Costs for New Resources

Cost	CCCT	SCCT	Geo- thermal	Wind	Biomass	Landfill Gas
Heat Rate (BTUs/kWh)	6903	9,251			n/a	11,000
Capital ($/kW)	$747	$758	$3,176	$1,734	$2,238	$1,773
Fixed O&M ($/kW-yr)	$11.88	$75.60	$71.92	$34.33	$73.24	$66.12
Wheeling ($/kW-yr)	$18.91	$18.91	$18.91	$18.91	$18.91	$18.91
Fuel	GED Gas Price Forecast	GED Gas Price Forecast	Included in Capital	$0.00	Included in Capital	
Variable O&M ($/MWh)	$2.87	$5.49	$4.63	$1.00	$3.78	$7.66
Integration & Shaping ($/MWh)				$7.82		

Resources Evaluated in the IRP

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

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

(See the 2006 IRP Draft and Final Environmental Impact Statements, and the 2008 Addendum, for additional information on environmental impacts.)

Hydroelectric Efficiency Improvement

City Light has pursued ongoing efficiency improvements to the hydro plants that it owns, including replacement of turbines and runners, on a prescribed schedule. The new hydroelectric resource considered for this IRP is an efficiency improvement at Gorge Dam, part of City Light's Skagit Project.

Hydroelectric Efficiency Improvement	
Technology & Fuel	The Gorge Reservoir supplies water to the powerhouse through a single tunnel. The efficiency improvement would involve the installation of a second tunnel that would decrease flow velocities, reduce energy lost to turbulence when water flows at high velocity, and reduce the frictional losses that occur between the water and the tunnel wall, thereby increasing the effective hydraulic head. Greater power production would result for the same amount of water. This efficiency improvement would increase annual generation by about 5.40 average megawatts. In January, generation is estimated to increase by 5.14 average megawatts.
Current Status & Outlook	A FERC license amendment and other permits would be required for this project. It would be completed in about eight years, with the first three years devoted to the FERC license amendment process.
Characteristics	**Transmission requirements.** Already available **Dispatchability.** The output from the hydroefficiency would be dispatchable. **Environmental attributes.** The generation from the hydroefficiency improvement would be a renewable resource. Specific environmental impacts will be evaluated during project design and planning.

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 1,700 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. Wind turbine generators are grouped together in order to maximize energy output and minimize costs. 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 economically viable potential for wind power in the Pacific Northwest at approximately 5,000 megawatts. State requirements for renewable resources, including Initiative 937 in Washington, are driving the development of new wind power. 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.
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.

Biomass

Biomass generation is the production of electricity using biomass fuel, 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 wood waste (e.g., residues from forest thinning, logging and mill processes), methane produced at wastewater treatment plants, and methane produced from the decomposition of animal manure, agricultural residues and energy crops. For the 2008 IRP, wood-waste plants were modeled.

Extremely large amounts of biomass fuels are usually not available near any single location, thus incurring transportation expense. Most future biomass plants will typically have generating capacities of between 10 megawatts and 25 megawatts.

Biomass	
Technology & Fuel	The raw forms of many biomass fuel sources have low energy content, so generating electricity from biomass requires large quantities of organic material. Biomass is converted into fuel using thermochemical or biochemical technologies. Both types of technology generate electricity by processing 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.
Current Status & Outlook	Limited opportunities to acquire these types of generating resources are expected, and costs and other characteristics are situation-specific. While woody residue is available in large quantities, the high cost of collection and transportation limits the economics of plants distant from fuel sources. Technical difficulties and seasonality of fuel availability preclude significant use of agricultural field residues for generation. A small, undeveloped potential for energy recovery exists at municipal wastewater treatment plants
Characteristics	**Transmission requirements.** Biomass generation is usually sited near transmission or distribution lines. **Dispatchability.** Biomass generating resources usually operate as baseload generation **Environmental attributes.** Most biomass fuel is a renewable resource, with low environmental impacts. Biomass generation does not add large net amounts of carbon dioxide to the atmosphere, but it does emit nitrogen oxides and particulate matter. Biomass generation based on 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.

Landfill Gas

Landfill gas is a product of the natural degrading and decomposition of municipal solid waste by anaerobic microorganisms in sanitary landfills. The gases produced, carbon dioxide and methane, can be collected by a series of low-level pressure wells and can be processed into a gas that can be burned to generate steam or electricity.

Landfill Gas	
Technology & Fuel	As organic materials in solid waste landfills decompose anaerobically, high concentrations of combustible gases are released. Landfill gas is composed of 50 to 60% methane; most of the rest is carbon dioxide. These gases can be put to productive use as fuel for generating electricity using internal combustion engines or combustion turbines. Generation capacity is usually 10 megawatts or less. Fixed and variable costs for landfill gas projects depend on the type of generating technology that is used. Smaller projects use internal combustion engines, while larger projects use combustion turbines.
Current Status & Outlook	Landfill gas is used to produce electricity at 380 landfills in the United States. Landfill gas generating projects use mature technologies. Future availability of opportunities to develop landfill gas generating projects will be influenced by the number and location of solid waste landfills.
Characteristics	**Transmission requirements.** Most solid waste landfills are already served by the local electrical transmission and distribution network. **Dispatchability.** Most landfill gas generating projects are operated as baseload resources in order to ensure that all gas is burned. **Environmental attributes.** Net environmental impacts are small. Landfill gas projects consume a fuel source that would otherwise be flared. Landfill gas may contain impurities that can create hazardous air emissions unless they are removed usually by filtration of the gas prior to combustion. Depending on where the landfill is located and neighboring land uses, noise may need to be controlled.

Geothermal

Geothermal is the only large renewable resource that provides base load generation, has a 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% of the time and may operate for 100 years or more.

Geothermal plants are typically built as 20 to 50 megawatt units, but modular systems are as small as 5 megawatts. The most likely locations in the Northwest are the Basin and Range geologic province that extends over southeastern Oregon and southern Idaho and the High Cascades. Binary technology was modeled for the 2008 IRP.

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 identified nearly 1,300 megawatts of developable geothermal generation in Washington. The outlook for development of geothermal generating resources in the Pacific Northwest is unclear because extensive exploratory drilling has not been done. The most likely locations are in the parts of Basin and Range geologic province in Oregon and Idaho.
Characteristics	**Transmission requirements.** Sites with geothermal potential are located near City Light owned or controlled transmission. Upgrades to 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 baseload 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 gases (though low for binary), 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 technologies considered for the IRP are combined cycle combustion turbines (CCCTs) and simple cycle combustion turbines (SCCTs).

Natural Gas	
Technology & Fuel	A combustion turbine is a rotary engine composed of three basic parts. Air is taken in through a compressor and then 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. 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, without recovery of exhaust heat as in combined cycle turbines. 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 is over 4,000 megawatts of CCCT generating capacity. The Northwest also has slightly more than 1,500 megawatts of SCCT generating capacity. High and volatile prices for natural gas have dramatically slowed the development of new combustion turbine generating projects. The outlook for natural gas prices is a significant source of uncertainty for CCCT and SCCT generating resources.
Characteristics	**Transmission requirements.** Siting requires access to a natural gas pipeline and 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 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 (CO_2), small amounts of sulfur dioxide (SO_2), nitrogen oxides (NO_x), and other air pollutants. Control technologies are used to eliminate most emissions of SO_2 and NO_x. CO_2 production remains a major consideration. Also, some projects require large amounts of water, and there are impacts from fuel extraction and transportation.

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 capacity purchases were the types of market transactions considered for the IRP, in addition to the long-term power purchases described in Chapter 2.

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 an ideal solution in meeting the utility's seasonal resource needs since it enables the utilities in both regions to maintain less generating capacity than would otherwise be necessary. City Light's current portfolio includes a seasonal exchange with utilities in Northern California.

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 exchanges in the modeling process, 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, for example, California or the Desert Southwest). If sufficient firm transmission capacity did not exist, it was assumed that new transmission capacity would need to be constructed, with a minimum of seven years given before the exchange could begin. 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 in assessing exchanges was ensuring that the total amount of energy City Light energy delivered during the summer months did not deprive City Light of energy it would need to meet growing summer loads in later years.

Capacity Purchases

A capacity purchase contract gives the buyer the right to a given amount of electric power at an established price. The contract usually identifies the generating resource(s). If and when the terms are exercised, the buyer takes delivery of power up to the maximum amount the contract specifies.

Seasonal capacity contracts are flexible as a resource and can ensure the availability of power when needed on a seasonal or temporary basis, without City Light bearing the full cost or risk of long-term resource ownership. The utility pays a fee to the owner of the generating resource for providing this service. If the utility exercises the contract terms, it pays the pre-negotiated price for the amount of power produced by the generator party to the contract.

A number of factors can affect the availability and costs of capacity purchases, such as the balance of supply and demand in the power market; price volatility in the market; prevailing prices when the contract is negotiated; and expectations of both the utility and the seller about the future of the power market. The greater the length of time before a capacity purchase is made, the less information is available about these factors and the price is higher.

In modeling capacity purchases, City Light considered purchasing them in different years throughout the 20-year planning horizon, mostly as a tool for balancing resource requirements. For planning purposes, the cost of the premium for a capacity purchase is estimated as the fixed costs of a simple cycle combustion turbine for the period covered by the contract, plus a return on investment for the turbine owner.

City Light does not view seasonal capacity contracts as a substitute for a generating resource, because there is more uncertainty about their long-term availability and cost. When planning for the years after 2012, capacity purchases are only used to bridge the gap in resources for a few years at a time in the candidate portfolios until load grows large enough to merit purchasing or building another generating resource.

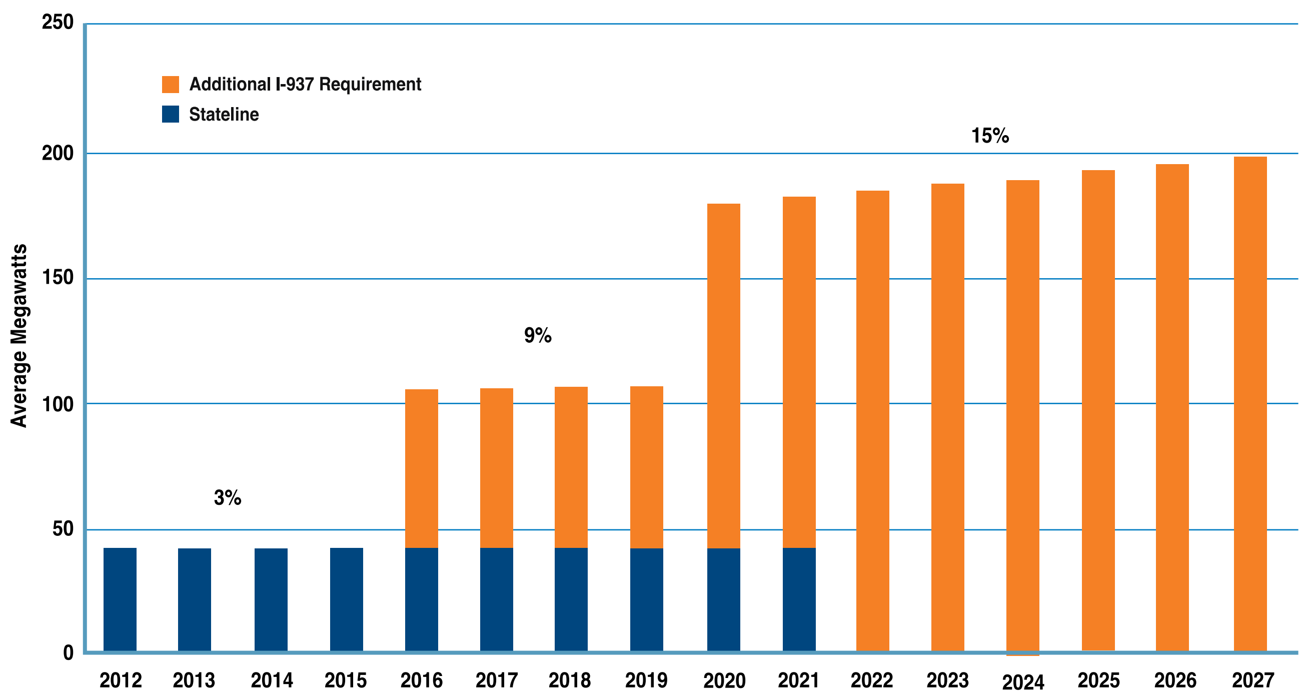
Resource Additions and Portfolio Design Considerations

In planning the 2008 IRP and considering new resources, City Light begins by examining the particular characteristics of each resource, e.g., cost, reliability, and so forth. We have also taken into account the requirements of Initiative 937, referenced throughout this report; Renewable Energy Credits (as they relate to I-937); and the future need for new transmission for new resources. These considerations are described below.

Initiative 937 Resource Requirements

Initiative 937, the Energy Independence Act, was passed by Washington voters in November 2006 and in large part dictates what resources City Light acquires after 2015. The chart below shows that City Light meets the renewable resource requirement through 2015 because of wind energy purchased from Stateline. Until then, resource adequacy drives acquisition choices, but afterwards the utility must meet both I-937 and resource adequacy requirements. The two sets of requirements are not complementary, and there may be times when City Light acquires new resources to meet I-937 requirements when it does not need them for resource adequacy.

Figure 4-1. I-937 Resource Additions



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. The credits are also known as Green Tags, Renewable Energy Certificates (RECs), or Tradable Renewable Certificates (TRCs).

Qualifying resources include power generated with solar, wind, geothermal, tidal, wave, and biomass resources. Some states define hydropower as renewable. Washington state’s definition of renewable resources includes only new hydropower generated in irrigation canals or as a result of certain efficiency-related investments at existing hydropower plants.

RECs can be purchased or traded so that the holder of the certificate can claim purchase or use of new renewable energy, despite having used power generated with large hydro or non-renewable resources. Electric utilities can use RECs to comply with state laws that require them to use a certain percentage of new renewable energy in serving retail customers.

In Washington state, the Western Renewable Energy Generation Information System (WREGIS) serves as the regulatory tracking system for RECs. Registration and tracking of RECs by WREGIS helps to ensure that RECs are properly assigned to their owners, are not double-counted and are retired after they have been consumed.

In addition to tracking, other organizations certify RECs as meeting important environmental and consumer standards. Seattle City Light certifies the RECs used in its voluntary "Green Up" program for retail customers with the Green-e Renewable Energy Program. The Green-e certification ensures that "Green Up" meets strict environmental and consumer protection standards established by the non-profit Center for Resource Solutions.

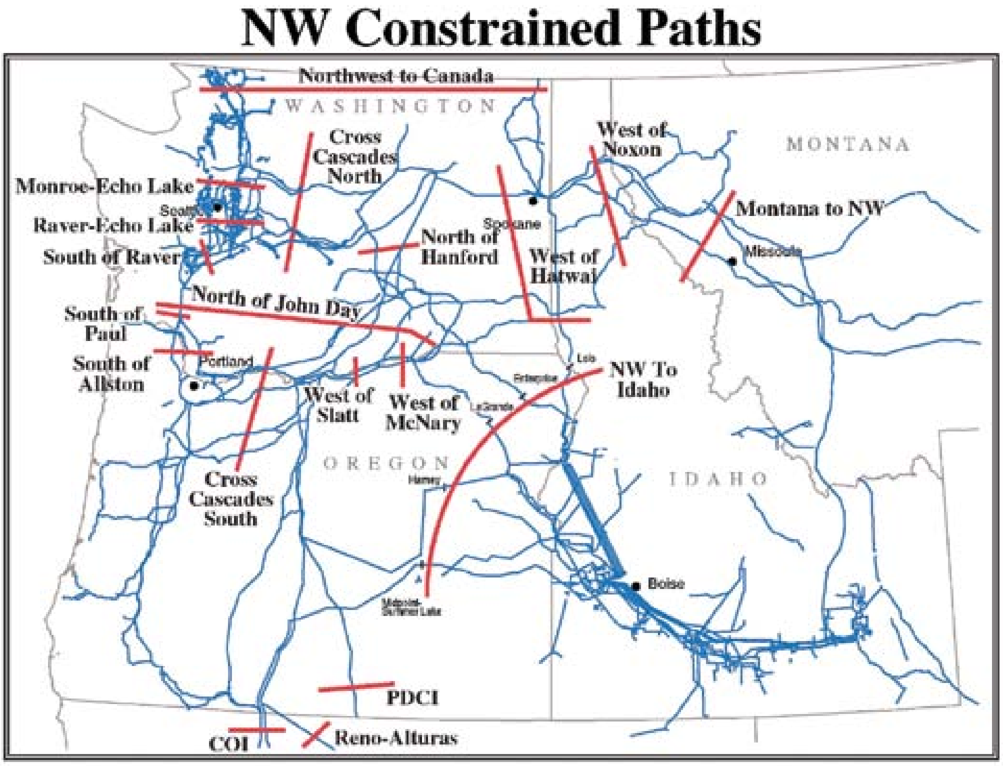
Washington state utilities can purchase RECs from qualifying renewable energy resources in Oregon, Idaho, and western Montana in addition to in-state. Washington state law will impose a $50/MWh fine (in 2006 dollars) for failure to have sufficient qualifying renewable energy or RECs to meet the state requirements under Initiative 937. REC prices in Washington today are primarily a function of the value placed upon them by voluntary buyers of RECs and out-of-state utility buyers who can use them to qualify for their own state renewable portfolio standards. This is expected to change at least one year before 2012, the first year of renewable resource requirements for I-937.

Of particular importance for City Light, a utility can be awarded non-tradable RECs for investing in many kinds of hydro efficiency projects. For each incremental MWh generated as a result of these efficiency measures, City Light receives one non-tradable REC. These non-tradable RECs can be used to meet I-937 requirements for renewable energy, the same as tradable RECs. City Light has and continues to make investments in efficiency measures at its hydroelectric plants. These measures may include structural changes, upgrades to turbines and runners, more efficient transformers, and other equipment. An example is City Light's planned efficiency improvement at the Gorge power plant, Gorge Tunnel II, described earlier in this chapter.

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% 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 flowgates, in the Northwest are shown on the map below.

Figure 4-2. Northwest Constrained Transmission Paths



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. And as the transmission system ages, more frequent and longer duration maintenance outages are needed to maintain system capacities and prevent path deratings. Scheduled outages often cause inefficient management of generation resources.

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 from distant, new generating resources can be delivered to Seattle. This section identifies issues associated with acquiring long-term firm transmission.

Transmission Contracts and Future Planning

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 BPA under its FERC-compliant open-access transmission tariff (OATT) and provide distinct quantities of transmission capacity on a point-of-receipt (POR) to a point-of-delivery (POD) 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.

In the Pacific Northwest, BPA periodically convenes its stakeholders to assess transmission adequacy and seek solutions to both short-term and long-term congestion. BPA has developed both short-term and long-term firm methodologies that are used to evaluate new requests for transmission service. In 2007, a regional, coordinated planning and expansion effort that will augment the BPA planning process started. These efforts will address transmission system planning challenges including: determining how much transmission is needed and when; where transmission needs to be sited; who will own and control transmission facilities; how the costs of new facilities will be allocated; and what measures might forestall the need for construction.

Issues

City Light does not expect to directly site and develop transmission outside its service area. Transmission facilities required for new City Light generating resources probably will be built by other utilities; however, City Light has a substantial interest in resolving issues such as:

- Lack of available, long-term firm transmission capacity on Northwest transmission paths.
- Lack of clear responsibility for planning and constructing transmission facilities.
- Time required from planning to construction (average of five to ten 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.
- Insufficient coordination between transmission and resource planning and development processes.
- Changes to open-access transmission tariff provisions.

To meet its resource adequacy criterion, City Light may need to build new generating resources in the Northwest if it cannot take advantage of seasonal diversity of power demand, such as importing from California or the Desert Southwest on a firm basis during the fall and winter to meet peak load requirements. The Northwest power market is seasonally surplus and energy prices may be depressed during the spring and summer when transmission congestion limits the ability to export surplus power to high demand regions. Such seasonal exchanges of power have historically made more efficient use of generating capacity in the Western Interconnection, but are constrained by the transmission system capacity limits. Transmission congestion can cause City Light to sell surplus power during the spring and summer when regional prices may be depressed, and purchase power during the fall and winter when prices are high.

Anticipated Need for and Estimating the Cost of New Transmission

City Light may need new or upgraded transmission facilities to transmit power from any additional resources to its service area, or to balance its power supply surpluses and deficits in regional power markets. New transmission also may be needed to improve reliability, or increase the capacity of the system to facilitate market transactions that reduce or defer the need for new generation sources.

Because long-term firm available transmission capacity (ATC) is based on forecasts, actual transmission requirements cannot be known until the capacity, location and operating characteristics of proposed new generating resources are identified. In general, generating plants farther from load centers are likely to impact more constrained paths and require more transmission capacity expansion than resources close to load centers.

The following table provides a summary of long-term firm transmission rates for transmission providers that may provide service for new generating resources.

Table 4-5. Long-term Firm Transmission Rates for New Generating Resources

PTP Transmission Rates for NW Providers			
Based on Rates Effective in 2007-2008			
		Ancillary Services	
	Firm PTP Rate ($/kW-mo)	Fixed ($/kW-mo)	Variable ($/MWh)
BPA	$1.2980	$0.2030	$0.5679
Avista	$1.4000	$0.2682	$ -
BCTC	$4.6700	$0.2606	$1.2850
Idaho Power	$1.7650	$0.1959	$ -
NW Energy Montana	$3.4200	$0.6100	$ -
PacifiCorp	$2.0250	$ -	$1.1660
Portland General	$0.5230	$0.2669	$ -
Puget Sound Energy	$0.2300	$0.2666	$ -

The Western Electricity Coordinating Council (WECC) has received a handful of requests from utilities and transmission project developers to construct and establish a transfer capacity rating for merchant transmission projects in the west. These projects may provide additional transmission capacity across constrained paths that will primarily be useful for seasonal exchanges. The price for service on these projects is not known at this time, but may be estimated based on the scope and estimate capacity rating of the project.

Designing Candidate Portfolios

After gathering information on the range of resources that might be added to City Light's existing resource portfolio, candidate portfolios were constructed in order to meet these objectives:

- Minimize the amount of resources needed to meet resource adequacy and I-937 requirements, largely by accelerating the acquisition of conservation.
- Use lower cost resources, such as exchanges and capacity purchases, in the early years to minimize the net present value of the cost of the portfolios.
- Avoid large resource commitments in the early years by using exchanges, capacity purchases and conservation.
- Produce portfolios that will meet the resource adequacy requirement and I-937 requirements.
- Use scalable resources when possible as opposed to separate projects (e.g., wind, geothermal, combustion turbines).
- Ensure that there is sufficient new generation in summer months to meet proposed seasonal exchanges.
- Avoid exchanges or resources in the early years that would require new transmission to be constructed on an unreasonably short timeline.

Once the portfolios were created, their performance was evaluated. Criteria for evaluation and the evaluation process are described in Chapter 5. Chapter 6 describes the results of two rounds of evaluation.

Chapter 5 – Evaluating Candidate Resource Portfolios

This chapter reviews the methodology, assumptions and criteria that City Light staff used to evaluate each of candidate resource portfolio.

Preparing an integrated resource plan requires planning staff to make informed assumptions or forecasts about the future. These assumptions or forecasts pertain to

- Fuel price forecasts (natural gas, coal, and oil)
- Wholesale market power price forecasts
- Customer load forecasts
- Resource capacity factors
- Resource availability
- Transmission availability
- Environmental impacts and regulations

These forecasts and assumptions provide a structured, consistent basis for evaluating and comparing candidate portfolios.

The integrated resource planning team evaluated the candidate resource portfolios using a special-purpose computer model to simulate the dispatch the new resources, along with City Light's existing resources, to serve customer load. The model also simulates short-term sales and purchases of power in the wholesale market. One strength of this modeling approach is the ability to test each candidate portfolio's handling of the variability in hydroelectric generation and the volatility of market prices for fuels and wholesale power.

Once each portfolio was modeled, its performance was evaluated against four criteria. These criteria follow City Light's mission statement and adhere to the requirements of HB 1010: provide reliable service; minimize cost to customers; manage risks; and minimize environmental impacts. They are described in detail in this chapter. Also described is the computer model of the electric market that City Light used to evaluate each portfolio's performance.

The modeling of portfolio performance was conducted in two rounds. Based on information gleaned from the Round 1 analysis, another set of portfolios were constructed for Round 2. Scenarios were used to test and analyze the Round 2 portfolios further.

Scenarios used in the 2008 IRP are conceptually different from the scenarios used in the 2006 IRP. The 2006 IRP scenarios were developed by Global Energy Decisions (now Ventyx), and they represented different paths that the national economy and electrical energy industry might take. Each of the GED scenarios had varying effects on natural gas prices, renewable resource prices, non-renewable resource prices, carbon tax, etc.

For the 2008 IRP, the scenarios focus on specific issues stakeholders and policy makers raised. They address these "what if" questions:

- What if the region experiences unprecedented growth throughout the planning period?
- What if the service area experiences a recession in the near-term years, pushing out the need for resource additions?
- What if climate change proceeds as projected by regional researchers?
- What if plug-in hybrid vehicles become commercially available?
- What if natural gas prices follow a high case rather than the base case forecast?
- What if the cost of renewable resources is much higher than expected?

Each scenario tests the sensitivity of candidate portfolios to changes in model inputs. The scenarios' descriptions appear at the end of this chapter.

Although the focus of City Light's resource planning is on the Pacific Northwest, power price forecasts are driven by the much broader Western wholesale power market, in which City Light conducts power transactions (see Chapter 4). The Western power market is influenced by such diverse factors as high summer temperatures in the Southwest and cold winter temperatures in the Northwest; transmission constraints in various locations in the West; precipitation levels in the Pacific Northwest; nuclear plant outages in California; coal plant outages in Montana, Wyoming or Utah; natural gas deliveries from Alberta, Canada; and power imports to the U.S. from Canada or Baja, Mexico.

Fuel Prices

As a major determinant of generator costs to produce power, fuel prices are important data for input into a power price outlook. In a competitive power market, fuel prices can drive rapid changes in power prices. This section gives an overview of the how fuel prices affect resource portfolios the IRP.

Natural Gas

The Pacific Northwest market for natural gas is heavily influenced by national market trends because of the national network of natural gas pipelines that allows transport of natural gas across the country. Natural gas-fired generation plays an important role in the West because it is usually the generating unit to be dispatched last (known as the "marginal unit"). Lower cost resources are dispatched before natural gas-fired generation resources if no transmission constraints or reliability concerns exist.

The cost of dispatching the marginal unit frequently determines the short-term power price in the Western wholesale power market, so that the short-term (spot) power prices City Light sees correlate with the price of natural gas. Given the volatility of City Light's own hydro resources and of electricity demand, the utility must buy or sell on the power market to balance its power supply. Even though City Light has no natural gas-fired generation, the price of natural gas will continue as an important factor in determining City Light's wholesale power costs and revenues. In the forecast, the following factors are important in moderating natural gas prices from early 2006 levels:

- Natural gas drilling platforms and pipelines in the Southeastern U.S. damaged by Hurricane Katrina are fully repaired.
- New import terminals for liquefied natural gas (LNG) are constructed at ports in the United States and Mexico, allowing foreign natural gas supplies to bolster declining North American natural gas production and reserves.
- Growth in generation from resources other than natural gas helps to temper the need for more natural gas for power generation.
- In the long run, fuel prices will be influenced less by financial speculation in commodity markets and more by the market fundamentals of supply and demand.

In 2007 and the first half of 2008, the price of natural gas followed the dramatic run-up in the price of oil, rising to above $13.00/MMBTU. This price was well above the 2007 long-term Ventyx forecast of natural gas used in the 2008 IRP. However, at the time of writing, natural gas prices have fallen back to a little above $8.00/MMBTU in the western US, with the prospect of further declines. While the price of natural gas is very important to the price of power in the western wholesale power market, it does not affect the relative performance of the Round 2 resource portfolios in the 2008 IRP. The Round 2 resource portfolios are entirely comprised of conservation and renewable resources. The value of surplus energy is affected, as discussed further in the high natural gas price scenario.

Resource Supply

Most Western states have adopted renewable portfolio standards. Washington state's legislation, Initiative 937, requires utilities to acquire all cost-effective conservation. There's a question whether sufficient renewable resources can be developed within the timeframes specified in state mandates. Ventyx, a consulting firm that provides services to electric utilities, doubts that the supply of renewable resources can keep up with the demand. A California Utility Commission study from several years ago shows the difficulties in bringing renewable resources online on time.

With a tax credit incentive, wind developers have been successful in developing new plants and generating as much energy as possible. There has been some regional development of biomass and geothermal. Some landfills managers have even installed small generation plants and found utilities to buy the output.

Supply Forecast

Most parts of the West, including the Pacific Northwest, currently have surplus generating capacity. A number of assumptions prevail for this supply forecast:

- All City Light owned resources will continue to operate through the forecast period.

- Power purchase contracts will expire according to contract terms.
- The Bonneville Power Administration will continue to supply power to City Light from the Federal Columbia River System at cost-based rates.
- Renewable resources and any transmission necessary to bring power to the service area will be available when needed throughout the planning horizon

Resources that are currently available are added in the near term, with technologies less well-established added later.

Electricity Prices

Electricity price forecasts are used to evaluate the costs of buying power and the revenues from selling power. They determine when it is economical to make sales or to make purchases. Since natural gas fired generation is on the margin most of the time in the West, the spot market price and the price of natural gas tend to move in tandem.

The Evaluation Criteria

City Light staff established four criteria for evaluating alternative resource portfolios:

- Provide reliable service
- Minimize cost to customers
- Manage risks
- Minimize environmental impacts

To quantify the expected performance of each candidate resource portfolio in meeting each of the criteria, City Light chose specific measures, listed in Table 5-1 and described on the following pages.

Table 5-1. Criteria and Measures for Evaluating Resource Portfolios

Criteria	Measures
Provide Reliable Service	Occurrence of unserved customer energy need.
Minimize Costs to Customers	20-Year net present value of portfolio costs.
Manage Risks	Volatility of portfolio costs (net revenue).
Minimize Environmental Impacts	Air emissions of $CO2$, $SO2$, NOx, mercury, and particulates. Impacts on land use, surface and groundwater, soils and geology, plants and animals, employment, aesthetics and recreation, environmental health, and cultural and history were also evaluated in the EIS.

Provide Reliable Service

A critical part of City Light's mission is to provide reliable service – electricity is available when customers want to use it. Failure to provide reliable power can have serious and immediate consequences to health, safety and economic security, and City Light has procedures in place to ensure it can provide power or restore power quickly when needed.

The main requirements for providing reliable service are:

- Enough power generation to meet demand.
- Sufficient functioning transmission infrastructure to bring power to City Light's service area.
- Sufficient functioning distribution infrastructure to bring power from the transmission system to the customer.

The distribution aspects of reliability are not considered quantitatively in the IRP, with one exception. Energy savings from conservation programs are assumed to defer investment in new distribution infrastructure. To quantify this benefit, the cost of all energy efficiency measures assessed in the IRP was reduced. The reliability of power supply depends on:

- Adequacy of generating capacity to meet demand (resource adequacy).
- Adequacy of fuel (e.g. natural gas, coal, water) to generate the energy needed.
- Operational capability of the generating facility.

The question of whether there is enough generating capacity was evaluated in the IRP through the resource adequacy analysis (described in Chapter 2). This is an important step in determining the amount of resources needed and when to meet the reliability standard.

In the resource adequacy analysis, City Light compared energy demand to the energy available from its owned and contracted resources, and a limited amount of market resource. Many possible combinations of hydropower outputs – a critical issue given City Light's dependence on hydropower – and load were considered, and each combination was evaluated by month over the 20-year planning horizon.

In addition to ensuring an adequate amount of generating capacity, fuel sufficiency and the resource's operational reliability must be considered. Each type of resource has its own fuel and operational uncertainties. For example:

- Hydropower depends upon precipitation, snowmelt and variations in the timing of the migration and spawning cycles of fish. Hydroelectric generation in the Northwest produces power between 45 and 65 percent of the time. Hydroelectric resources are the most flexible and least cost resources available for following load.
- Most coal plants in the West are located near the coal mines, so access to fuel is highly certain. Unexpected outages are relatively rare, and most western coal plants operate 85 to 90 percent of the time.
- Wind farms are able to produce electricity only when the wind blows. While generating units are highly dependable, the wind is not. New Northwest wind generating plants produce power on average about 32% of the time, according to the Northwest Power and Conservation Council.
- Natural gas combined cycle plants sometimes face fuel supply issues, particularly in high demand periods, but this is not common when a plant is operated to meet a utility's firm load. Their operations have been limited by the periodic high price of natural gas. These resources can generate electricity over 90% of the time.

In modeling candidate resource portfolios, these uncertainties are addressed by introducing variability of hydro operations, wind patterns and forced outages. If correctly constructed, each candidate portfolio is able to meet the 95% resource adequacy criteria despite the above challenges. In effect, the reliability criterion is "hard-wired" by design into the resource portfolio. Each portfolio can then be examined for the number of hours of unserved energy needs occurring to verify it is meeting the reliability criteria.

Minimize Costs to Customers

A fundamental policy issue is balancing the cost of providing service with providing reliable service. In real terms, the cost of electricity declined in the Northwest for decades until about 1980. Even now, the Northwest enjoys the lowest cost power supply in the country due to its reliance on hydroelectric generating plants. Factors influencing cost vary for each type of resource, as described in Chapter 4.

In calculating the costs of specific resources, the IRP assumes that City Light will contract to buy the output of a resource through a power purchase agreement. Whether it is more advantageous to own a resource rather than contract for its output will be determined at the time the utility is ready to acquire a resource and has received cost information for both approaches through competitive bidding. The exceptions are resource alternatives based on contracting for energy, such as seasonal exchanges and capacity purchases.

Costs in the IRP are evaluated over the entire resource portfolio. For example, a higher cost resource may be included in small amounts in a portfolio, and that small addition can help City Light avoid investment in a much larger resource that may have lower per unit of energy costs, but higher overall costs. The measure chosen for this criterion is 20-year net present value (NPV) of net power costs. The net present value accounts for the costs of the resources through time (including capital, operation and maintenance costs, and fuel), power purchases, and revenues received from selling unneeded energy.

Manage Risk

Current practice in integrated resource planning emphasizes identifying and analyzing sources of risk. Many forms of risk are evaluated in the IRP, some quantitatively and some qualitatively. Quantifiable risks include:

- Variations in demand for electricity (City Light's load) due to factors such as weather and economic conditions.

- Generation plant output, particularly hydropower, where output can vary widely from year to year and month to month, depending on precipitation and snowmelt patterns or wind where output can vary widely from hour to hour and day to day.
- Prices for electricity on the wholesale market.
- Cost of fuel such as natural gas.
- Potential cost of complying with environmental regulations, particularly emissions.

Evaluating these risks does not guarantee that all risks are explicitly known, but it defines a range of possible risk and associated costs. Other types of risk can be more difficult to evaluate, or even impossible to quantify. These include the potential for regulatory or policy changes that could affect the availability and cost of resources, policies related to transportation of fuels by pipeline or rail, and requirements related to resource and transmission adequacy.

Because City Light's hydro output varies dramatically from year to year, and because so many factors determine future market prices, the utility has developed strategies to mitigate the risk. One of the primary goals of the IRP is to illustrate the trade off between these risks and the other criteria, such as cost and reliability. While the IRP does not provide a fool-proof solution, it does show how portfolios can result in more risk than others, and illustrates the options.

Mitigating the risk of buying and selling electricity in the market occurs in three stages:

1. Designing a low-risk resource portfolio, one of the primary goals of the IRP process. This is done by evaluating the portfolios under different combinations of plausible future conditions, such as drastic changes in City Light's demand for electricity, the cost of renewable resources, the cost of natural gas and other fuels, and environmental regulations. The IRP process tests candidate portfolios against a range of conditions that might occur in the future, without knowing which set of conditions will actually happen.
2. Implementing the long-term resource strategy developed in the IRP. This stage includes acquiring new resources, and may also involve entering into long-term transactions designed to improve the overall balance of loads and resources in the utility's portfolio.
3. Managing risk on an ongoing basis. Resource portfolios change over the years, and their output and performance can change daily or even hourly. This presents a significant challenge to utility resource operators, whose responsibility is to guarantee City Light's ability to meet demand at all times.

The criterion used to evaluate risk is the range of variability of net power cost for each candidate portfolio. Risk is attributed to the changes in the net power cost as a result of changes in the total cost or output of resources, total cost of contract purchases, and net market purchases and sales. In other words, the risk of one particular portfolio is larger if the net power cost is more volatile when it experiences drastic changes in cost or amount of resource, contract purchases, and net market purchases and sales. Variability of resource costs includes variation in fuel prices and the extent and frequency of plant operations. Net market purchases and sales are influenced by the extent of surplus generation and the spot market price.

Using the net power cost as the index of evaluation, three methods are used to calculate the risk. The primary risk measure is "net-power-cost at risk." This measure reflects the point value where 95% of the potential outcomes would be better (lower cost). For the 2008 IRP, this measure is calculated for changes in hydro, fuel prices, and demand, both individually and combined. It is the combined measure that is used to evaluate resource portfolios. Generalized variance is applied, where historical information on net power cost is used to simulate out-of-the-ordinary conditions in the demand for electricity and fuel prices. Inspecting the net power cost subject to these extreme conditions allows one to understand the range of variability of the net power cost.

Minimize Environmental Impact

Air emissions were explicitly included in the modeling and analysis of portfolios because of their importance to the environment and because they can be quantified without specific siting information. For other environmental elements including land use, surface and groundwater, soils and geology, plants and animals, employment, aesthetics and recreation, environmental health and cultural resources, each portfolio was assessed for the level of impact in each element. Details of the environmental impact analysis of Round 2 portfolios are described in the 2008 Addendum to the Environmental Impact Statement for the 2006 IRP.

For each generating resource portfolio, total emissions into the air of carbon dioxide (CO_2), sulfur dioxide (SO_2), nitrogen oxides (NOx), mercury (Hg), and particulates (PM) are estimated over the 20-year period.

The method chosen to evaluate environmental costs in the IRP is to estimate the mitigation cost (or control cost) for total emissions of each of the five substances. The mitigation cost includes an estimate of the additional costs of meeting more stringent emissions control standards in the future, based upon current legislation. The approach for estimating emissions control costs does not place a value on the damage done by pollutants, but does allow a direct comparison between resource portfolios with respect to estimated cost of mitigating environmental impacts. Environmental mitigation costs of each portfolio are tabulated by year and expressed as a net present value.

Certain assumptions were made in estimating greenhouse gas emissions from the generating resources. Biomass and landfill gas were assumed to have zero net impact on greenhouse gas. They were considered closed-loop systems, where the carbon dioxide emissions are equal to the carbon dioxide captured by the plants and other organic matter prior to being combusted. The air emission impacts of market sales and market purchases were accounted for by using Ventyx forecasts of resources on the margin in the Western power market. City Light market sales were assumed to displace a corresponding amount of energy from the marginal generating unit in the market at the time of the sale. Conversely, market purchases were assumed to be generated by the marginal generating unit at the time of the purchase. Given that City Light's resource portfolio is mostly comprised of hydropower and new resources that have zero net greenhouse gas emissions and low or zero emissions of other pollutants, market sales could have a significant positive air emissions impact by backing down less efficient Western thermal generators on the margin, most often natural gas-fired turbines.

In evaluating and comparing candidate resource portfolios, the largest factor was frequently the amount of carbon dioxide emitted from a resource portfolio. City Light assumes that carbon dioxide emissions must be offset according to City policy.

Using the AURORAxmp® Model to Evaluate Portfolios

This section describes the analytical tool – the computer model – that City Light used to analyze the candidate resource portfolios.

Much of the analysis in the current IRP has been performed using AURORAxmp® Electric Market Model (Aurora) developed by EPIS, Inc. First developed in 1997, the current model has an extensive database of the North American power market and is used by many utilities, resource planners and regulatory agencies for long-term planning. The IRP team worked to capture the features of City Light's existing resources — hydro variability chief among them — in the model, and to describe the operating and financial characteristics of the candidate resources that make up the portfolios.

Aurora forecasts future energy prices, given the structure and characteristics of the past and current market; evaluates the economic performance and reliability of a resource or a portfolio of resources based on cost minimization; and performs risk analysis and tests the reliability of resources under a number of scenarios. The model uses economic dispatch logic to select which resources operate, considering electricity demand, generation and transmission costs, and seasonal hydroelectric generation patterns. The model also has the capability of locational marginal pricing (LMP) market analysis. While the Pacific Northwest does not have an LMP market, the California ISO operates a power market that has been designed using locational marginal pricing principles.

Using time series data on past market characteristics, Aurora simulates supply and demand on an hourly basis to provide both short-term and long-term electric price forecasts. The model forecasts future energy prices, assuming that the market will behave as it has in the past. With the future energy prices, the model identifies the resources likely to perform better than others, enabling resource planners to make long-term decisions. The method used to compare the performance between resources computes the price of supplying an additional MW of load at each location in the system. Resources providing additional load at a lower cost are preferred over resources that cost more per additional load.

Aurora takes the following costs into account: initial costs for capacity building, operation and maintenance costs, environmental costs, transmission congestion costs, among other items.

Once the resource manager has identified candidate resources to test — or a portfolio of resources to test — Aurora dispatches the resources based on their economic performances.

Aurora tests portfolios under a number of scenarios which gives an idea of each portfolio's reliability and how portfolios perform against one another.

Selecting Portfolios for Analysis

Integrated resource planning involves examining a wide range of alternative resources. Three key objectives were considered in constructing the resource portfolios:

- Develop a range of resource portfolios that contain all or predominately renewable resources.
- Ensure sufficient supplies of generation each month during the 20-year period to avoid unserved energy needs with a 95% degree of confidence.
- Utilize a mix of resources believed to be commercially available to City Light and resources specifically recommended for inclusion in the portfolios through the public input process.

For the first round of analysis, City Light developed six portfolios of new resources that in principle would be able to fill the resource gap determined by the resource adequacy study. Based on these results, six new portfolios were defined for analysis in the second round. The resources listed below and described in Chapter 4 were used in various combinations to define the portfolios.

- Accelerated Conservation
- Renewable Generation
  - Hydro (Gorge Tunnel hydro-efficiency improvement)
  - Wind
  - Geothermal
  - Biomass
  - Landfill gas
- Non-renewable Generation
  - Natural gas combined cycle combustion turbine (CCCT), simple cycle combustion turbine (SCCT)
- Mixed resources
  - Seasonal exchanges, capacity purchases
  - Bonneville Power Administration, 100%
  - Bonneville Power Administration, 50% Block, 50% Slice
  - Wholesale power market

Scenarios

Seattle City Light tested Round 2 portfolios against selected scenarios, or sets of potential future conditions, to determine how well they would perform over the 20-year planning horizon. The scenarios used to examine portfolio performance are Climate Change, High Load Growth, Prolonged Recession, High Natural Gas Prices, High Renewable Resource Costs, and Plug-In Hybrid Electric Vehicles (PHEVs). Results of these scenarios are discussed in Chapter 6.

Climate Change Scenario

This scenario uses climate change outlooks from the University of Washington and an analysis from the Northwest Power & Conservation Council to examine some of the potential impacts of climate change for City Light. It includes impacts to demand from warming and impacts to supply from an earlier spring run-off.

High Load Growth Scenario

The High Load growth scenario examines the impacts to City Light's resource needs and resource costs resulting from a prolonged period of high load (demand) growth. City Light examined historical periods of high load growth and selected a pace at the upper end of the range.

Prolonged Recession Scenario

As the 2008 IRP is being prepared, the US economy has already experienced a downturn and may enter a recession. To evaluate the impacts of a prolonged recession upon future resource needs and individual resource portfolios, City Light modeled a scenario patterned after the 2001 recession.

High Renewable Resource Costs Scenario

Eight of 11 western states have passed legislation creating renewable portfolio standards. The renewable portfolio standards of many states are on nearly the same schedule, so that many utilities are required to buy renewable resources at the same time. This has led to concerns about scarcity of renewable resources and the prospect of further price escalation. The scenario examines the impacts of high renewable resource prices, referencing price escalation seen in wind resources since 2002.

High Natural Gas Prices Scenario

Along with the run-up in oil prices seen in 2007-2008, natural gas prices rose dramatically. City Light constructed a scenario using a "high" natural gas forecast from Ventyx and examined the impacts of sustained high natural gas prices for each of the Round 2 resource portfolios.

Plug-In Hybrid Electric Vehicle Scenario

At a time of unprecedented highs in oil and gasoline prices and expanding offerings from manufacturers of plug-in hybrid electric vehicles (PHEVs), it is prudent to examine the load impacts and resource requirements of a potential future where PHEVs gain a growing share of the automobile market. Using a recent study from the Electric Power Research Institute (EPRI) and the Natural Resources Defense Council (NRDC) , City Light examined the implications of a range of assumptions for vehicle energy consumption, PHEV sales growth in the Seattle area, recharging profiles and vehicle replacement for its Seattle area customers.

The PHEV scenario was analyzed, but not modeled in Aurora. PHEVs will be commercially available at the earliest in 2010. Assumptions about future technologies and long-term impacts of PHEVs on specific electric utility operations are highly speculative at this point. Accordingly, the PHEV analysis instead focuses on sensitivities in order to establish a range of possible outcomes.

The next chapter details Round 1 and Round 2 portfolios, their performance on measures of cost, risk, and emissions; and the scenario results.

Chapter 6 – Identifying the Best Portfolio for Seattle City Light

This chapter presents the results from two rounds of portfolio analysis, showing how the candidate resource portfolios would perform and meet the four evaluation criteria.

The Integrated Resource Plan (IRP) team evaluated two rounds of resource portfolios. This chapter details the portfolios selected for each round of analysis, compares their performance in terms of the four criteria defined in Chapter 5, summarizes the conclusions and presents the recommended portfolio.

In Round 1, a range of resource types were included in each of six candidate portfolios. Each portfolio was evaluated in comparison to the current City Light resource portfolio, augmented by spot market purchases only. Although most of the candidate portfolios relied on conservation, renewable resources and seasonal power exchanges, two portfolios also included natural gas-fired combustion turbines, the only fossil fuel generation resource considered. The Bonneville Power Administration resource was modeled in accordance with the existing power purchase contract through 2011; after 2011, changes to that resource reflect likely new contract provisions.

Information gained from this exercise guided portfolio construction for the Round 2 analysis. Power generation from fossil fuel, for example, was eliminated from further consideration because of the high costs associated with the assumption of allowances for carbon emissions. Round 2 focuses on a smaller number of resource types, varying the sizing and timing of the most promising resources. Round 2 portfolios were tested against the scenarios described at the end of Chapter 5.

This process gave the team invaluable information about how the portfolios would perform over the 20-year planning period. It also allowed for a comprehensive review by utility management and the stakeholder committee as well as public review and commentary, promoting the opportunity to build consensus with stakeholders and the public.

Round 1 Analysis

The purposes of the first round of portfolio analysis were threefold:

1. To utilize the capabilities of the Aurora model to simulate the operation of candidate resources within a defined quantitative framework.
2. To observe how a varied mix of resource technologies with different fixed costs, marginal costs, and capacity factors would influence overall portfolio performance.
3. To eliminate from consideration the worst performing resource technologies and portfolios before conducting the Round 2 analysis.

Round 1 was successful in accomplishing these purposes. Many complexities of the resources and portfolios were uncovered, and evaluating the six resource portfolios resulted in a wealth of performance data. This data enabled IRP staff to gain insights to the importance of resource availability, resource sizing and scalability, transmission requirements, tradeoffs between resources and the optimal level of conservation, fuel risk and capitalization issues.

Round 1 Portfolios

The six alternative portfolio designations are listed below and the resources in each portfolio by 2027 are given in Table 6-1:

- Portfolio 1: High Landfill Gas (LFG) and High Biomass
- Portfolio 2: Simple Cycle Combustion Turbine (SCCT) and High Wind
- Portfolio 3: High Geothermal and High Biomass
- Portfolio 4: Combined Cycle Combustion Turbine (CCCT) and Biomass
- Portfolio 5: High Exchange and High Geothermal
- Portfolio 6: High Geothermal and Wind

Table 6-1. Total New Resources in Round 1 Portfolios (Average Megawatts in January by 2027)

Resource	1 High Landfill Gas & High Biomass	2 SCCT & High Wind	3 High Geothermal & High Biomass	4 CCCT & Biomass	5 High Exchange & High Geothermal	6 High Geothermal & Wind
I-937 Conservation	159	159	159	159	159	159
Capacity Purchase	20	10	5	5	20	5
Exchange 1	50	50	50	50	50	50
Exchange 2	50	55	55	55	0	55
Exchange 3	0	0	0	0	95	0
Gorge Tunnel II	13	13	13	13	13	13
Landfill Gas	31	21	21	21	21	21
Geothermal	100	0	125	45	125	125
Wind	0	140	0	40	40	125
Biomass	125	0	125	60	25	0
CCCT	0	0	0	100	0	0
SCCT	0	100	0	0	0	0
2027 Total	548	548	553	548	548	553

Common to all resource portfolios are accelerated conservation and seasonal exchanges. Conservation and exchanges are cost-effective approaches to meeting seasonal resource needs.

Also common to all Round 1 portfolios is the planned construction of a second tunnel for Gorge dam at the utility's Skagit project. This hydro efficiency measure would count toward the satisfaction of I-937 requirements and increase output by 5 megawatts during January, possibly beginning as early as 2012.

With the exception of Rely on the Market, all portfolios contain a capacity purchase of 20 megawatts in 2008, with the amounts in the out years varying by portfolio. Capacity purchases provide a means to acquire power under improbable but possible circumstances. As such, a capacity purchase is not likely to be exercised, but it would help the utility to make sure load will be met in such events as the combination of severe drought and an extended period of extreme weather conditions. A capacity purchase was unnecessary in 2008, since it was an average water year

Renewable resources are added to each of the portfolios to supplement conservation, hydro efficiency, exchanges, and capacity purchases. Resource additions are made in recognition of amounts likely to be available at the time they are needed. Landfill gas, for example, is more likely to be available in the near-term, with resources such as geothermal further out.

A simple cycle and combined cycle natural gas turbine are included in each of two of the Round 1 portfolios. Although they have environmental drawbacks, combustion turbines can work well partnered with certain renewable resources to improve portfolio performance.

Each candidate portfolio was evaluated by simulating how the new resources in it, plus City Light's existing resources, would perform over the 20-year planning period. Results from the evaluation of the candidate resource portfolios were then compared to City Light's current portfolio, with all new power requirements met by short-term purchases in the Western wholesale power market, rather than new generation or new conservation. Short-term (spot) market purchases are made at the forecasted market price, set by the marginal generating unit in the West. From an environmental perspective, this means that at any given time, air emissions will be driven by whatever generating unit is on the margin in the spot market at that time. Currently in the West, natural gas-fired generation is on the margin more than 90% of the time.

Portfolio 1: High Landfill Gas & High Biomass

This portfolio contains mainly landfill gas and biomass in the early years, plus some geothermal later, in addition to conservation, hydro efficiency at Gorge, two seasonal exchanges, and occasional capacity purchases. Four of this portfolio's resources–biomass, landfill gas, the capacity purchase, and the exchange–emit pollutants. The biomass (assumed to be wood) and landfill gas resources are treated as greenhouse gas neutral, but they have some limited emissions such as sulfur dioxide and nitrogen oxides. While the generating resources supplying the exchange would operate seasonally each year, the generating resources backing up the capacity purchase would seldom operate–only if called upon. The capacity purchase would not be exercised under normal weather and hydro conditions. Table 6-2 shows the schedule for new resource acquisition through 2027.

Table 6-2. High Landfill Gas & High Biomass Portfolio – New Resources (Average Megawatts in January for 2008 through 2027)

High Landfill Gas & High Biomass

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	CCCT	SCCT	Total
2008	8	20	50									78
2009	18		50	50		6						124
2010	29		50	50		6						135
2011	42		50	50		9						151
2012	55		50	50	13	19						186
2013	68		50	50	13	21			50			252
2014	81		50	50	13	21			50			265
2015	94		50	50	13	24			50			280
2016	106		50	50	13	24			50			293
2017	120		50	50	13	26			50			309
2018	131	30	50	50	13	26			50			350
2019	140	40	50	50	13	28			50			371
2020	148		50	50	13	28			125			415
2021	150		50	50	13	31			125			419
2022	152	5	50	50	13	31			125			425
2023	153		50	50	13	31	100		125			522
2024	154		50	50	13	31	100		125			523
2025	156		50	50	13	31	100		125			525
2026	158	5	50	50	13	31	100		125			531
2027	159	20	50	50	13	31	100		125			548

Portfolio 2: Simple Cycle Combustion Turbine (SCCT) & High Wind

The SCCT & High Wind portfolio pairs a renewable resource–wind–with a simple–cycle combustion turbine. Emissions in this portfolio come from the simple cycle turbine (SCCT) and the exchanges. This portfolio has more generation capacity than any of the other portfolios: the variability of wind resources causes them to generate, on average, roughly 32% of their nameplate capacity (a 32% capacity factor). At this capacity factor, more wind plant resource must be added to get the same amount of generation as other resources with higher capacity factors. A simple cycle combustion turbine can be ramped up and down more easily than other resources, and can complement wind resource generation. The SCCT is assumed to be sited in western Washington and therefore would have relatively low transmission costs. The SCCT is the main source of emissions in this portfolio, along with the exchanges, the capacity purchase, and the landfill gas resource. Table 6-3 shows the schedule for acquisition of a new wind resource and a SCCT through 2027.

Table 6-3. SCCT & High Wind Portfolio – New Resources (Average Megawatts in January for 2008 through 2027)

SCCT & High Wind

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	CCCT	SCCT	Total
2008	8	20	50									78
2009	18		50	55		6						129
2010	29		50	55		6						140
2011	42		50	55		9						156
2012	55		50	55	13	9					50	231
2013	68		50	55	13	11					50	247
2014	81		50	55	13	11					50	260
2015	94		50	55	13	14					50	275
2016	106		50	5	13	14					50	288
2017	120		50	55	13	16					50	304
2018	131		50	55	13	16		50			50	365
2019	140		50	55	13	18		50			50	376
2020	148		50	55	13	18		100			100	485
2021	150		50	55	13	21		100			100	489
2022	152		50	55	13	21		100			100	490
2023	153		50	55	13	21		140			100	532
2024	154		50	55	13	21		140			100	533
2025	156		50	55	13	21		140			100	535
2026	158		50	55	13	21		140			100	536
2027	159	10	50	55	13	21		140			100	548

Portfolio 3: High Geothermal & High Biomass

In addition to the conservation, capacity purchase and exchanges present in all portfolios, the High Geothermal portfolio also has landfill gas in the near-term and some biomass in the out years. Emissions in this portfolio come from the exchanges, the capacity purchase, the landfill gas, and biomass. Table 6-4 shows the schedule for new resource acquisition through 2027.

Table 6-4. High Geothermal & High Biomass Portfolio – New Resources (Average Megawatts in January for 2008 through 2027)

High Geothermal & High Biomass

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	CCCT	SCCT	Total
2008	8	20	50									78
2009	18		50	55		6						129
2010	29		50	55		6						140
2011	42		50	55		9						156
2012	55		50	55	13	9						181
2013	68		50	55	13	11	55					252
2014	81		50	55	13	11	55					265
2015	94		50	55	13	14	55					280
2016	106		50	55	13	14	55					293
2017	120		50	55	13	16	55					309
2018	131		50	55	13	16	55		40			360
2019	140		50	55	13	18	55		40			371
2020	148		50	55	13	18	125		40			450
2021	150		50	55	13	21	125		40			454
2022	152		50	55	13	21	125		40			455
2023	153		50	55	13	21	125		40			457
2024	154		50	5	13	21	125		125			543
2025	156		50	55	13	21	125		125			545
2026	158		50	55	13	21	125		125			546
2027	159	5	50	55	13	21	125		125			553

Portfolio 4: CCCT & Biomass

In addition to conservation, a capacity contract, and two long-term exchanges, the High CCCT portfolio contains 50 MW of natural gas turbine capacity beginning in 2013, which is doubled in 2024. In addition to emissions from the CCCT, other resources with air emissions are the exchanges, the capacity purchase, the landfill gas resource, and the biomass resource. Table 6-5 shows the schedule for new resource acquisition through 2027.

Table 6-5. CCCT & Biomass Portfolio – New Resources (Average Megawatts in January for 2008 through 2027)

CCCT & Biomass

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	CCCT	SCCT	Total
2008	8	20	50									78
2009	18		50	55		6						129
2010	29		50	55		6						140
2011	42		50	55		9						156
2012	55		50	55	13	9						181
2013	68		50	55	13	11				50		247
2014	81		50	55	13	11				50		260
2015	94		50	55	13	14				50		275
2016	106		50	55	13	14			40	50		328
2017	120		50	55	13	16			40	50		344
2018	131		50	55	13	16			40	50		355
2019	140		50	55	13	18	45		40	50		411
2020	148		50	55	13	18	45		40	50		420
2021	150		50	55	13	21	45		60	50		444
2022	152		50	55	13	21	45	40	60	50		485
2023	153		50	55	13	21	45	40	60	50		487
2024	154		50	55	13	21	45	40	60	100		538
2025	156		50	55	13	21	45	40	60	100		540
2026	158		50	55	13	21	45	40	60	100		541
2027	159	5	50	55	13	21	45	40	60	100		548

Portfolio 5: High Exchange & High Geothermal

The High Exchange & High Geothermal portfolio contains a larger exchange than the other portfolios. Exchanges should compare favorably to other resources in terms of cost, because summer surplus power, which is of lower value to City Light for serving its native load, is exchanged for power in winter, when power is most needed by the utility's customers. Exchanges may not be as reliable as owned resources or long-term contracts for the output from specific resources. Emissions from this portfolio are from the exchanges, the capacity purchase, and small amounts of landfill gas and biomass resources. Like the High Wind portfolio, this portfolio has a larger amount of total generating capacity than portfolios without wind resources. As in the High Wind portfolio, more wind capacity is required because of the low capacity factor. Table 6-6 shows the schedule for new resource acquisition through 2027.

Table 6-6. High Exchange & High Geothermal Portfolio - New Resources (Average Megawatts in January for 2008 through 2027)

High Exchange & High Geothermal

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	CCCT	SCCT	Total
2008	8	20	50									78
2009	18		50	55		6						129
2010	29		50	95		6						180
2011	42		50	95		9						196
2012	55		50	95	13	9						221
2013	68		50	95	13	11			25			262
2014	81		50	95	13	11			25			275
2015	94		50	95	13	14			25			290
2016	106		50	95	13	14			25			303
2017	120		50	95	13	16			25			319
2018	131		50	95	13	16			25			330
2019	140		50	95	13	18	75		25			416
2020	148		50	95	13	18	75		25			425
2021	150		50	95	13	21	75		25			429
2022	152		50	95	13	21	75	40	25			470
2023	153		50	95	13	21	125	40	25			522
2024	154		50	95	13	21	125	40	25			523
2025	156		50	95	13	21	125	40	25			525
2026	158	5	50	95	13	21	125	40	25			531
2027	159	20	50	95	13	21	125	40	25			548

Portfolio 6: High Geothermal & Wind

This portfolio features acquisition of 55 aMW of geothermal resource by 2013, with an additional 70 aMW in 2020. This amount of geothermal can be helpful in managing the addition of 40 aMW of a wind resource for 2018-2022, increasing to 125 aMW in 2024. Table 6-7 shows the schedule for new resource acquisition through 2027.

Table 6-7. High Geothermal & Wind Portfolio - New Resources (Average Megawatts in January for 2008 through 2027)

High Geothermal & Wind

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	CCCT	SCCT	Total
2008	8	20	50									78
2009	18		50	55		6						129
2010	29		50	55		6						140
2011	42		50	55		9						156
2012	55		50	55	13	9						181
2013	68		50	55	13	11	55					252
2014	81		50	55	13	11	55					265
2015	94		50	55	13	14	55					280
2016	106		50	55	13	14	55					293
2017	120		50	55	13	16	55					309
2018	131		50	55	13	16	55	40				360
2019	140		50	55	13	18	55	40				371
2020	148		50	55	13	18	125	40				450
2021	150		50	55	13	21	125	40				454
2022	152		50	55	13	21	125	40				455
2023	153		50	55	13	21	125	40				457
2024	154		50	55	13	21	125	125				543
2025	156		50	55	13	21	125	125				545
2026	158		50	55	13	21	125	125				546
2027	159	5	50	55	13	21	125	125				553

Results of Portfolio Evaluations

As described in Chapter 5, quantitative measures were devised in order to compare the portfolios against four evaluation criteria: reliability, cost, risk and environmental impact. The criteria and corresponding measures are shown in Chapter 5, Table 5-1.

The results of the portfolio evaluations, with rankings, are displayed in Table 6-8.

Table 6-8. Summary of Round 1 Portfolios, with Rankings
Net Present Value (Millions of Dollars)

	Portfolios in Round 1	Net Power Cost		5% Chance of Higher Cost		Direct Emissions Costs		Overall Rank
P0	Rely on Market (No Action)	$254	6	$2,998	7	$ 0	1	7
P1	High Landfill Gas & Biomass	$157	2	$2,415	2	$ 4.0	6	3
P2	High Wind & SCCT	$287	7	$2,614	6	$ 3.1	5	6
P3	High Geothermal, Biomass	$150	1	$2,414	1	$ 2.1	4	1
P4	CCCT & Wind	$217	5	$2,458	4	$19.9	7	5
P5	High Exchange	$198	4	$2,574	5	$ 0.8	2	4
P6	High Geothermal, Wind	$172	3	$2,427	3	$ 0.9	3	2

The two best-performing Round 1 portfolios across all measures are:

- High Geothermal and Biomass
- High Geothermal and Wind

The top two Round 1 portfolios in terms of net present value of net power costs (revenue net of cost) are

- High Geothermal and Biomass
- High Landfill Gas and Biomass

The portfolios having the least direct emissions, including residual air emissions from generation (carbon dioxide, sulfur dioxide, nitrogen oxide, particulates and mercury) are

- High Exchange
- High Geothermal and Wind

Environmental Impact Summary

Since Round 1 portfolios were only used to perform a broad overview analysis of potential resource combinations and do not make up the set of alternatives considered for the 2008 IRP Action Plan, they are not evaluated in the 2008 Addendum to the EIS for the 2006 IRP. However, the discussion below highlights a few of the key findings on environmental impacts of the Round 1 portfolios.

In the Round 1 portfolios, the highest levels of potential impact are associated with natural gas-fired resources and, to a lesser extent, biomass and landfill gas. Conservation, the hydro efficiency improvement at the Skagit project's Gorge tunnel and wind are expected to have the fewest emissions impacts, followed by geothermal resources. More broadly, the following resources could have the following potential environmental impacts:

- Landfill gas – air quality impacts
- Wind - high aesthetic impacts and possible impacts on birds and bats
- Geothermal – physical disturbance to geologic structures, groundwater impacts and the possibility of development in pristine areas where land use and recreation impacts would be an issue
- Biomass – substantial land disturbance over an extensive area if a dedicated crop is the fuel source, as well as impacts from transporting biomass fuel
- Gas turbines – air quality impacts, water use impacts, and depending on location, land use impacts and noise
- Market transactions – air emissions and fuel extraction, based on the assumption of fossil fuel resources used in market transactions

Conclusions from Round 1 Analysis

Analysis of the Round 1 portfolios led to these conclusions:

- Portfolios with geothermal and landfill gas perform well using a broader range of risk metrics
- The expected value NPV range between the most costly and least costly portfolio was 82%
- The range between the most risky and least risky portfolio was 8% when looking at the tail risk for the worst 5% of outcomes. Other measures of risk are also evaluated.
- Diversification of resources brings significant measurable benefits for reducing portfolio risk
- The assumption of an emissions allowance cost for CO2 emissions was an important factor in the poor performance of the portfolios with natural gas-fired resources relative to those without.
- In the later years of the planning period, the supply of energy available for exchanges in the summer may not be sufficient unless new investment in baseload generation and conservation along the way maintains a level of surplus power in the summer.
- Seasonal energy exchanges with summer-peaking utilities are generally seen as very cost effective since they can help to substantially delay the need for capital investment, while helping to ensure winter resource adequacy. However, the High Exchange portfolio did not perform as well as expected. The net power cost and risk measures were the reasons. The risk is higher with exchanges because City Light only receives power a few months of the year, meaning that the resource is unavailable for about nine months of the year. For the same reason, there is little opportunity to sell power into the wholesale power market and thereby help to offset overall portfolio costs.
- Accelerated conservation compares favorably to the cost of acquired generation resources.

Round 2 Portfolios

The Round 2 portfolios were designed with the following objectives in mind:

1. Increase the pace of accelerated conservation from the Round 1 resource portfolios.
2. Minimize the amount of resources required to meet resource adequacy requirement and when applicable, Initiative I-937
3. Use lower cost resources in the early years to maximize the net present value of the portfolios
4. Avoid large resource commitments in the early years by relying on exchanges, capacity purchases, and conservation
5. Produce portfolios that will meet the resource adequacy requirement and I-937 requirements
6. Use scalable resources, such as wind and geothermal, when possible
7. Ensure that there is sufficient new generation in summer months to meet any seasonal exchanges
8. Avoid exchanges or resources in the early years that would require new transmission to be constructed on an unreasonably short timeline
9. Recognize that there are limitations on the amount of each resource type that can reasonably be included in a portfolio

The portfolio designations are listed below. All of them meet the conservation and renewable resource requirements of Initiative I-937. The resources in each portfolio by 2027 are given in Table 6-9.

- Portfolio 1: High Biomass and Geothermal
- Portfolio 2: High Exchange, Geothermal and Biomass
- Portfolio 3: High Wind and Geothermal
- Portfolio 4: High Exchange, Wind and Geothermal
- Portfolio 5: High Biomass, Geothermal and Wind

Performance of the Round 1 portfolios informed the construction of the Round 2 portfolios. However, the costs and other performance measures in Round 2 are not directly comparable with Round 1. As modeled within Aurora, Round 2 is essentially a different power marketplace for City Light.

More resources were "constructed" for City Light in Round 1 than in Round 2 because of a lower pace of conservation. In Round 2, there are less generating resources available to City Light in the area because of putting greater amounts of conservation in the Round 2 portfolios and having less generating resources "constructed" in nearby areas. While the relative performance of the portfolios is unaffected, the greater scarcity of resources in nearby areas and higher cost of market purchases create higher net present values of costs for Round 2. As in Round 1, all Round 2 portfolios are compared to the current City Light resource portfolio, supplemented with wholesale power purchases.

All of the Round 2 portfolios have an equal amount of conservation, hydro efficiency (Gorge Tunnel II), landfill gas, and one exchange of 50 aMW. They each feature a second exchange and, in years when needed, capacity purchases. Beyond these resource additions, resource adequacy is met with an additional exchange and combinations of these renewable resources: geothermal, wind, and biomass.

Table 6-9. Total New Resources in Round 2 Portfolios (Average Megawatts of Output in January, 2027)

Resource	1 High Biomass & Geothermal	2 High Exchange, Geothermal & Biomass	3 High Wind & Geothermal	4 High Exchange, Wind & Geothermal	5 High Biomass, Geothermal & Wind
I-937 Conservation	159	159	159	159	159
Capacity Purchase	5	15	5	0	5
Exchange 1	50	50	50	50	50
Exchange 2	55	0	55	0	55
Exchange 3	0	85	0	85	0
Gorge Tunnel II	5	5	5	5	5
Landfill Gas	21	21	21	21	21
Geothermal	125	125	125	125	125
Wind	0	0	125	100	85
Biomass	125	85	0	0	40
2027 Total	545	545	545	545	545

Portfolio 1: High Biomass & Geothermal

This portfolio features geothermal generation at 45 aMW starting in 2013, and elevating to 125 aMW by 2020. In 2018, generation from biomass is introduced at 40 aMW, and increases to 125 aMW starting in 2024. In this portfolio, geothermal and biomass contribute to the majority of the load growth, apart from conservation. Table 6-10 shows the schedule for new resource acquisition through 2027 for this portfolio.

Table 6-10. High Biomass & Geothermal (Average Megawatts in January for 2008 through 2027)

High Biomass & Geothermal

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Exchange 3	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	Total
2008	10	20	50								80
2009	22		50	55			6				134
2010	37		50	55			6				148
2011	52		50	55			9				166
2012	68		50	55			9				182
2013	84		50	55			11	45			245
2014	97		50	55			11	45			258
2015	110		50	55		5	14	45			278
2016	122		50	55		5	14	45			291
2017	135		50	55		5	16	45			306
2018	146		50	55		5	16	45		40	357
2019	149	10	50	55		5	18	45		40	373
2020	152		50	55		5	18	125		40	446
2021	153		50	55		5	21	125		40	449
2022	154		50	55		5	21	125		40	450
2023	155		50	55		5	21	125		40	451
2024	156		50	55		5	21	125		125	537
2025	157		50	55		5	21	125		125	538
2026	158		50	55		5	21	125		125	539
2027	159	5	50	55		5	21	125		125	545

Portfolio 2: High Exchange, Geothermal & Biomass

This portfolio features a small amount (10 aMW) of geothermal beginning in 2013, reflecting the fact that little geothermal is likely to be available in the near term. By 2018, the total generation from geothermal is 125 aMW, consistent with the prospect of greater availability of this resource. The portfolio also has a sizable exchange that contributes to a better match between load and resources and tends to keep costs lower. Table 6-11 shows the schedule for new resource acquisition through 2027.

Table 6-11. High Exchange, Geothermal & Biomass (Average Megawatts in January for 2008 through 2027)

High Exchange, Geothermal & Biomass

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Exchange 3	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	Total
2008	10	20	50								80
2009	22		50		55		6				134
2010	37		50		85		6				178
2011	52		50		85		9				196
2012	68		50		85		9				212
2013	84		50		85		11	10			240
2014	97		50		85		11	10			253
2015	110		50		85	5	14	10			273
2016	122		50		85	5	14	10			286
2017	135		50		85	5	16	10			301
2018	146		50		85	5	16	125			427
2019	149		50		85	5	18	125			433
2020	152		50		85	5	18	125			436
2021	153		50		85	5	21	125			439
2022	154		50		85	5	21	125			440
2023	155		50		85	5	21	125			441
2024	156		50		85	5	21	125		85	527
2025	157		50		85	5	21	125		85	528
2026	158	5	50		85	5	21	125		85	534
2027	159	15	50		85	5	21	125		85	545

Portfolio 3: High Wind & Geothermal

Table 6-12 shows the schedule for new resource acquisition through 2027 for this portfolio. Geothermal generation is introduced in 2013 at 45 aMW, which increases to 125 aMW in 2020. Wind is introduced in 2018 at 40 aMW. In this portfolio, geothermal, wind, and conservation contribute to the majority of the load growth, although conservation does not vary across portfolios.

Table 6-12: High Wind & Geothermal (Average Megawatts in January for 2008 through 2027)

High Wind & Geothermal

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Exchange 3	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	Total
2008	10	20	50								80
2009	22		50	55			6				134
2010	37		50	55			6				148
2011	52		50	55			9				166
2012	68		50	55			9				182
2013	84		50	55			11	45			245
2014	97		50	55			11	45			258
2015	110		50	55		5	14	45			278
2016	122		50	55		5	14	45			291
2017	135		50	55		5	16	45			306
2018	146		50	55		5	16	45	40		357
2019	149	10	50	55		5	18	45	40		373
2020	152		50	55		5	18	125	40		446
2021	153		50	55		5	21	125	40		449
2022	154		50	55		5	21	125	40		450
2023	155		50	55		5	21	125	40		451
2024	156		50	55		5	21	125	125		537
2025	157		50	55		5	21	125	125		538
2026	158		50	55		5	21	125	125		539
2027	159	5	50	55		5	21	125	125		545

Portfolio 4: High Exchange, Wind & Geothermal

Table 6-13 shows the schedule for new resource acquisition through 2027. Generation from geothermal begins in 2013 at 10 aMW, increasing to 125 aMW starting in 2018. The portfolio also has a sizable exchange that contributes to a better match between load and resources while keeping costs low. Wind generation is introduced in 2024 at 100 aMW, providing for additional load growth to meet demand towards the end of the planning period.

Table 6-13. High Exchange, Wind & Geothermal (Average Megawatts in January for 2008 through 2027)

High Exchange, Wind & Geothermal

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Exchange 3	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	Total
2008	10	20	50								80
2009	22		50		55		6				134
2010	37		50		85		6				178
2011	52		50		85		9				196
2012	68		50		85		9				212
2013	84		50		85		11	10			240
2014	97		50		85		11	10			253
2015	110		50		85	5	14	10			273
2016	122		50		85	5	14	10			286
2017	135		50		85	5	16	10			301
2018	146		50		85	5	16	125			427
2019	149		50		85	5	18	125			433
2020	152		50		85	5	18	125			436
2021	153		50		85	5	21	125			439
2022	154		50		85	5	21	125			440
2023	155		50		85	5	21	125			441
2024	156		50		85	5	21	125	100		542
2025	157		50		85	5	21	125	100		543
2026	158		50		85	5	21	125	100		544
2027	159		50		85	5	21	125	100		545

Portfolio 5: High Biomass, Geothermal & Wind

Portfolio 5 features geothermal, biomass, and wind generation as the main contributors to load growth. In 2013, 45 aMW of generation from geothermal begins, increasing to 125 aMW in 2020. In 2018, biomass generation begins and remains at 40 aMW, while wind generation begins in 2024 at 85 aMW and remains at that level. Table 6-14 shows the schedule for new resource acquisition through 2027.

Table 6-14. High Biomass, Geothermal & Wind (Average Megawatts in January for 2008 through 2027)

High Biomass, Geothermal & Wind

Resource (aMW)	I-937 Conservation	Capacity Purchase	Exchange 1	Exchange 2	Exchange 3	Gorge Tunnel II	Landfill Gas	Geothermal	Wind	Biomass	Total
2008	10	20	50								80
2009	22		50	55			6				134
2010	37		50	55			6				148
2011	52		50	55			9				166
2012	68		50	55			9				182
2013	84		50	55			11	45			245
2014	97		50	55			11	45			258
2015	110		50	55		5	14	45			278
2016	122		50	55		5	14	45			291
2017	135		50	55		5	16	45			306
2018	146		50	55		5	16	45		40	357
2019	149	10	50	55		5	18	45		40	373
2020	152		50	55		5	18	125		40	446
2021	153		50	55		5	21	125		40	449
2022	154		50	55		5	21	125		40	450
2023	155		50	55		5	21	125		40	451
2024	156		50	55		5	21	125	85	40	537
2025	157		50	55		5	21	125	85	40	538
2026	158		50	55		5	21	125	85	40	539
2027	159	5	50	55		5	21	125	85	40	545

Evaluation of Round 2 Portfolios

Round 2 portfolios were evaluated using the same criteria as the Round 1 portfolios: reliability, cost, risk and environmental impact. Further qualitative screens were applied based upon prudent operational strategy and the requirements of Initiative 937, as described above.

Reliability

All resource portfolios in Round 2 meet the resource adequacy target. This criterion is hard-wired into each of the resource portfolios, since each resource portfolio is specifically designed to meet the reliability criteria.

Cost

Several types of costs are considered in the IRP. Resource total costs include the capital, fixed operations and maintenance, and variable operations and maintenance costs of a resource portfolio. Each new resource portfolio is evaluated in the context of the entire portfolio, capturing the more complex interactions of the existing resources with the new resources.

Table 6-15. Resource Total Costs Net Present Value (Millions of Dollars)

Portfolio	Resource Total Costs NPV (millions)
High Geothermal, Biomass	$1,516
High Exchange, Geothermal	$1,434
High Geothermal, Wind	$1,488
High Exchange, Wind, Geothermal	$1,138
High Biomass, Geothermal, Wind	$1,501

The resources added to the resource portfolios through time are similar to an "insurance policy." They enable Seattle to have sufficient power available to deliver to customers even in years with low water. When considering costs, it is important to include the effects of short-term purchases and sales, which may help to offset the resource total cost. With the proposed 20-year resource portfolios, it is expected that short-term power sales will be much greater than short-term power purchases under average water conditions. This can be seen in Table 6-16.

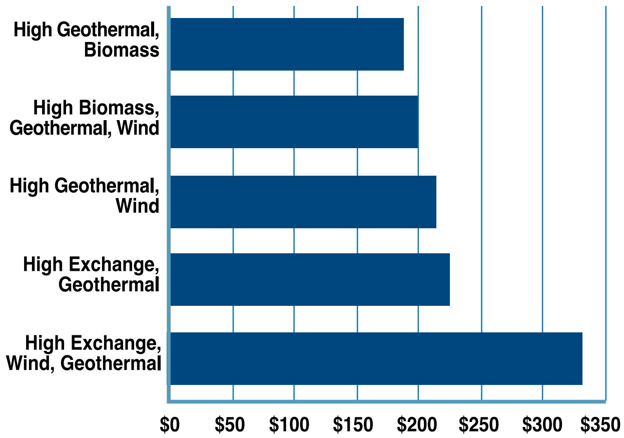
Table 6-16. Market Purchases and Sales Net Present Value (Millions of Dollars)

Market Purchases	Market Purchases	Market Sales
High Geothermal, Biomass	$210	$3,482
High Exchange, Geothermal	$236	$3,389
High Geothermal, Wind	$234	$3,454
High Exchange, Wind, Geothermal	$325	$3,077
High Biomass, Geothermal, Wind	$234	$3,466

Differences in resource total costs are most pronounced from the middle to the end of the planning period, creating most of the cost variation among portfolios. The first sizable generation resource additions occur in 2013 and 2018. The delays in the addition of new resources and the reliance upon capital-intensive renewable resources results in a more limited range of net power costs for the five Round 2 resource portfolios.

Capital costs play a very strong role in resource total costs (including emissions costs) and the economics of renewable resources, while operation and maintenance costs, which include fuel, are more often the major cost factor in fossil-fueled resources. Yet, capital costs are not the only important factor for evaluating resource portfolios for City Light. Table 6-17 shows the range of resource total costs for the Round 2 resource portfolios. Despite High Geothermal, Biomass being the portfolio with the greatest resource total cost, it is also the portfolio with the lowest overall net power cost. Its having the lowest net power costs is because of market purchases and sales. The high capacity factor of geothermal energy (95%) lowers both transmission costs and power production costs per megawatt-hour. The High Geothermal, Biomass portfolio has a comparatively low power cost, which allows it to sell into the market more frequently, creating revenues that help to offset its capital costs.

Figure 6-1. Net Power Costs (NPV in Millions of Dollars)



Another example of the importance of market purchases and sales for net power costs is found in the High Exchange, Wind, Geothermal portfolio. It has the lowest resource total cost, yet has the highest net power cost. This portfolio has the lowest amount of market sales and the highest amount of market purchases. This portfolio relies upon a larger amount of exchanges and wind than the other resource portfolios. Exchange resources are only available during a few winter months out of the year, so that exchanges cannot support power sales most of the year. The natural variability of the wind resources requires that market purchases be made frequently to fill in the periods of low wind resource production.

Risk

To measure risk for the portfolios, Net-Power-Cost-at-Risk (NPC-at-risk) was calculated. It measures the 5% worst case financial outcomes for Net Power Cost (95% of the outcomes would be better). For this risk measure, three important risk factors were varied ("shocked") to see what the impacts on net power cost would be. The risk factors shocked were hydroelectric output, electricity demand, and fuel cost. This measures the potential impacts to net power cost from varying hydro availability in different water years, recessions and high economic growth periods, and swings in natural gas and other fuel prices.

The methodology used for assessing this risk measure was to first calculate the NPC-at-risk for each of the three risk factors individually, then combined. The focus is on the combined measure, but calculating them individually gives us an approximation of the relative contribution of each risk factor to the combined risk (the combined risk is not additive). The highest risk contribution by risk factor is hydro first, followed closely by demand, then fuel costs. Hydro is an important and familiar factor in determining risk to net power costs for City Light. However, the results suggest that demand too is an important factor. Fuel costs contribute less risk because the portfolios are mainly comprised of hydropower, conservation, exchanges, and renewable resources. Of these resources, only biomass is directly affected by fuel price risk. The major source of risk from fuel in these portfolios is related to market prices.

Table 6-17. Net Power Cost at Risk (Millions of Dollars)

Portfolios	Total NPV (95%)
High Biomass, Geothermal	$2,456
High Exchange, Geothermal, Biomass	$2,473
High Wind, Geothermal	$2,476
High Exchange, Wind, Geothermal	$3,079
High Biomass, Geothermal, Wind	$2,452

Environmental Impacts of Round 2 Portfolios

The 20-year net present value calculation for each of the Round 2 portfolios included the costs of mitigating emissions of five pollutants: sulfur dioxide, nitrogen oxides, mercury, particulate matter, and carbon dioxide. All costs, except those for carbon dioxide, are estimates of the cost of pollution control equipment. Projections of the cost of emissions allowances are used for carbon dioxide. Two resources that do emit carbon dioxide, biomass and landfill gas, are not assigned any cost for carbon dioxide because the organic matter that is consumed for the production of electric power would have otherwise been released into the atmosphere through decomposition.

The emissions costs for Round 2 portfolios are close to $2 million in the 20-year net present value calculation for each portfolio. This amounts to little more than $100,000 annually for up to five million MWh.

Candidate resources for Round 2 portfolios all have extremely low emissions compared to non-renewable resources. Table 6-18 shows the total number of metric tons for each pollutant for all resources additions to City Light's current resource portfolio.

Table 6-18. Emissions from Round 2 Portfolio Resource Additions, 2008-2027 (metric tons)

Portfolio		Sulfur Dioxide	Nitrogen Oxides	Mercury	Particulate Matter	Carbon Dioxide
P1	High Biomass, Geothermal	0	1,889	0	486	0
P2	High Exchange, Geothermal, Biomass	0	1,286	0	291	0
P3	High Wind, Geothermal	0	774	0	125	0
P4	High Exchange, Wind, Geothermal	0	774	0	125	0
P5	High Biomass, Geothermal, Wind	0	1,377	0	320	0

Market purchases are the main source of carbon dioxide and sulfur dioxide for each of the portfolios, as shown in Table 6-19. Market purchases are assessed an emissions cost that is a west-wide average for all utilities and contains a high amount of coal-fired and natural gas-fired generation. City Light purchases a relatively small amount of this power in the wholesale market, primarily for load balancing. Market sales outweigh market purchase by a factor of about fifty. The market sales are mostly hydro power or renewable energy, displacing generation in the market that would pollute a great deal more. This is especially true of exports to California in the summer.

Table 6-19. Emissions from Round 2 Portfolio Market Purchases, 2008-2027 (metric tons)

Portfolio		Sulfur Dioxide	Nitrogen Oxides	Mercury	Particulate Matter	Carbon Dioxide
P1	High Biomass, Geothermal	42	349	0	133	866,552
P2	High Exchange, Geothermal, Biomass	57	471	0	177	1,168,685
P3	High Wind, Geothermal	49	415	0	139	1,034,150
P4	High Exchange, Wind, Geothermal	88	755	0	209	1,888,270
P5	High Biomass, Geothermal, Wind	46	381	0	136	949,167

Evaluating Round 2 Portfolios Across Scenarios

As described in Chapter 5, the resource portfolio evaluation for Round 2 portfolios originally involved testing them across five scenarios. They were ultimately tested in four scenarios because insufficient information was available for the Climate Change scenario to make definitive statements about the relative performance of the Round 2 portfolios, and because analysis of Plug-In Hybrid Electric Vehicles suggested little impact on SCL's system. The original six scenarios are:

- Climate Change
- High Load Growth
- Prolonged Recession
- High Renewable Resource Costs
- High Natural Gas Prices
- Plug-In Hybrid Electric Vehicles

Climate Change Scenario

Climate change is expected to alter both the seasonal demand for power and its availability. University of Washington (UW) climate research suggests that warming in the Pacific Northwest may occur at the rate of approximately one degree per decade, with greater warming occurring during the summer months, especially July and August, than in the rest of the year. Modeling of climate change for this IRP is based on work done by the Northwest Power and Conservation Council (NPCC) and the UW for the NPCC's Fifth Power Plan (2005).

City Light used the temperature changes associated with the UW/NPCC work to forecast changes in load. The combination of lower winter loads and greater winter availability of power could reduce the need for new resources to meet January loads and cause market prices to be lower in January. Hotter summer temperatures will cause greater use of air conditioning in summer. While air conditioning is not in great use by Seattle residential customers now, it is used for much of the year by large commercial buildings, a growing portion of Seattle's load. City Light has analyzed load changes on hot summer days.

Considerable concern has been raised that climate change will cause–or is already causing–greater variability in weather and increased magnitude and frequency of storms, which can affect hydro management practices and resource adequacy needs. The mountainous terrain of the Skagit watershed presents special challenges in modeling climate change impacts on demand and generation because it causes rain shadows, variability in the timing of snowmelt by elevation, and the challenge of integrating glacier models. Including changes in storm severity and frequency, flooding and glacier melting in the modeling was not possible for the 2008 IRP. Nor does the 2008 analysis include potential changes to fish protection or flood control requirements. The ability of climate models to forecast at regional levels is improving as is the ability to integrate regional forecasts with more detailed watershed models. City Light expects to have better information available for the next IRP.

Long-term exchange agreements could become less valuable in the future. City Light will need to look at changes in natural flows not only in terms of generation capability but also in combination with its commitment to maintain flows for fish and to regulate reservoir levels for recreation and flood control.

A climate change scenario was constructed using the best information presently available from the UW Climate Impacts Group and the NPCC. However, City Light analysts soon identified a critical issue: the impacts of the missing information could easily overwhelm the results of the analysis, which averaged a 1 degree centigrade temperature change per decade, resulting in lower winter loads and earlier melting of Cascade mountain snow pack. The missing information includes the impacts of climate change on North Cascade glaciers, new types of regulation of reservoirs that may be required under climate change, the possibility of changes in precipitation patterns, severe storms and flooding, and the potential need to change reservoir operations to preserve habitat for bull trout and salmon. These questions affect City Light hydro projects and those of a key supplier, the Bonneville Power Administration. City Light's Skagit River hydroelectric projects are glacier-fed, especially in the summer, so that understanding the impacts to North Cascade glaciers is critical to understanding the full range of impacts of climate change upon City Light customers. The climate change analysis helps to clarify future research priorities and focus City Light's continuing work with the UW and Lawrence Livermore National Laboratory.

The Round 2 resource portfolios are constructed entirely of conservation and renewable resources, which helps to mitigate some of the risks from climate change. Nevertheless, currently available information does not provide sufficient guidance for critically evaluating differences in the prospective renewable resource portfolios in Round 2. However, the analysis does indicate some interesting trends.

Table 6-20 Climate Change Impacts to Round 2 Portfolios – Difference from Base Case (20-Year NPV in Millions)

NPCC 5th Power Plan Regional Climate Change Assumptions Unadjusted			
	Market Purchases	Market Sales	Net Power Cost
Average of Six Round 2 Portfolios	$18	($12)	$30
NPCC 5th Power Plan Regional Climate Change Assumptions Adjusted for City Light Service Area			
Average of Six Round 2 Portfolios	$36	($82)	$118

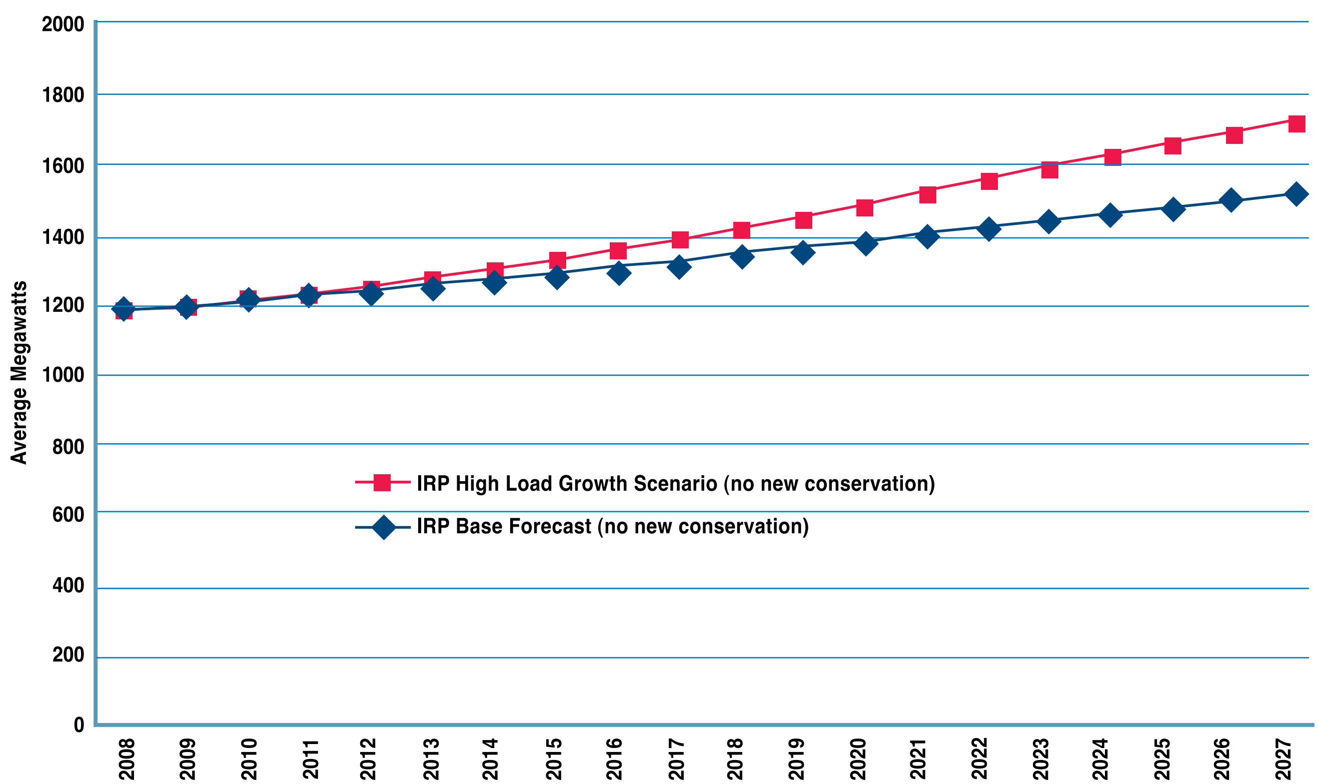
City Light modeled two different cases for climate change impacts for comparison. The first was to use the same general climate change impacts found for the Northwest in the NPCC 5th Power Plan, applying them unadjusted to City Light load and hydro resources. A second case was modeled where there is less load sensitivity to changes in temperature than the regional average. This case reflects the differences between Seattle's customer mix and its more moderate, marine-influenced climate from the regional averages.

The modeled results suggest that the moderating influence of the marine climate in the Seattle area may work against City Light with respect to net power costs. If the rest of the West has proportionately greater climate change impacts, winter loads will fall more and summer loads rise more, creating unfavorable price effects for City Light power purchases and sales. In Table 6-20, climate change increased City Light's net power costs in both cases because of increased cost of market purchases in the summer and decreased sales revenue in the winter. For the second case that is more tailored to Seattle's service area, sales declined more, purchases increased more, and net power costs rose proportionately more from the base case than the regional average. For a more detailed discussion of this analysis, see Appendix G – Climate Change in the 2008 IRP.

High Load Growth Scenario

Load growth is positive when the economy is growing, but during downturns, the load growth rate can be zero or negative for short periods. The base case assumes that load will grow in the long run and years of no or low growth will be offset by years of higher than average growth. In the long run, the base case assumes an average annual growth of about 0.8%. If in the future the base case forecast proves to be too low, there would not be enough resources to meet demand. Figure 6-2 compares the IRP high load growth forecast to the IRP base forecast.

Figure 6-2. High Load Growth Scenario



The high load growth case assumes that years of no or low load growth do not occur at all. In the high load growth scenario, every year has positive growth similar to the growth levels that occur during times of robust economic activity. The high case scenario provides information about the possible range of growth that might actually occur. In the high case scenario, a growth rate similar to the highest rates of growth for consecutive years of historical load growth is used, amounting to an average annual rate of 2.0%, after conservation. A high load growth scenario that assumes continuous positive growth for the long run can help gauge the highest potential load for a given feasible rate of growth.

The level of demand growth selected for this scenario is quite high. It is a level of demand growth for which City Light today believes there is a 95% chance that the actual level of demand growth will be lower. It surpasses the most aggressive demand case seen in the plug-in hybrid electric vehicle analysis.

The modeling results for the High Demand Growth scenario suggest a costlier outcome for supplying power than envisioned in the base case for the 2008 IRP. In this scenario, net power costs roughly triple using the level of new resources established in the IRP base case due to a growing reliance upon power being purchased in the wholesale power market.

In reality, City Light would not lock into the 2008 integrated resource plan for the remainder of the 20-year period. The plan is revised every two years, so that the resource strategy would be adjusted to recognize the higher-than-expected demand growth. The economic consequences relying so heavily on the market for long-term resource supply are thus overstated. Still, the High Demand scenario is instructive for what it suggests for future acquisition of new resources. In the early years of the scenario, demand growth exceeds the base case forecast by just 15 aMW after 4 years. This amount may not cause significant concern by itself. However, just three years later that amount grows to 48 aMW, a much more significant amount for relying upon the wholesale power market.

Relying upon the wholesale market for power supplies could cause increased costs on the order of tens of millions of dollars and potentially have implications for resource adequacy, depending upon the status of regional power supplies. It also has implications for offsetting carbon dioxide emissions for power purchased from the wholesale market, in keeping with City policy.

Despite the increased costs, the portfolios maintain the same ranking as in the IRP base case, as seen in the table below. A key lesson from this scenario is to ensure that sufficient long-term resources are available to City Light, so that it does not rely excessively on the wholesale power market.

Table 6-21. Net Power Costs – High Demand Scenario 20-Year Net Present Value in Millions of Dollars

Portfolio	Net Power Cost NPV	Rank
High Biomass, Geothermal	$624	1
High Biomass, Geothermal, Wind	$634	2
High Wind, Geothermal	$640	3
High Exchange, Geothermal	$665	4
High Exchange, Geothermal, Wind	$742	5
No Action	$803	6

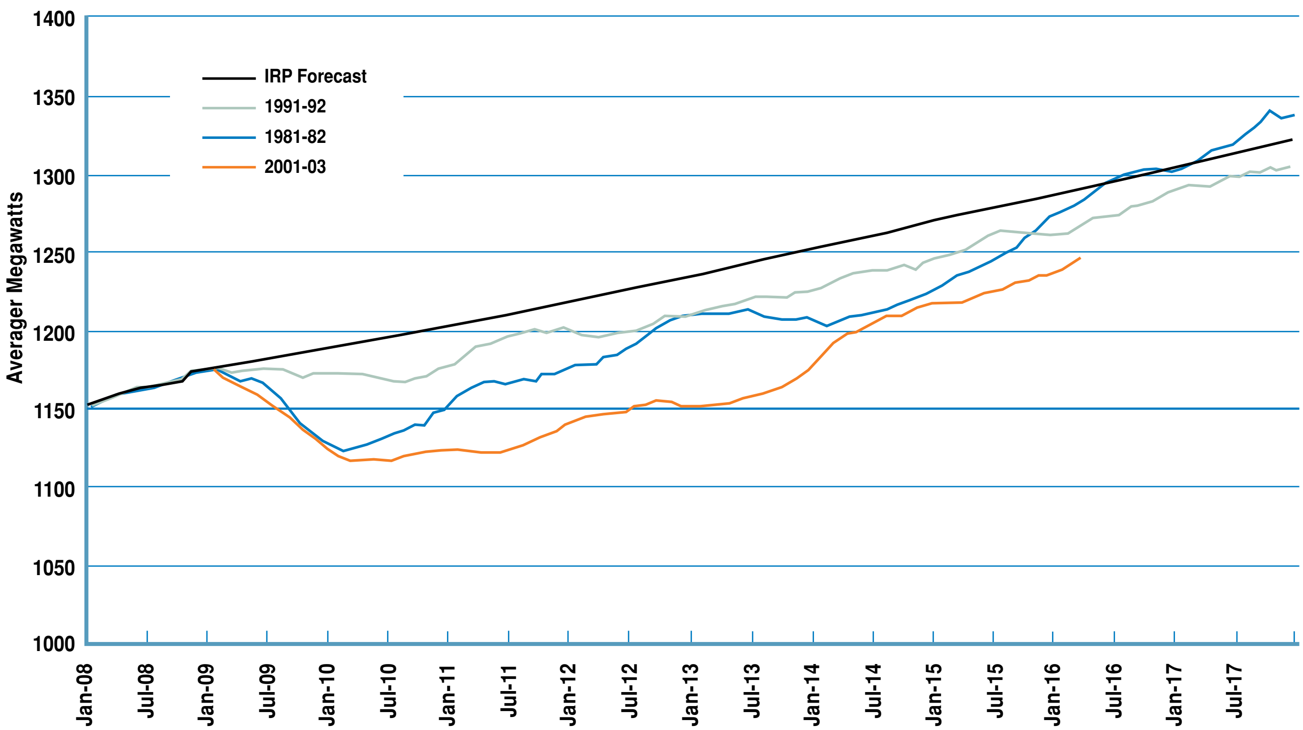
Prolonged Recession Scenario

The Pacific Northwest, along with the rest of the nation, faces a potential economic recession in the near term. While some economists believe the nation is already in recession, the Bureau of Economic Analysis has yet to make that determination. The load forecast in the base case for all portfolios for this IRP already assumes an economic slowdown for near-term years, but does not reflect a full-blown recession for City Light's service area.

The prolonged recession scenario assumes the decline in and recovery of load similar to the most recent recession. Loads declined by nearly 70 aMW in the recession after the 2000-2001 West Coast power crisis and the resulting decline in consumption by the aluminum industry; a power surplus resulted. Regional loads fell to 1990s levels even as new power plants were built to respond to the power shortages experienced in 2000-2001. The system load took about seven years to regain its previous level.

Figure 6-3 shows the IRP base forecast along with the patterns of the last three recessions. The recession of 2000-2001 (the lowest line) was modeled for this scenario.

Figure 6-3. Load Forecast and Patterns of Past Recessions



The recession scenario causes Seattle's electricity demand to drop in 2009, without recovering to pre-recession levels for five years. The prolonged recession scenario suggests significant changes in need for new resource acquisition in the first seven years. However, the implications are not uniform across the time period. In the first two years (2008-2009), winter resource needs are relatively unchanged. By the third year, winter resource needs would be reduced from the base case by 58 average megawatts and by 90 average megawatts in the fourth year of the recession. It is not until 2015 that winter resource needs have fully stabilized and have returned to a typical growth pattern. Several implications arise from this scenario. The recession did not immediately have significant impacts upon winter resource needs. It took three years for winter resource needs to decline by a sizable amount. Once the prolonged recession was over and winter electricity demand had returned to a more typical growth pattern, demand was reduced from the base case by about 56 average megawatts. In the scenario, City Light would be long in resources by that amount and have more surplus power to sell in the wholesale power market.

Within the logic in the Aurora model, having surplus resources does not necessarily lead to a bad outcome. The assumption about retail sales is that over the long run, City Light will just cover costs. However, when selling into the wholesale power market, there is sometimes an opportunity to sell power for more than marginal cost. If the prevailing market prices cover the marginal cost of production, the renewable generating units will be operated. In the recession scenario, City Light is assumed to acquire resources at a pace faster than ultimately needed because of unexpectedly low demand. The resulting surplus power could be sold in the market. The increased sales and wholesale revenues in the scenario lead to substantially lower net power costs.

Table 6-22. Net Power Costs – Prolonged Recession Scenario 20-Year Net Present Value in Millions of Dollars

Portfolio	Net Power Cost NPV	Rank
High Biomass, Geothermal	($175)	1
High Biomass, Geothermal, Wind	($167)	2
High Wind, Geothermal	($161)	3
High Exchange, Geothermal	($137)	4
High Exchange, Geothermal, Wind	($74)	5
No Action	($22)	6

The net power cost information in this scenario should not be given much credence because of the limited scope of the scenario design. The scenario was designed to evaluate the impact of a severe recession on resource needs as requested. It does not consider important factors that could affect financial outcomes. For example, it does not consider the financial impacts of lost retail load. It does not consider that after the first five years, City Light would reduce future resource acquisition plans to reflect the lower-than-expected demand growth and lower resource needs. The key risk of acquiring a sizable amount of surplus resources, that market prices may not cover the new resource costs, is also unaddressed within the scenario. Rather, this scenario was designed foremost to evaluate the impacts of a recession on the need for new resources.

High Renewable Resource Costs Scenario

Recent years have seen increases in the cost of wind projects. Much of the increased cost is due to higher priced commodities such as steel and cement. The prices of commodities are influenced by international markets, and at times by the actions of speculators or entities that periodically gain market power. Another factor that could affect future prices of renewable resources is disequilibrium between the supply and demand for renewable resources. Utilities seeking to meet state mandates for prescribed levels of renewable resources will be forced to bid against each other for possibly scarce resources, driving up prices to utilities and their ratepayers. This scenario will test the performance of each of the Round 2 portfolios against this eventuality.

The high renewable resource cost scenario is constructed so that renewable resource costs continue on a similar growth path that they have followed for the last five years. For example, growth in wind turbine costs and a declining value for the US dollar have caused the cost of wind to grow by more than 70% since 2002, or an average growth rate of about 9.2% per year. In this scenario, renewable resources maintain their relative cost differences, but as a group they are growing at an average of 7.3% per year in nominal terms. The costs peak about 2020 and then very slowly begin to decline. This simple scenario underscores the impacts of continued growth of commodity prices such as steel, copper, aluminum and concrete. It also suggests the risk of a growing scarcity of renewable resources relative to non-renewable resources as many utilities simultaneously pursue renewable resources to meet state renewable portfolio standards. One result of this scenario is that those portfolios with proportionately higher capital costs tend to perform the worst. The cost of power from the new resources reaches the point where it begins to be priced out of the wholesale market. The worst performing portfolios have lower sales and higher purchases. The model will purchase power from the wholesale market, rather than operate owned resources if the market price is lower than generation costs. In this scenario, the cost of non-renewable resources, even with the assumed regulatory requirement for purchase of CO2 emissions allowances, becomes increasingly competitive throughout the 20-year period relative to growing cost of renewable resources.

Table 6-23. Net Power Costs – High Renewables Cost Scenario 20-Year Net Present Value in Millions of Dollars

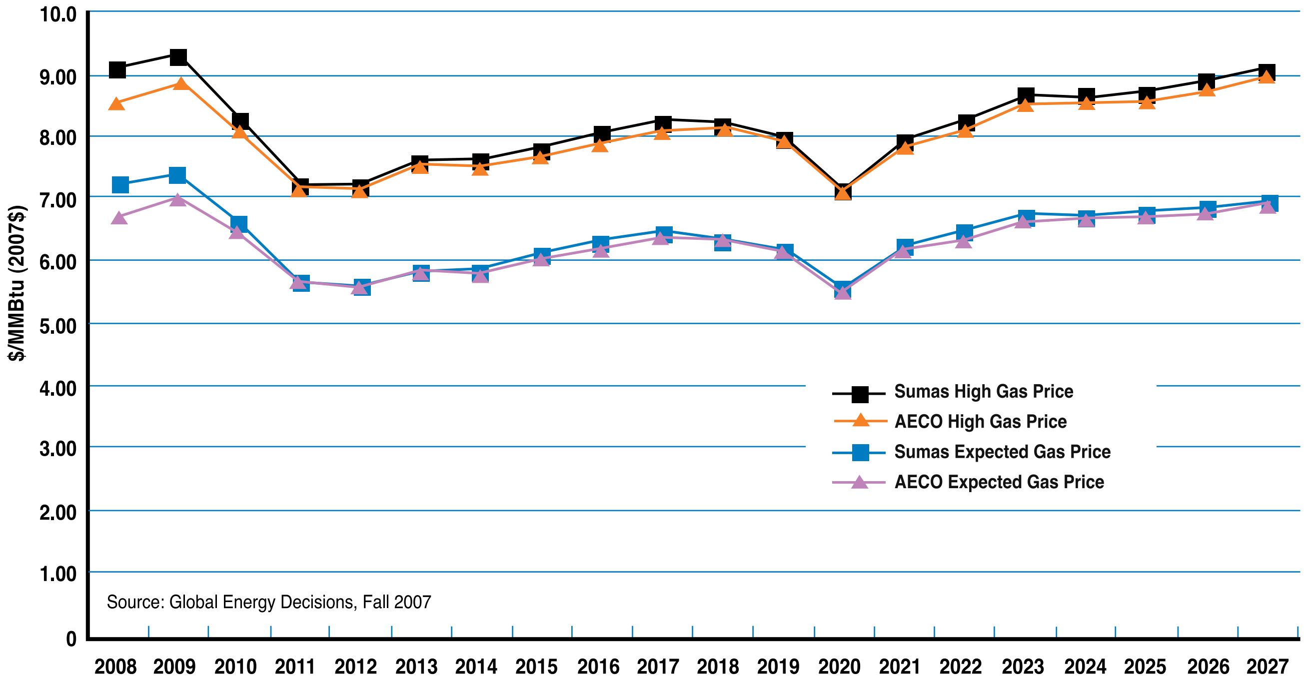
Portfolio	Net Power Cost NPV	Rank
High Biomass, Geothermal	$298	1
High Exchange, Geothermal	$326	2
High Wind, Geothermal	$327	3
High Exchange, Geothermal, Wind	$349	4
No Action	$453	5
High Biomass, Geothermal, Wind	$633	6

High Natural Gas Price Scenario

The natural gas prices used in the modeling of the portfolios in the High Natural Gas Price scenario are taken from the Ventyx (formerly Global Energy Decision's) Fall 2007 baseline forecast. Much uncertainty exists around the expected natural gas price forecast. Consequently, resource portfolios which include combined cycle turbines face substantial cost volatility since gas prices dictate the bulk of operating costs. Wholesale electricity prices are strongly correlated with natural gas prices, since gas turbines are usually the marginal generating unit. Natural gas prices will affect the amount of wholesale revenue City Light receives from selling its surplus power on the market. To capture some of this uncertainty, a scenario is run to test the sensitivity of portfolio costs under high natural gas prices.

Ventyx performed a stochastic analysis of long-term Henry Hub gas prices to develop a probability distribution of expected prices. Prices at Henry Hub are often the basis for the forecast of prices at other market centers, such as AECO and Sumas, the difference being the price of transportation. The 75th percentile of this distribution is its high gas price scenario. Figure 6-4 shows both the expected and the high average annual gas prices at AECO and Sumas. A weighted average of the high prices at these two centers is used for the high natural gas price scenario. In reality, 2008 natural gas prices reached the upper end of the distribution forecasted by GED in 2007 and have since declined. Price “excursions” have been a common feature in natural gas markets since power production became a major end-use for natural gas.

Figure 6-4. Forecast of Natural Gas Prices



In the high natural gas price scenario, little or no downside risk is expected from the Round 2 portfolios. While this scenario could be serious trouble for many electric utilities, it would not be for City Light. City Light’s existing resources are primarily hydro and are not directly affected by high natural gas prices. All the proposed resources are either conservation or renewable resources, which are also not directly affected by high natural gas prices. Natural gas is typically the price-setting resource in the western wholesale power market during most hours. In a regional market environment where natural gas prices have risen substantially, market prices for electricity are also expected to rise substantially. With an average water year, City Light would have much more power available to sell in the western wholesale power market than it would need to purchase. This means that with higher wholesale power prices, City Light’s wholesale power revenues would be higher. Using a high natural gas price forecast from Ventyx, this expectation was confirmed in the modeling results. In addition, the relative performance of the portfolios is the same as the base case.

Table 6-24. Net Power Costs – High Natural Gas Price Scenario 20-Year Net Present Value in Millions of Dollars

Portfolio	Net Power Cost NPV	Rank
High Biomass, Geothermal	($566)	1
High Biomass, Geothermal, Wind	($553)	2
High Wind, Geothermal	($544)	3
High Exchange, Geothermal	($507)	4
High Exchange, Geothermal, Wind	($356)	5
No Action	($228)	6

Plug-In Hybrid Electric Vehicle Scenario

Plug-in hybrid electric vehicles (PHEVs) are similar to conventional hybrid electric vehicles but use a larger battery and a plug-in charger which enables electricity from the grid to replace part of the gasoline.

The economic incentive for drivers to use a PHEV is the comparatively low cost of fuel, especially as the cost of oil continues to rise. The electric equivalent of the "drive energy" in a gallon of gasoline delivering 25-30 miles in a typical midsized car is about 9-10 kWh, assuming a vehicle efficiency of 2.9 mile/kWh. A study by the Electric Power Research Institute (EPRI) found a significant potential market for PHEVs, depending on vehicle cost and the future cost of gasoline.

City Light used assumptions from a July 2007 study that EPRI and the Natural Resource Defense Council (NRDC) jointly conducted on PHEVs to evaluate electricity use implications for City Light.

The impact of PHEVs on City Light system load depends upon the ultimate technology used for the PHEVs, consumers' rate of adoption and customer charging patterns. PHEV proponents point out that the batteries could be charged during off-peak hours, when base load generation (primarily coal and nuclear plants) is cheap and available. This argument is strongest for parts of the country that have such surplus power, but less compelling in the Pacific Northwest and with City Light because of the storage capability of much of hydro generation. Figure 6-5 shows the charging pattern used for the EPRI/NRDC analysis, which assumed an incentive for off-peak charging. Figure 6-6 shows EPRI/NRDC market share assumptions.

Figure 6-5. PHEV Charging Pattern per EPRI/NRDC

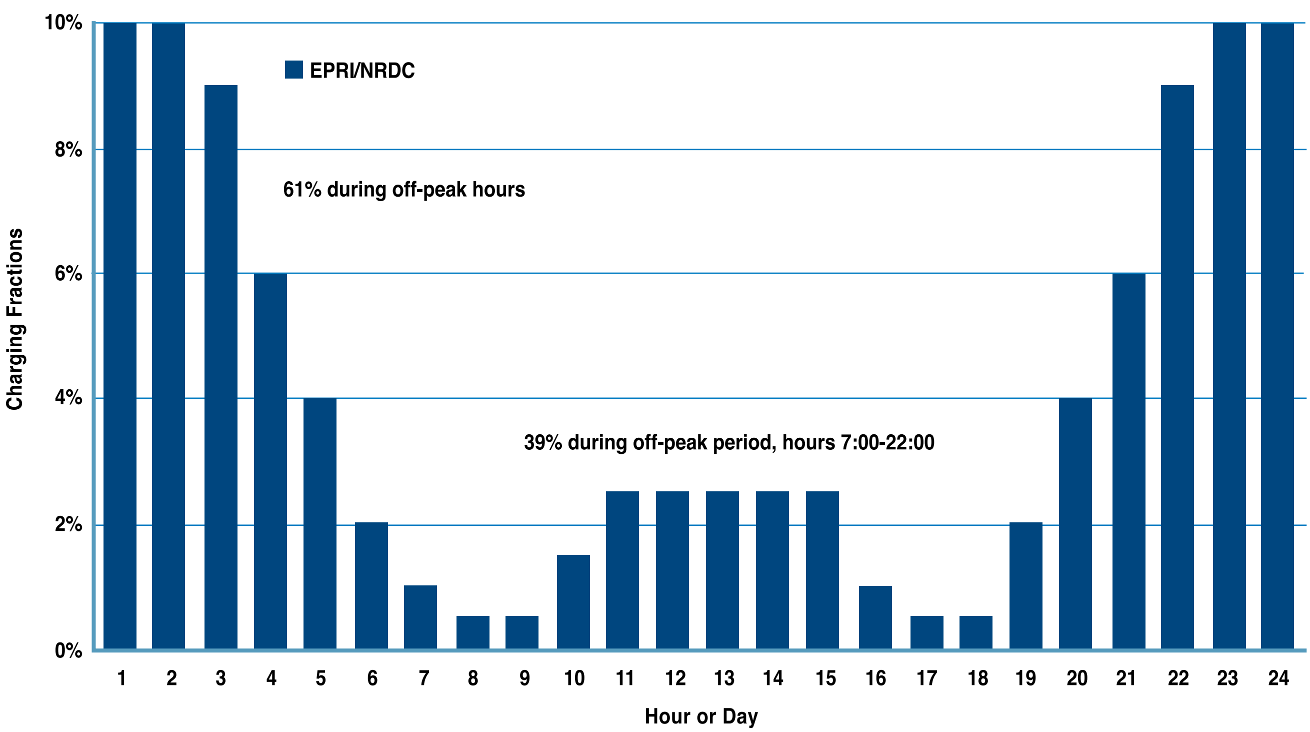
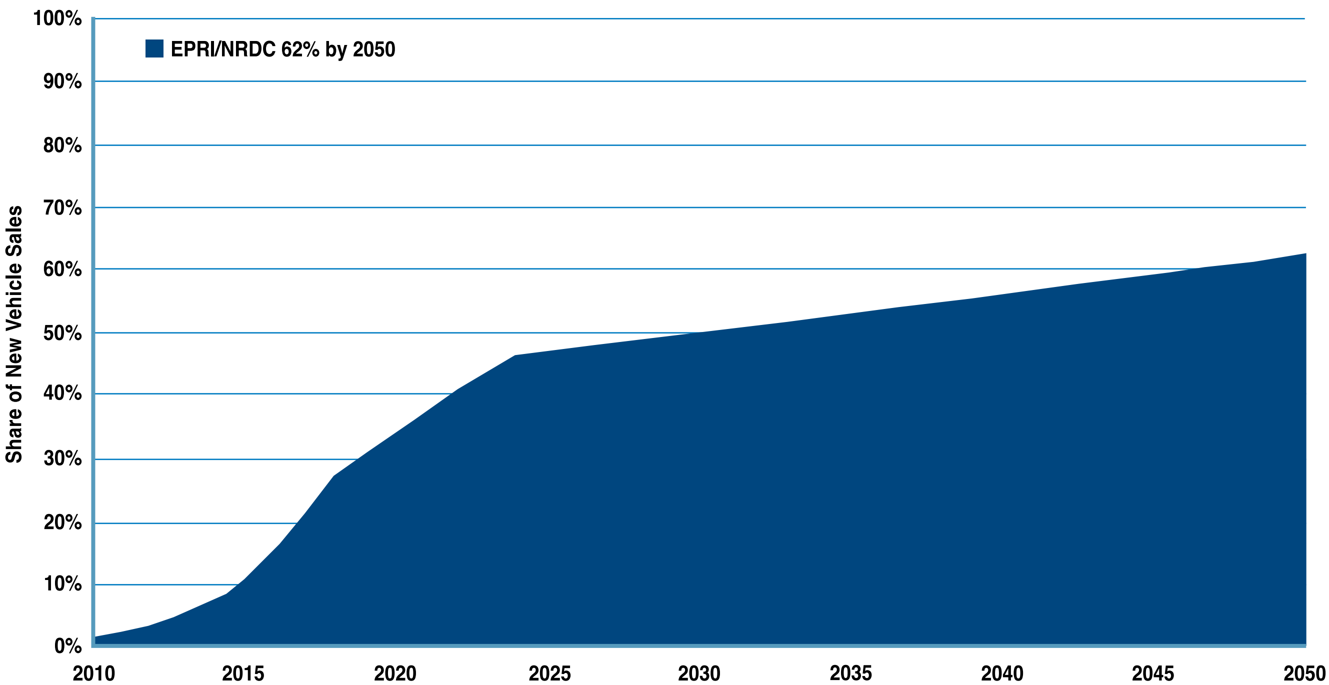


Figure 6-6. EPRI/NRDC Market Share Assumptions



There are two PHEV scenarios for the 2008 IRP. The first, base case, largely relies upon assumptions developed by EPRI/NRDC. The second scenario, or aggressive case, has more aggressive assumptions about 1) market penetration, 2) charging during the peak period, and 3) annual consumption per vehicle, and tests the high end of the range of all three assumptions simultaneously.

Assumptions common to both PHEV scenarios:

1. Commercial availability by 2010.
2. PHEVs with a 40-mile range per charge (highest range anticipated by EPRI).
3. Rate of new vehicle registrations per Washington household average of 10.6%.
4. Replacement rate for PHEVs of 100%.

Table 6-25 below compares the assumptions in the base and aggressive cases for PHEVs. While the base case is representative of an "expected value," the aggressive case is representative of an extreme, establishing what is seen as the outer boundary of potential outcomes,

Table 6-25. PHEV Electricity Demand for Battery Charging, Base and Aggressive Cases

Case	Market Penetration	By Year	Annual Battery Charging / PHEV (kilowatt-hours)	Percent of Charging On-Peak	On-Peak Demand (aMW)	Year 2027 Demand (aMW)
Base	62%	2050	2,477	39%	21	55
Aggressive	80%	2030	4,745	49%	67	140

The results of this analysis are highly sensitive to the pace of technological change, the rate of adoption of PHEVs by consumers, and the timing of battery charging. However, the results of the two cases suggest two general conclusions:

1. The impacts of PHEV electricity demand are likely to be manageable for City Light, provided that the technology continues to be monitored and adequate resources are acquired ahead of time.
2. Influencing the timing of charging PHEVs to off-peak hours can greatly reduce the amount and costs of new power resource requirements.

Scenarios Summary

These scenarios help to identify the degree of risk that underlies the 2008 IRP resource portfolios, especially when viewed in combination with other risk measures. While the relative risk seems similar by portfolio, the greatest risks identified in the scenarios were: 1) having insufficient resources; 2) having the growth in costs for renewable resources outpace the growth in costs for fossil fuel resources, even when including a cost for carbon dioxide emissions; 3) having rapid growth in load for recharging PHEVs during peak demand hours; and 4) the potential for disproportionate costs from climate change compared to the region.

The degree of risk of "having insufficient resources" is greatly dependent upon the state of the regional wholesale power market for both reliability and net power cost. It also has implications for compliance with Washington Initiative 937. Having the unexpectedly high demand growth in the high growth scenario would lead to non-compliance with Initiative 937 for one or more years and up to a $26 million fine per year ($50 per megawatt-hour escalated for inflation). This would suggest that acquiring renewable resources earlier may be advantageous for City Light's customers.

City Light does not subscribe to the idea that commodity prices will continue to rise unabated at the same pace for the next 20 years as they do in the high renewable resource cost scenario. There is less certainty about the potential risk for scarcity of renewable resources. Many utilities are beginning to investigate the supply of renewable resources, given the renewable portfolio standards adopted by many states. In time, economies of scale and innovations in both conservation and renewable resource technologies may eventually overwhelm the commodity-driven price escalation seen in this decade.

The main conclusion that can be drawn from the scenario for PHEVs is that it is very important to try to influence the recharging of PHEVs to occur in the off-peak hours. Even a relatively high rate of growth in sales for PHEVs could be accommodated (with recharging in the off-peak) with a moderate need to acquire new resources (21 aMW). However, the aggressive case, where a sizable amount of recharging occurs during the daytime, results in the need to acquire nearly 70 aMW of additional resources (over 23 years) to serve increased load from PHEVs.

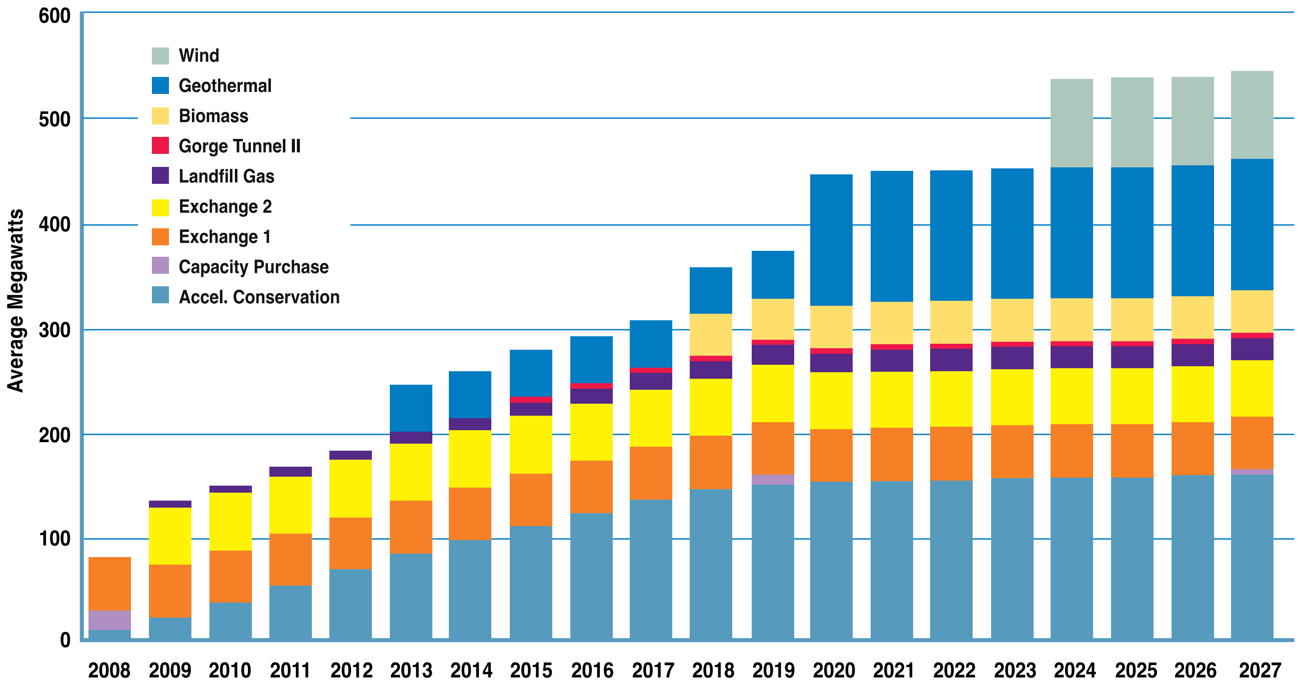
The analysis of climate change is preliminary and has substantial missing information. While City Light does not consider this analysis in any way conclusive, it does indicate a risk that climate change could have previously unanticipated negative impacts to net power costs based upon relative changes in seasonal demand and prices. Preparing for climate change could include evaluating strategies to reshape seasonal resources to shift more power production and resource availability into the summer as climate change progresses. Seasonal shaping of City Light resources should and will be re-evaluated on an ongoing basis as part of integrated resource planning. However, if existing forecasts of climate change are reasonably accurate, having sufficient winter resources will continue to be the main focus of resource adequacy concerns for many years to come.

Finally, the scenarios serve to demonstrate the durability of the net power cost results of the Round 2 portfolio rankings under widely different conditions than those envisioned in the base case forecast.

The Recommended Resource Portfolio

The recommended resource portfolio, P5: High Biomass, Geothermal, and Wind, continued to perform well within the scenarios. It is the best performing in risk measures, a close second best in net power cost, and, like the other Round 2 portfolios, has low direct emissions costs. It targets the widest range of renewable resources of the Round 2 portfolios, increasing the likelihood of success for acquiring renewable energy resources in a highly competitive market. With an increased reliance upon conservation, it is comparatively low cost and has low environmental impacts. It meets the requirements of I-937 and advances the Mayor's agenda for Climate Action Now.

Figure 6-7. Recommended Portfolio (Average Megawatts in January)



Chapter 7 – The Action Plan

This chapter presents City Light's recommended long-term strategy and two-year action plan.

This Integrated Resource Plan (IRP) presents a course of action that utilizes the best information available. The plan meets the overall objective of determining strategies for the type, amount and timing of new resource acquisitions to meet electrical load over the 20 years between 2008 and 2027.

The preferred portfolio satisfies the criteria established at the beginning of the planning process: reliability of service, reasonable costs, reasonable risks and limited environmental impacts. The preferred portfolio:

- Focuses on improving City Light's seasonal resource balance in the short term, thus avoiding the costs of major resource additions early in the planning period.
- More clearly identifies the reliability risk inherent in the current resource mix and provides a plan of action to mitigate that risk.
- Considers the risks attributable to new resources when evaluating them for the plan.
- Clearly identifies the environmental impacts of resources and portfolios in the plan, in terms of the emissions of air pollutants and impacts to land, water, wildlife and aesthetics.

Any 20-year plan faces many uncertainties. This is particularly true in an environment as dynamic and volatile as energy markets. The intent of the IRP is not to lock the City of Seattle or City Light into a 20-year course of action but to provide long-term strategic direction for resource acquisition and a short-term action plan to move in that direction.

City Light confronts a wide range of challenges in meeting its mission of providing reliable, competitively priced and environmentally sound electricity to customers. These challenges require many decisions each year, large and small, related to power resources. Creating a long-term resource plan provides the framework for a short-term action plan that will help guide the utility on a path that brings long-term resource benefits to customers.

Action Plan

This section describes City Light's action plan as related to resource acquisition, transmission and planning. Major elements of the action plan include:

Resource Acquisition

- Continue to acquire conservation resources
- Investigate new generating resources
- Evaluate and acquire cost-effective "lost opportunity" resources

Transmission

- Ensure adequate transmission capacity to meet resource needs

Planning

- Explore, monitor and evaluate potential future technologies and resources
- Enhance IRP analytical capabilities
- Keep the IRP up-to-date with new information

Resource Acquisition

Conservation

Conservation has proven to be a good investment for more than 30 years, and City Light will continue to pursue the acquisition of cost-effective conservation.

While the cost and environmental benefits of conservation are well known, one benefit of conservation may have gone relatively unnoticed. In a transmission-constrained future, conservation becomes more cost effective and pragmatic as a resource. Expanding transmission infrastructure takes many years and depends upon the close cooperation of a variety of governmental agencies and electric utilities. However, the citizens of Seattle can directly control acquisition of conservation resources.

Generation

The IRP makes many assumptions about the availability and costs of generic resources. Implementation of the IRP requires confirming resource availability and costs for specific opportunities. If the specific resource opportunities from real world suppliers do not match City Light's assumptions, the IRP must be adjusted to more accurately reflect the costs and characteristics of the resources that are actually available.

Lost Opportunities

The 2008 IRP identifies "lost opportunity" resources including seasonal exchanges, seasonal capacity contracts, landfill gas, and a contract with an existing hydro facility. These opportunities may be lost if they are not acted upon within a certain time frame and will require prompt investigation. This can mean acquiring resources ahead of schedule, if it is more cost effective to do so than to acquire a higher cost resource at a later time.

Investigation and monitoring of new resource technologies is also important to keep abreast of future resource opportunities. Technological advancement and economies of scale can expand future choices for cost-effective and environmentally responsible resources.

During the 2008 IRP, City Light identified potential generation efficiency upgrades at its Skagit River hydroelectric facilities. Because of uncertainty about development costs, this resource was not included in the portfolios in the 2006 IRP. It is included in the 2008 IRP.

Transmission

Adequate transmission capacity can reduce the costs of new resources by allowing more seasonal exchanges and power purchases, thereby reducing the amount of generation reserves that would otherwise be necessary. Important decisions to expand regional transmission facilities in the Pacific Northwest will be made well within the 20-year time frame of this plan. City Light will work to ensure the availability of adequate transmission facilities that are critical to Seattle's electricity supply, reliability, cost and energy policy objectives.

Future Integrated Resource Planning

Improving information and planning capabilities can enhance the quality of information available to City policy-makers and facilitate better long-term decision making, lower costs and reduced risk.

This 2008 IRP sets the long-term strategic direction for how City Light will meet future growth in electricity demand for Seattle. Many assumptions about the future are used in the IRP. While City Light sought to use the best information and analytical methods available for the 2008 IRP, it is impossible to correctly forecast all aspects of a dynamic market, operating and technological environment. City Light will continue to develop and refine its modeling tools and assumptions for use in future resource planning. Demand forecasts will be prepared and updated routinely and new information on resource costs and availability will be collected.

IRP Action Plan, 2008-2009

Specific actions recommended/planned for the next two years are shown in the table below.

Table 7-1. IRP Action Plan, 2008-2009

Actions	2008	2009
Conservation Resources		
Pursue accelerated conservation in the targeted amounts	8.4 aMW by end of 4th Qtr	12 aMW by end of 4th Qtr
Generation Resources		
Pursue full BPA contract rights	Finalize negotiations and elections for 2011	
Complete a power purchase agreement with a landfill gas supplier by mid-2009	Negotiate contract by end of 4th quarter	Plant to begin construction and testing
Investigate future capacity versus energy needs as the region grows shorter on capacity	Begin data collection	Complete analysis in time for 2010 IRP
Market Resources		
Investigate and acquire seasonal exchanges and/or capacity contracts to offset near-term reliability risk	Additional 50 aMW as needed	Additional 55 aMW as needed
Other New Resources		
Evaluate results of the distributed generation market study and pursue any cost-effective opportunities with customers	Engage in discussions with appropriate customers by year end	Decision on go or no go with appropriate customers by 2010
Collect and update information on costs of a wide range of new resources commercially available by June 2008	Ongoing	Ongoing
Continue investigating the development status, costs and commercial availability for geothermal, solar, and demand response. Acquire these resources as appropriate	Ongoing	Select technologies for inclusion in 2010 IRP
Transmission		
Continue to participate in and support the development of Columbia Grid	Ongoing	Ongoing
Provide comments to the U.S. Department of Energy and Federal Energy Regulatory Commission on transmission issues important to City Light	Ongoing	Ongoing
Future IRPs		
Continue to refine assumptions, forecasts and modeling	Ongoing	Ongoing
Support research on the impacts of climate change to North Cascade glaciers and water temperatures in the Skagit, Pend Oreille, and Columbia Rivers	Ongoing	Ongoing

Acronyms

aMW	Average megawatt
BPA	Bonneville Power Administration
CCCT	Combined Cycle Combustion Turbines
CDEAC	Clean and Diversified Energy Advisory Committee (Western Governors)
CHP	Combined Heat and Power (Cogeneration)
CPA	Conservation Potential Assessment
CTED	Community, Trade, and Economic Development (Washington State)
DOE	Department of Energy (Federal)
EFSEC	Energy Facility Site Evaluation Council (Washington State)
FERC	Federal Energy Regulatory Commission
GED	Global Energy Decisions (consultants hired by Seattle City Light to assist with the modeling of portfolios)
GCPHA	Grand Coulee Project Hydroelectric Authority
GW, GWh	Gigawatt, gigawatt-hour
IGCC	Integrated Gasification Combined Cycle
IRP	Integrated Resource Plan
KW, KWh	Kilowatt, kilowatt-hour
LNG	Liquified Natural Gas
Mid-C	Mid-Columbia
MW, MWh	Megawatt, Megawatt-hour
NCPA	Northern California Power Agency
NERC	North American Electric Reliability Council
NPCC	Northwest Power and Conservation Council
NPV	Net Present Value
OATT	Open Access Transmission Tariff
O&M	Operations and Maintenance
PPA	Purchased Power Agreement
PTC	Production Tax Credit
PUD	Public Utility District
PURPA	Public Utility Regulatory Policy Act (Federal)
REC	Renewable Energy Credit
RPS	Renewable Portfolio Standard
SCCT	Simple Cycle Combustion Turbines
WECC	Western Electricity Coordinating Council

Glossary

Average Megawatt (aMW)

Average energy output over a specified time period (total energy in megawatt-hours divided by the number of hours in the time period).

Baseload Resource

A resource that runs continuously except for maintenance and scheduled or unscheduled outages.

Biomass

Plant material used as a fuel or energy source; e.g. logging or mill residues, urban wood-waste and construction debris, dedicated wood or agricultural crops, and agricultural waste.

Biogas

Methane and other combustible gases released from decomposition of organic materials.

Block Product

City Light acquires power under its contract with Bonneville Power Administration in two forms: Block and Slice. The Block product is a fixed amount of power per month delivered at a constant rate through the month. (See also "Slice Product".)

Bonneville Power Administration (BPA)

A power marketing and electric transmission agency of the United States government headquartered in Portland, Oregon. BPA owns and operates the regional transmission system and markets power from the Federal Columbia River Power System. BPA is by far the largest provider of power and transmission services in the Northwest region. City Light buys over 40% of its firm power and most of its transmission from BPA.

Capacity Factor

The portion of full generation capacity that is actually used on average over a specified period of time. Wind facilities, for example, use about 32% of their full generation capacity over the period of a year.

Cogeneration

The multiple use of one energy source, such as the use of steam to generate electricity or power machinery as well as to provide heat. The simultaneous production and use of heat and electricity. Also referred to as Combined Heat and Power (CHP).

Combined Cycle Combustion Turbine (CCCT)

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

Conservation

The reduction of electric energy consumption as a result of increases in the efficiency of production, distribution and end use.

Demand

The rate at which electric energy is delivered to or by a system at a given instant, usually expressed in megawatts.

Dispatchable Resource

A resource whose electrical output can be controlled or regulated to match the instantaneous electrical energy requirements of the electric system.

Distribution System

The utility facilities that distribute electric energy from convenient points on the transmission system to customers.

Economic Dispatch

In electrical system operations modeling, the selection of the least-cost resource under a prescribed set of conditions.

Environmental Impact Statement (EIS)

A written analysis of the environmental impacts to be anticipated from a proposed construction activity (e.g., a power plant or electric transmission line, or programmatic activity). An EIS may be required by the National Environmental Policy Act (NEPA) and/or the Washington State Environmental Policy Act (SEPA) as part of the environmental review of proposed activities, including approval of plans by governmental agencies.

Federal Energy Regulatory Commission (FERC)

The division of the United States Department of Energy that is responsible for regulating power generation and licensing hydroelectric dams and other generation.

Generation Capacity

The maximum amount of power that a generator can physically produce.

Geothermal Energy

Energy derived from heat deep beneath the earth's surface generated from hot rock, hot water or steam.

Gigawatt (GW) and Gigawatt-Hour (GWh)

A gigawatt is a unit of power equal to 1 billion watts, 1 million kilowatts, or 1,000 megawatts. A gigawatt-hour (GWh) is a measure of electric energy equal to one gigawatt of power supplied to or taken from an electric circuit for one hour.

Hydro Resources

Facilities used to produce electricity from the energy contained in falling water (river, locks or irrigation systems).

Integrated Resource Planning

A planning approach that projects the amount of new electricity generation and conservation needed to meet future loads by considering a range of power resource alternatives and future conditions, and using evaluative criteria including but not limited to minimizing cost.

Landfill Gas

Gas generated by the natural degrading and decomposition of municipal solid waste by anaerobic microorganisms in sanitary landfills. The gases produced, carbon dioxide and methane, can be collected by a series of low-level pressure wells and can be processed into a medium Btu gas that can be burned to generate steam or electricity.

Levelized Cost

The present value of a resource's cost (including capital, interest and operating costs) converted into a stream of equal annual payments and divided by annual kilowatt-hours saved or produced. For example, the amount borrowed from a bank is the present value of buying a house; the mortgage payment including interest on a house is the levelized cost of that house.

Load

The amount of electric power delivered or required at any specified point or points on a system. Load originates primarily at the power-consuming equipment of the customer.

Load Forecasting

The procedures used to estimate future consumption of electricity. Load forecasts are developed either to provide the most likely estimate of future load or to determine what load would be under a set of specific conditions; e.g., extremely cold weather, high rates of inflation or changes in electricity prices.

Load Profile or Shape

A curve on a chart showing power supplied plotted against time of occurrence to illustrate the variance in load in a specified time period.

Megawatt (MW) and Megawatt-Hour (MWh)

One thousand kilowatts, or 1 million watts; the standard measure of electric power plant generating capacity. A megawatt-hour (MWh) is a measure of electric energy equal to one megawatt of power supplied to or taken from an electric circuit for one hour.

Peak Capacity

The maximum output of generating plant or plants during a specified peak-load period.

Peak Demand

The maximum demand imposed on a power system or system component during a specified time period.

Peak Power

Power generated by a utility system component that operates at a very low capacity factor, generally used to meet short-lived and variable high-demand periods.

Physical Call Option

A contractual agreement with a power generator to deliver power only when requested, at a pre-arranged cost per megawatt-hour.

Portfolio

A set of power supply resources currently or potentially available to a utility. Used in the IRP to mean alternative sets of resources that could be added to existing resources to meet expected future need. City Light's current portfolio consists primarily of hydroelectric resources (86%) with small amounts of conservation, wind, natural gas, nuclear and other resources such as coal, biomass and petroleum.

Resource Mix

The different types of resources that contribute to a utility's ability to generate power to meet its loads.

Renewable Resource

A resource whose energy source is not permanently used up in generating electricity. As defined by the Pacific Northwest Electric Power Planning and Conservation Act, a resource that uses solar, wind, hydro, geothermal, biomass, or similar sources of energy to either generate electric power or reduce the customer electric power requirements.

Reserve Requirement

The requirement that a utility have capacity at its disposal that exceeds its expected peak demand by a certain percentage.

Resource Adequacy

A measure defining when a utility has sufficient resources to meet customer needs under a range of conditions that affect supply and demand for electricity. For this IRP, City Light has set a resource adequacy standard of 95%, meaning a 95% probability that all energy needs will be met.

Seasonal Exchange

An agreement between two electricity suppliers to send each other electricity at different times, so they can shape their resources to fit customer demand. Such agreements work best between suppliers whose peak demands occur in different seasons. For example, City Light usually has surplus energy during the summer while its heaviest load is in the winter. Other utilities have load or resource profiles that are the reverse of City Light's, with peak demand in the summer.

Shaping

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

Simple Cycle Combustion Turbine (SCCT)

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

Slice Product

City Light acquires power under its contract with BPA in two forms: Block and Slice. The Slice product is an amount of power that varies year to year according to the amount of water flowing through the BPA hydroelectric system. In a good water year (above average precipitation), more power is delivered to the same customer than in a poor water year (below average precipitation). (See also "Block Product".)

Surplus Energy

Energy that is not needed to meet a utility or marketing agency's commitments to supply firm or non-firm power.

Transmission System

An interconnected network of electric transmission lines and associated equipment for the movement or transfer of high-voltage electricity between points of supply and points at which it is transferred for delivery to consumers or to other utilities.

Wheeling

The use of a utility's transmission facilities to transmit power to and/or from another utility system.