

# 2012 INTEGRATED RESOURCE PLAN



Your Seattle City Light  
SEATTLE'S MUNICIPAL ELECTRIC UTILITY

# 2012 IRP STAKEHOLDERS

**John Chapman**  
*University of Washington*

**Calvin Chow**  
*City Budget Office, City of Seattle*

**Cameron Cossette**  
*Nucor Steel Seattle*

**Stuart Clarke**  
*Bonneville Power Administration*

**Kim Drury**  
*Northwest Energy Coalition*

**Tom Eckman**  
*Northwest Power & Conservation Council*

**Pam Jorgensen**  
*Harborview Medical Center*

**Tony Kilduff, Ph.D.**  
*Council Central Staff, City of Seattle*

**Steve LaFond**  
*Boeing (past) & Western Electricity  
Coordinating Council Board of Directors*

**Mike Locke**  
*McKinstry*

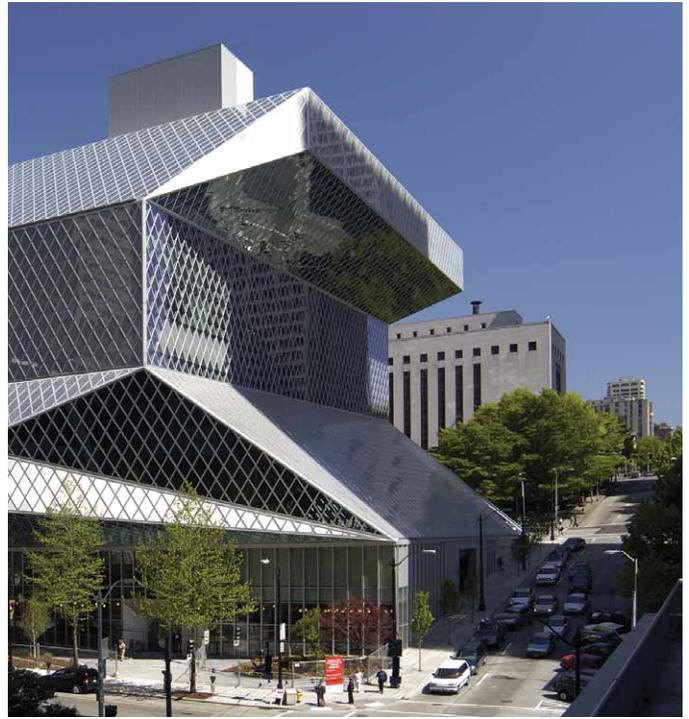
**Henry Louie, Ph.D.**  
*Seattle University*

**Christy Nordstrom**  
*Residential customer*

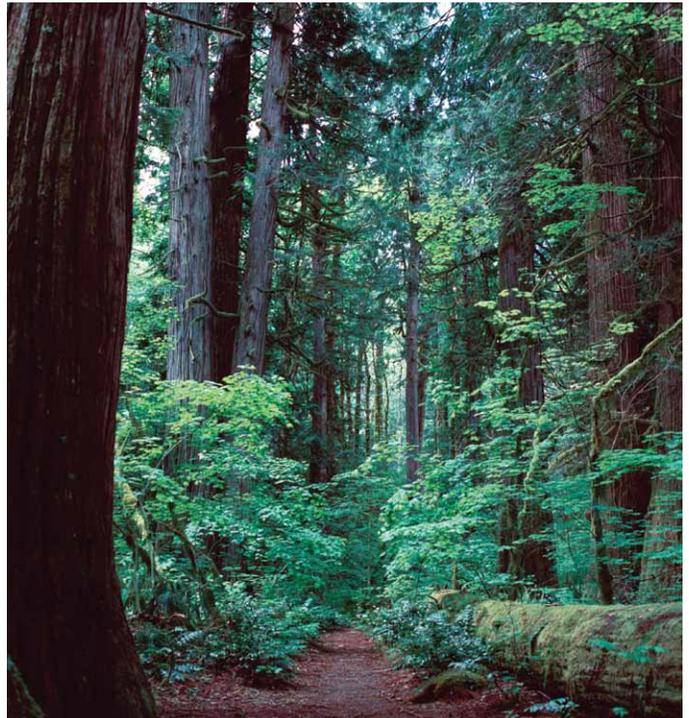
**Mike Ruby**  
*Envirometrics*

**Jennifer Sorensen, Ph.D.**  
*Seattle University*

**Paul Zemtsov**  
*Sierra Club volunteer*



City Light's customers include a mix of residential, commercial, and industrial users.



Seattle City Light was the first utility in the nation to become carbon neutral and continues a strong leadership role in conservation and environmental stewardship.

# EXECUTIVE SUMMARY

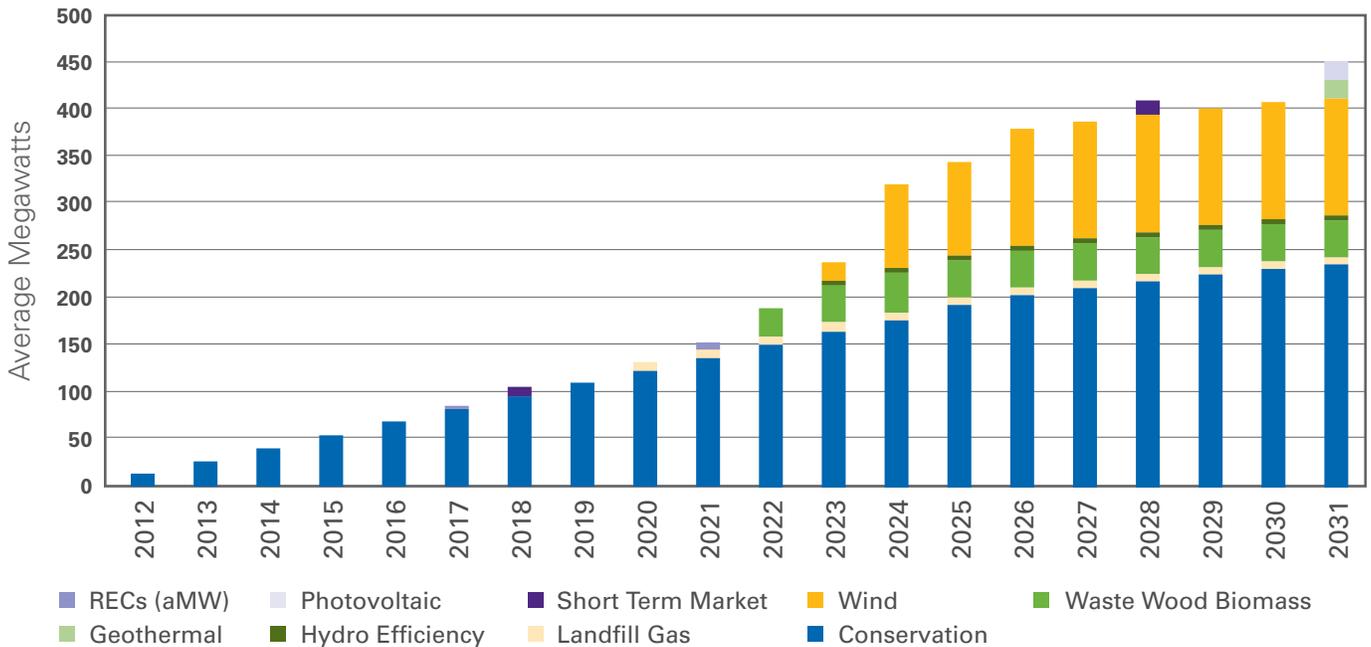
Seattle City Light’s 2012 Integrated Resource Plan (IRP) outlines how the utility will meet anticipated customer needs over the next 20 years. This long-term plan helps ensure resources are available when they are needed; identifies how much power and conservation is required and when; and analyzes a number of potential resources to add to the existing portfolio. The analysis evaluates combinations of generation and conservation resources for reliability, cost, risk, and environmental impact. The plan also incorporates public and stakeholder input, and presents a preferred portfolio as the best option to reliably meet customer demand and energy-policy objectives in the future.

The IRP is provided at the direction of the mayor, Seattle City Council, and legislation from Washington state. State law requires electric utilities to develop IRPs and file them with the Washington State Department of Commerce every two years.

## Highlights

- Seattle City Light can potentially meet its energy needs through the decade with conservation, seasonal market purchases, and power contract flexibility.
- City Light has purchased renewable energy credits (RECs) to meet Initiative 937 (I-937) requirements and may continue to do so, if needed, in the future.
- California policies and transmission constraints have resulted in lower Pacific Northwest REC costs, making REC acquisition increasingly cost-effective.
- Costs and policies have made natural gas generation more competitive in the 2012 IRP analysis than in 2010.
- Conservation is the resource of choice, a “no regrets” long-term resource strategy because it is lower cost, flexible, advantageous for economic development, and has minimal environmental impacts.

FIGURE 1: 2012 IRP PREFERRED PORTFOLIO



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Seattle City Light provides low-cost, reliable, and environmentally responsible electric power to more than 780,000 customers in the City of Seattle and eight adjacent jurisdictions.



The availability of reliable electricity is essential to the economic vitality and public safety of our city and region.

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Seattle City Light’s current resource portfolio is predominantly hydropower, both owned and contracted. (Pictured: Gorge Dam)

# INTRODUCTION

The Seattle City Light 2012 Integrated Resource Plan (IRP) is a long-term plan that describes how the utility will meet anticipated customer needs over the next 20 years. The IRP ensures that City Light can meet its obligation to supply reliable electricity to customers at a reasonable cost, while factoring in key environmental, social, and policy considerations.

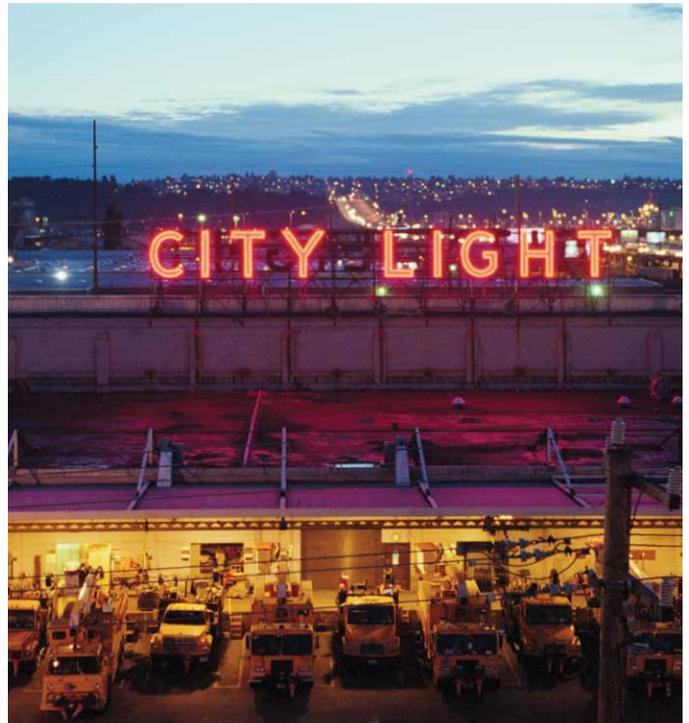
This report describes the purpose of the IRP, the planning process, the current portfolio, the load forecast, resource adequacy, and planning and regulatory requirements. It then describes eight prospective portfolios and the steps that led to the selection of the preferred portfolio. The report concludes with an overview of the two-year action plan. Additional details about the IRP are included as appendices.

## WHY AN IRP?

Integrated electricity systems are complex and capital-intensive. Electric utilities must plan ahead to ensure resources are available when they are needed. As a result, IRPs are typically based on load forecasts and resource options that extend well into the future. Because it takes a long-term view, the IRP needs to be sufficiently flexible to respond to changing market dynamics, evolving policies, and future uncertainties.

The IRP identifies how much power and conservation is needed and when. It analyzes a number of potential resources to add to the existing portfolio over the next 20 years. The plan incorporates public and stakeholder input and presents a portfolio identified as the best option to reliably meet customer demand and energy policy objectives.

Seattle City Light provides integrated resource planning at the direction of the mayor, Seattle City Council, and as required by state law. Revised Code of Washington 19.280 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



City Light is the 10th largest public utility in the nation, serving more than 400,000 accounts representing more than 780,000 customers in the City of Seattle and eight adjacent jurisdictions.

## Your City Light

***Seattle City Light was created by the citizens of Seattle in 1902, when they approved bonds to build a hydroelectric power plant on the Cedar River.***

The plant delivered its first electricity to customers in 1905. As a municipally owned public power system, Seattle City Light is governed by elected Seattle officials and primarily supported by customer revenues and surplus power sales. Recognized as a national leader in energy efficiency and environmental stewardship, Seattle City Light provides low-cost, reliable, and environmentally responsible electric power.

long-term electric power needs. As required by this state law, City Light submits an IRP to the Washington State Department of Commerce every two years. City Light also provides an IRP or an IRP update to its governing board, the Seattle City Council, every two years.

The 2012 Seattle City Light IRP determines the strategies for the type, amount, and timing of new resource acquisitions to meet the electrical load for the 20-year period between 2012 and 2031.

## THE PLANNING PROCESS

To formulate the IRP, Seattle City Light analyzed a number of potential resources to add to its existing portfolio over the next 20 years. Combinations of generation and conservation resources were evaluated for reliability, cost, risk, and environmental impact. Public and stakeholder input were solicited along the way and culminated in the selection of a preferred portfolio – the portfolio best able to reliably meet customer demand at the lowest cost, while being consistent with City policies.

The 2012 integrated resource planning process included these steps:

- Inviting citizens, stakeholders, and representatives of many organizations with diverse perspectives to participate;
- Recruiting team members from within the utility to work on the plan;
- Utilizing a detailed computer model of the western electric system, the AURORA<sup>xmp</sup>® Electric Market Model, to evaluate resources, portfolios, and portfolio risk, and enhancing the model to reflect City Light's unique operational environment;
- Conducting a conservation potential resource assessment;
- Forecasting hourly demand for electric power through 2031;
- Refining the resource adequacy measure and determining the timing and amount of future need;
- Developing candidate resource portfolios as part of the resource strategy to meet customers' power needs, and to comply with I-937 within a policy context;
- Developing costs and characteristics of alternative resources to be included in the candidate resource portfolios;
- Evaluating and comparing an initial round of candidate portfolios based on cost, risk, reliability, and environmental impacts;
- Narrowing and refining candidate portfolios and conducting additional analysis; and
- Recommending a long-term resource strategy and near-term resource action plan to the mayor and Seattle City Council.

## Gathering Public Input

### Opportunities for Input

- Five IRP stakeholder meetings with customer, power supply, energy efficiency, environmental, governmental, and university representatives
- Public meetings in north, central, and south Seattle
- Informational website with comment features

### Key Findings

- Support for continued aggressive pursuit of conservation
- Concern about City Light rate impacts (particularly to businesses and low-income households)
- Concern over risk and environmental impacts of generating power from shale gas
- Continued support for the use of renewable resources



A variety of industrial, residential, and commercial customers provided input to develop the IRP.

## Public Involvement

City Light gathered input from various interested parties to help understand and appreciate their perspectives and preferences related to electricity generation options. This information is essential. The IRP guides future choices about the investment of hundreds of millions of dollars of customer funds, affecting future operating costs, reliability, and the utility's environmental footprint for decades to come.

The IRP stakeholders committee represented customer, power supply, energy efficiency, environmental, governmental, and university interests. The stakeholders advised the planning effort and provided comments, suggestions, and questions throughout the process.

In the first phase of developing the IRP, the utility identified initial assumptions, including peak demand, forecasts of future energy prices, availability of spot market purchases, potential resources, resource costs, performance measures, and a wide range of potential resource portfolios that could meet projected demand. The stakeholder committee provided input and City Light adjusted some assumptions. City Light then simulated the operations of the alternative resource portfolios using a computer model of the electric system in the West and evaluated the performance of each portfolio based on reliability, cost, risk, and environmental impact.

In the second phase of the IRP process, City Light used more detailed portfolio performance results to identify the top three candidate portfolios. After this analysis, public meetings, and consulting with the IRP stakeholders and the City Council; City Light identified a preferred resource portfolio.



Conservation programs such as “Twist and Save” provide discounts on compact fluorescent lights (CFLs), helping customers save energy and money.

## 2012 Plan Highlights

### No new firm resources are needed for the remainder of this decade.

The utility can potentially meet its energy needs to 2020 with a combination of new conservation, seasonal market purchases, and power contract flexibility. The utility may acquire small amounts of generation resources if market conditions make it cost-effective.

### Conservation is the resource of choice and a top priority.

Conservation is lower cost, flexible, advantageous for economic development, and has minimal environmental impacts. Conservation is a “no regrets” long-term resource strategy. A surplus resource position, and concerns about long-term pricing and the environmental impacts of generating power from shale gas, led to a plan that continues to emphasize accelerated conservation.

### REC acquisition is an increasingly cost-effective compliance strategy.

A combination of the California Public Utilities Commission REC “import cap” and transmission constraints shrank the future REC market for wind generators, leading to a decrease in Pacific Northwest REC costs.

### Lower fuel and REC costs have made natural gas generation perform better in City Light’s IRP analysis.

Forecasts of lower costs for natural gas, lower costs for emitting carbon dioxide (CO<sub>2</sub>), and lower cost RECs make natural gas generation more competitive in the 2012 IRP analysis than it was in the 2010 IRP.



Shorepower (also known as cold ironing) saves fuel, reduces noise, and eliminates emission of carbon dioxide, particulates, and toxic fumes while ships are in port.

# CURRENT PORTFOLIO



Hydroelectric projects produce about 90 percent of Seattle City Light's electricity. (Pictured: J.D. Ross Dam)

**To begin the development of the IRP, Seattle City Light looked at its current portfolio. This section describes the existing resources in the utility's power supply.**

Seattle City Light relies on a mix of resources to fulfill its customers' energy needs. The current resource portfolio includes City Light-owned generation resources; long-term contract resources supplemented with power exchange agreements, near-term purchases, and sales made in the wholesale power market; and conservation.

**FIGURE 2: OWNED AND CONTRACTED RESOURCES**

	Nameplate Capacity (MW)	Energy Available Under Firm Water Conditions (MWh)	Energy Available Under Average Water Conditions (MWh)	Year FERC License Expires	Year Contract Expires
<b>Department-Owned Resources</b>					
<b>Boundary</b>	1,022	2,610,772	3,465,497	2012	N/A
<b>Gorge</b>	173	698,908	888,193	2025	N/A
<b>Diablo</b>	169	583,618	759,341	2025	N/A
<b>Ross</b>	460	556,352	781,084	2025	N/A
<b>Small Hydro</b>	48	150,962	154,809	Varies	N/A
<b>Department's Share of Purchase Resources</b>					
<b>Bonneville Block</b>	268	2,357,520	2,357,520	N/A	2028
<b>Bonneville Slice</b>	263	2,313,170	2,856,010	N/A	2028
<b>Priest Rapids</b>	14	16,540	23,735	2052	2052
<b>GCPHA</b>	64	233,598	240,039	2030/2032	2022/2027
<b>High Ross</b>	72	310,225	310,271	N/A	2066
<b>Lucky Peak</b>	113	236,817	240,372	2030	2038
<b>Stateline Wind</b>	175	N/A	371,162	N/A	2021
<b>Other Renewables</b>	14	N/A	155,772	N/A	Various

FIGURE 3: ENERGY RESOURCES MAP



**GENERATION RESOURCES**

**City Light Resources**

- Located on the Pend Oreille River in northeastern Washington, Boundary Dam is City Light’s largest resource. While the Boundary Project produces the most power and has substantial operational flexibility, it has only modest storage capacity.
- The Skagit Project includes the Ross, Diablo, and Gorge dams in the North Cascades. The Skagit Project has generous storage capacity.
- Additional power is provided by small hydro projects including Newhalem, located on a tributary of the Skagit River, the south fork of the Tolt, and the Cedar Falls Dam.

**Contracted Resources**

- City Light’s largest power purchase comes from the Bonneville Power Administration (BPA), which markets power from the hydroelectric projects on the Columbia and Snake rivers. City Light receives power from the Columbia and Snake Rivers, as well as several thermal and renewable projects in the Pacific Northwest. As one

of BPA’s “preference customers,” City Light is entitled to a substantial amount of low-cost power from this source.

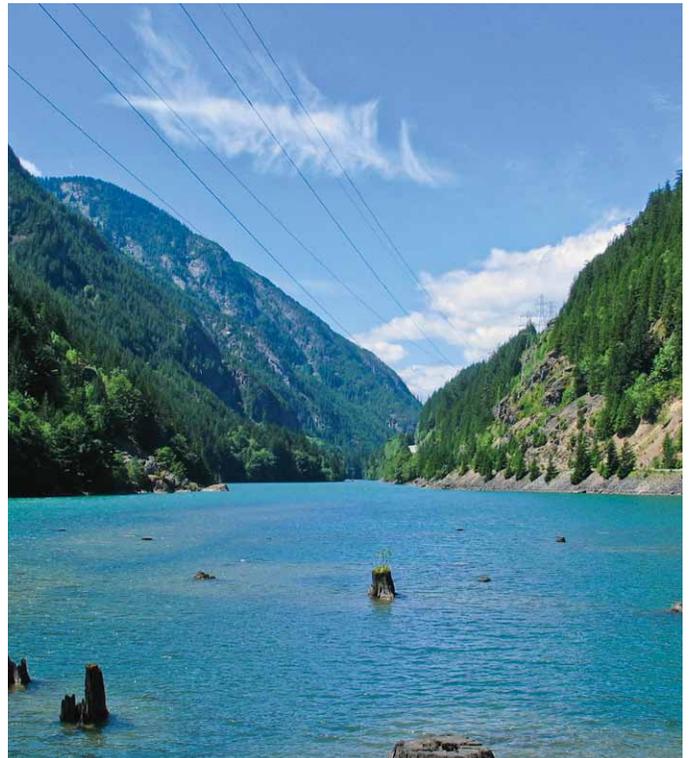
- Under an 80-year agreement with the Canadian province of British Columbia, City Light abandoned plans to raise the height of Ross Dam in exchange for power purchases from British Columbia Hydro.
- City Light has contracts with Lucky Peak, a hydro project located near Boise, Idaho, for 30 more years.
- City Light purchases power from the Priest Rapids (hydro) Project under a 2002 agreement with Grant County Public Utility District.
- The Grand Coulee Project Hydroelectric Authority (GCPHA) includes power from five Columbia River Basin hydroelectric projects. The projects are part of three irrigation districts, so electric generation is mainly in the summer months.
- Under an exchange agreement with the Northern California Power Agency (NCPA), City Light delivers energy to NCPA in the summer. In exchange, NCPA delivers energy to City Light in the winter.

- The Stateline Wind Project, on the Washington and Oregon border outside Walla Walla, Washington, provides wind-generated electrical energy and associated environmental attributes. This non-hydro project meets I-937 requirements.
- City Light receives small amounts of biomass and landfill gas through the Burlington Biomass, Columbia Ridge Landfill Gas Project, and King County West Point Wastewater Treatment Plant. These small projects qualify under I-937 as new renewable energy.
- Seattle City Light also purchases power in the wholesale market to supplement owned and contracted resources.

**Hydropower Variability and Seasonal Mismatch**

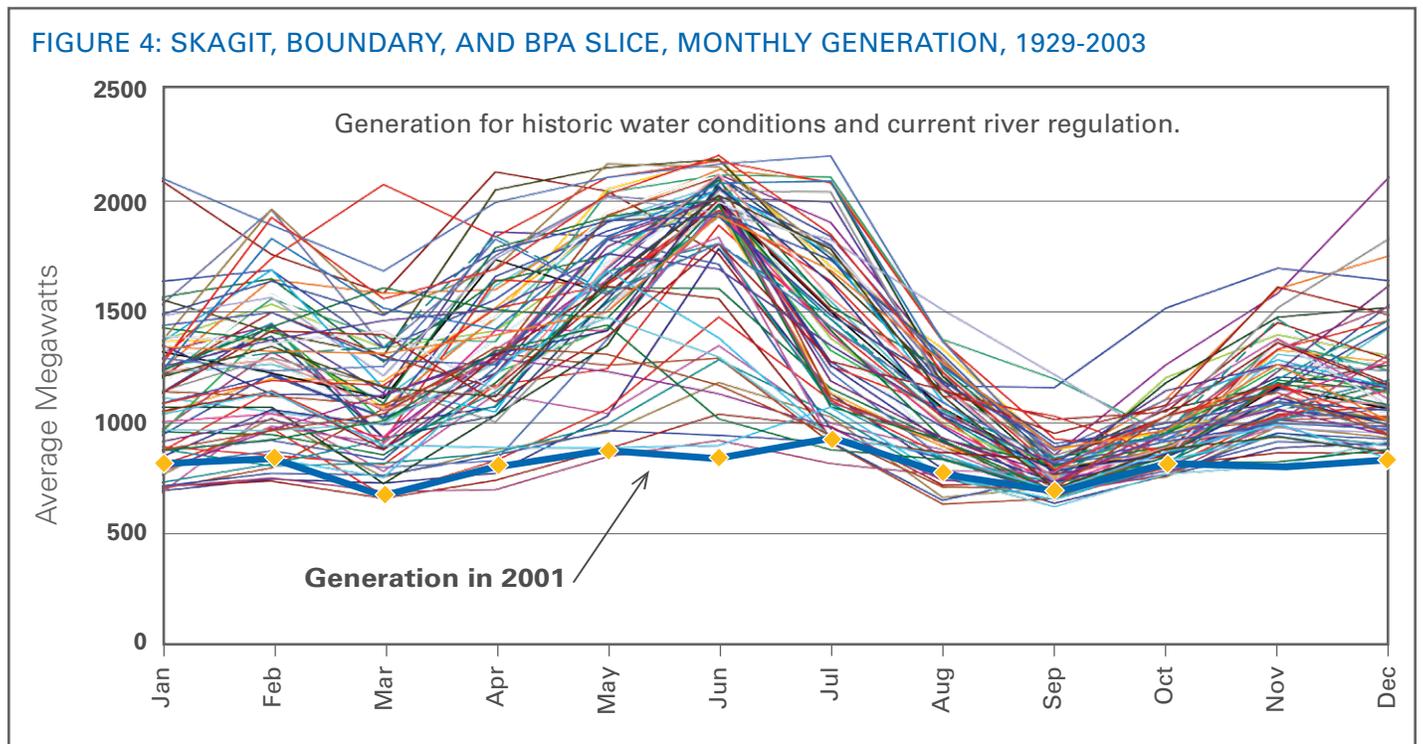
About 90 percent of City Light’s power is generated by hydroelectric plants, both owned and under contract. Hydropower is an excellent, but highly variable, power source. Dry months or years can reduce water flows and cause the need to buy power, raising costs. At the same time, wet seasons or years may result in surplus water flow.

City Light must also contend with a mismatch between the demand for hydropower and hydro’s production peak. Spring snow melt drives hydropower production to peak in May. Yet Seattle’s electricity demand peaks in the winter. Keeping sufficient power generation to meet winter demand can mean excess generation the rest of the year. In addition to this seasonal variation, precipitation may vary



The Skagit dams (Gorge, Diablo, and Ross) supply 20.5 percent of City Light’s energy. Hydro is an excellent resource, but can vary substantially from year to year.

significantly from year to year, worsening the imbalance. To address these complexities, City Light uses statistical measures of generation volatility in combination with the



## CONSERVATION

Conservation was introduced into City Light's resource mix more than 30 years ago and has remained the utility's first-choice resource to meet load growth. Conservation programs encourage customers to use power more efficiently and allow the utility to defer the acquisition of expensive new resources, including those that negatively affect the environment. Conservation is low cost and has low environmental impacts, including no greenhouse-gas emissions. Integral to developing the IRP, conservation programs will help City Light maintain its status as a greenhouse-gas neutral utility, support the City's climate change policy goals, and meet the requirements of I-937.

Conservation programs are designed for all customer classes and address specific energy end-uses such as lighting, water heaters, laundry appliances, HVAC, motors, and manufacturing equipment. These programs provide conservation information and financial incentives that encourage customers, for example, to insulate their homes, install energy efficient appliances, or install efficient lights in commercial and industrial establishments.

## MARKET RESOURCES

City Light relies on the wholesale electric power market in western North America to help balance energy surpluses and shortages, and to meet Seattle's power needs. Surplus power is sold and power shortages can be met with short-term seasonal and multi-year purchases. In a year with average temperatures and water supply, City Light often has substantial surplus power, even during peak-demand, winter months.

Wholesale electric power market transactions lower the rates charged to the utility's retail customers by generating revenues from sales of surplus energy, and allowing the purchase of lower-cost power.

## WESTERN STATES TRANSMISSION SYSTEM

The western electric transmission system physically defines the wholesale market for electricity in western North America. Eleven western states, two Canadian provinces, and northern Baja California, Mexico comprise this market.

Constructed primarily in the 1950s and 1960s, a combination of private and public utilities own the high-voltage transmission system. In the Pacific Northwest, BPA operates about 75 percent of the transmission system. Other large owners/operators include PacifiCorp, Puget Sound Energy, Avista, Idaho Power, British Columbia Transmission Company, and Portland General Electric. The system is near capacity in many parts of the West, including the Pacific Northwest.

## Conservation Potential Assessment

### *City Light conducted a conservation potential assessment in 2011 as part of the IRP process.*

The assessment forecasted demand by sector, segment, and end use, and considered more than 7,000 energy-efficiency measures. The study found there is still achievable potential exceeding 200 MW by 2031. The highest forecast load growth and greatest opportunity for savings are in the commercial sector (143 aMW of conservation potential by 2031).

The potential energy savings in the commercial sector is more than double the total for residential and industrial users combined. Within the commercial sector, lighting offers significant opportunity. For additional information, see Appendix 13: conservation potential assessment.

Market transactions are facilitated by City Light's ownership share of transmission capacity rights on the Third AC Intertie (an alternating current line that connects the Northwest with California and the Southwest). This ownership share was acquired in 1994, when City Light signed an agreement with BPA for rights to 3.33 percent of transmission capability over BPA's share of the Third AC Intertie.



City Light's Powerful Neighborhoods program fosters energy conservation through door-to-door outreach to seniors, non-English speaking households, low-income residents, and others.

# LOAD FORECAST

**The next step in the IRP is determining future customer demand (load forecast).**

Seattle City Light must meet customer demand for electricity under all conditions, even the coldest days and driest years, times when the system is highly stressed. Customers include residents and commercial and industrial organizations. Changes in any one of these customer segments can have significant impacts on the overall growth in electricity demand. To ensure that it can meet future demand, Seattle City Light determines how much electricity all of its customers will need each year.

Economic activity and the demand for electricity are closely correlated. This is well illustrated in recent load trends (see Figure 5). City Light’s load has declined from a pre-recession high of 1,160 annual aMW in September 2008 to 1,125 annual aMW at the end of 2010, a level first seen in early 1999. The load growth from 2010 and 2011 was 0.8 percent, indicating that the load is recovering from the recession.

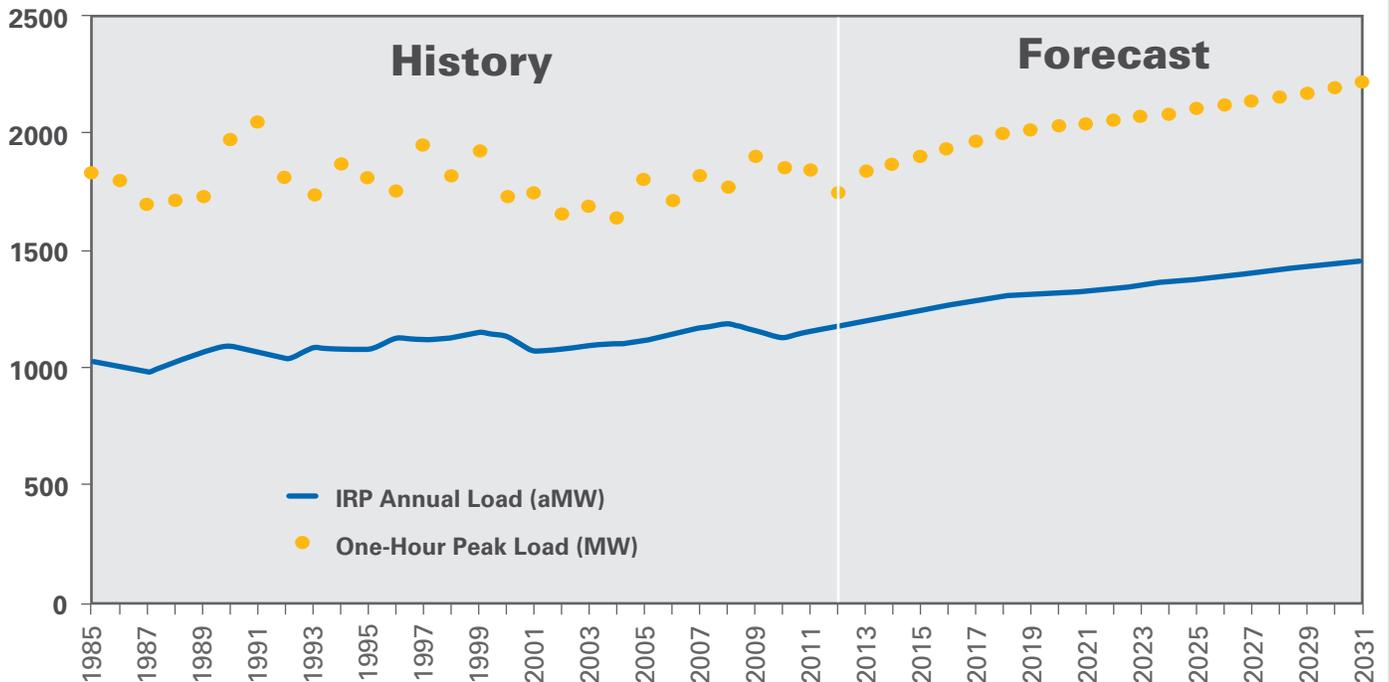
Looking forward, load forecasts use a combination of economic and demographic variables to predict future demand. City Light forecasts predict that system load will



Seattle City Light’s mission is to exceed customers’ expectations in producing and delivering environmentally responsible, safe, low-cost, and reliable power.

return to pre-recession levels by the end of 2013, and will grow at an average annual rate of 1.4 percent over the 20-year planning period, assuming no new programmatic conservation.

**FIGURE 5: LOAD HISTORY AND 2012 IRP FORECAST (WITH NO NEW PROGRAMMATIC CONSERVATION)**



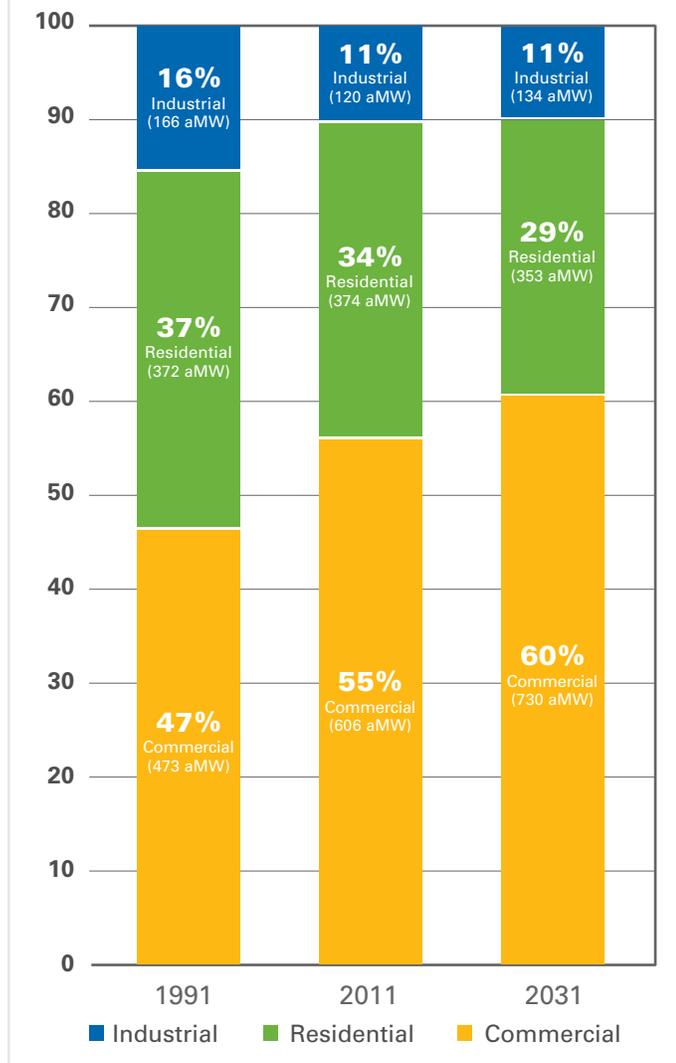
The IRP treats conservation like any other energy resource when evaluating prospective strategies. As a result, the load forecast used in the IRP represents expected demand without new City Light conservation activities.

Programmatic conservation will be acquired in the early years of the planning period, with the cumulative amount of new conservation reaching 125 aMW by 2020 and 237 aMW by 2031. This level of programmatic conservation reduces the overall growth rate to 0.8 percent.

In addition to analyzing overall growth, the load forecast considers the load mix. Because Seattle is a regional hub for commerce and finance, commercial load is expected to grow at a faster rate than residential or industrial load, becoming a larger portion of the total mix (see Figure 6).

Additional information on load and the load forecast is presented in Appendix 4: load forecast for IRP.

**FIGURE 6: CHANGE IN LOAD MIX AT 20-YEAR INTERVALS**



## Plug-In Hybrid and Electric Vehicles

**Demand for hybrid and electric transportation is growing. Electric vehicles such as the Nissan Leaf and the Chevrolet Volt are now commercially available, and other automakers are adding options to this evolving market.**

*The IRP looks at the implications of these trends and the potential impact on system load.*

The main obstacles to establishing a strong electric vehicle system are the cost, and the charging infrastructure. A subsidized electric vehicle costs about \$27,000. The batteries and home-charging station add additional expenses (e.g., \$2,000 for a home-charging station). The second obstacle — lack of charging infrastructure — contributes to what has been dubbed “range anxiety,” the fear of being stranded.

Subsidies and tax credits are being used to make electric vehicles more cost competitive in the short term, until mass production brings prices down. For those who qualify, the federal government offers a \$7,500 tax credit to the first owner of an electric car. The State of Washington offers additional incentives such as exemptions from sales and use taxes and emissions inspections. The West Coast Green Highway program is aimed at decreasing “range anxiety.” Through this program, the Washington State Department of Transportation is providing an electric-vehicle charging station every 25 to 60 miles along Interstate 5.

The Great Recession has reduced sales for all types of vehicles, including plug-in hybrid and electric vehicles. This gradual sales growth, combined with lower-than-predicted electric-vehicle energy consumption, positions Seattle City Light to be able to serve charging demand for years to come. The potential for increasing the level of vehicle-charging load is examined in Appendix 3: impact of electric vehicles on system load.



Seattle City Light Electricity Services Representative Dan Langdon shares helpful information about electric vehicles.

# RESOURCE ADEQUACY

***An electric utility’s ability to meet its customers’ energy requirements is called resource adequacy.***

City Light customers depend on reliable power. But volatility in hydro conditions, variability in customer demand, and forced outages threaten reliability. The IRP addresses reliability risks by analyzing “resource adequacy,” which means having sufficient generation capability to overcome these challenges and meet customers’ energy demand in all hours.

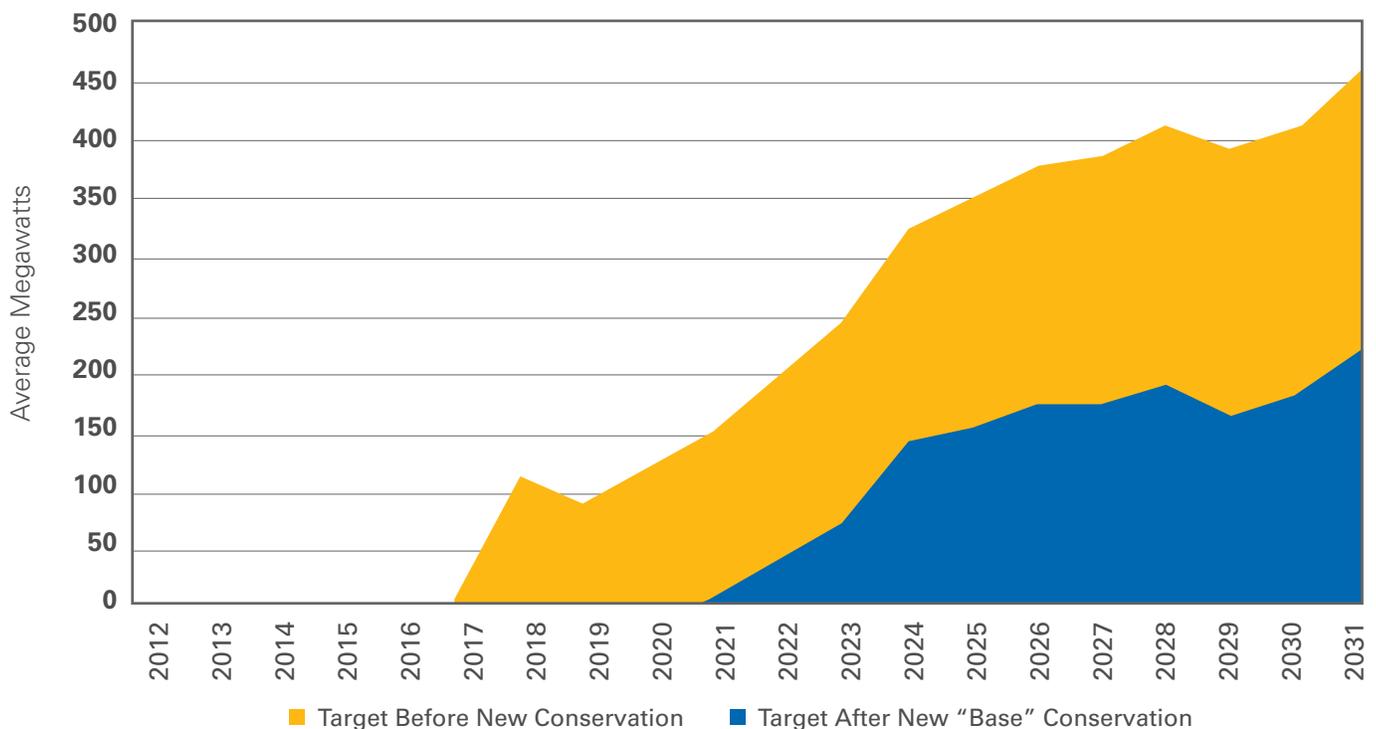
Because City Light relies on hydropower to meet most of its customers’ needs, water conditions, stored water in reservoirs, and forced outages are very important for resource planning. For two or three days, a hydro-generation plant with stored water is less dependent upon water conditions. However, as stored water is depleted due to prolonged operations at maximum output, a hydro plant becomes increasingly dependent upon water conditions.

To address resource adequacy, City Light conducts a detailed analysis of demand variability, hydro volatility, unplanned generation outages, planned generation outages, contract expirations, and operating reserves. In these analyses, City Light aims to have sufficient resources to meet customer demand with a 90 percent probability. City Light has established a resource adequacy target as a 90 percent probability of meeting customers’ highest hourly peak demand in the month of December (the month with the highest historical peak).

The resources needed each year to maintain this level of reliability become planned, new winter-resource additions, or planned energy conservation, in each of the prospective resource portfolios evaluated.

Figure 7 depicts the new conservation and generating resource targets used in the 2012 IRP, before and after new conservation. For more information, see Appendix 6: resource adequacy.

**FIGURE 7: IMPACT OF NEW CONSERVATION ON THE RESOURCE ADEQUACY TARGET (BEFORE AND AFTER NEW CONSERVATION TARGETS)**



## RESOURCE OPTIONS

New resources will be needed to meet load growth and to comply with I-937 over the next 20 years. The timing of resource acquisition depends on the rate of load growth, hydro volatility, together with the I-937 schedule for acquiring renewable resources and/or renewable energy credits.

The technologies considered for the 2012 IRP were limited to those that are commercially available, have low environmental impact, and have the lowest reasonable cost. The three main categories of resources are conservation, generation, and the wholesale power market. Generation resources can be further categorized as renewable and non-renewable.

### Conservation

Energy conservation is Seattle City Light's first choice as a resource to meet growing demand for power. City Light conservation programs encourage the use of energy-efficient equipment and energy-saving practices in homes and buildings. Conservation benefits the utility and customers by avoiding higher-cost generation, deferring transmission and distribution investments, reducing air pollution and greenhouse-gas emissions, and lowering customer bills. Conservation is also good policy because it avoids price risk and power delivery risk.

All candidate portfolios comply with I-937, featuring accelerated conservation programs to gain the greatest benefit.

### Generation Efficiencies

Efficiency improvements to existing generation resources can be cost-effective, with significantly less impact on the environment than new projects. For example, a proposed

second tunnel at Gorge Dam at the Skagit Project would increase its hydropower-production efficiency. However, with lower power prices in the western power market, the second tunnel project has been put on hold until conditions change and the project is more economically viable.

### Renewable Resources

Renewable resources offer an alternative to fossil fuel use and related air and water pollution. Wind, landfill gas, and biomass are available in the near term. Geothermal power is expected to become more widely available in the future.

The costs of new, renewable projects can be significant. In addition to their production costs, new, renewable resource projects can impose significantly more transmission costs if they are not located near transmission lines. Even when located near existing transmission, wind does not use transmission efficiently because of its high degree of variability, pushing up the cost to deliver wind energy. Most existing transmission paths are at or near their rated limits, further constraining the delivery of new renewable resources.

### Non-Renewable Resources

Policies and market forces shape Seattle City Light's resource environment. Several years ago, federal cap-and-trade policies seemed likely – the government would set a limit on the total amount of greenhouse gas that can be emitted nationally, and companies would buy or sell permits to emit these gases, primarily CO<sub>2</sub>. Prospects for federal cap-and-trade legislation for CO<sub>2</sub> have lessened over the last two years. However, the U.S. Environmental Protection Agency finalized mercury- and air-toxics standards in 2011, which are expected to speed the retirement of many older coal plants that have limited or no pollution control equipment.

## Maintaining Infrastructure and Reliability

### *The aging of Seattle City Light's hydroelectric plants and electric transmission assets means large repair and maintenance projects are necessary.*

City Light manages generating-unit outages for major repairs to maintain a high degree of reliability. Over the next decade, the utility will rebuild or replace turbines at Boundary, Diablo, and Gorge hydroelectric plants, sometimes taking as much as 200 MW out of service to work on a single unit. Large repair and maintenance projects take generation out of service, impacting resource adequacy.



Workers recently repaired a 312-ton sluice maintenance gate at the Boundary Dam. Replacing and upgrading aging equipment helps the utility continue to provide more predictable and reliable service.

At the same time, the dramatic growth in shale-gas extraction in the United States has driven down natural gas prices. This growth has been driven by technology improvements in extracting natural gas from shale.

Traditionally, western Canada has been a major natural gas producing area and has exported significant resources to the Midwest and the Pacific Northwest. Now U.S. shale gas is taking market share from Canadian imports. With U.S. shale gas displacing traditional markets for Canadian natural gas, experts predict continued low natural gas prices in the Pacific Northwest (see Figure 8).

This combination of federal policies and market forces means that cleaner burning natural gas will increasingly supplant coal-fired generation and capture a growing share of the western power market. City Light explored the possibility of natural gas combined-cycle turbines in two of the eight resource portfolios studied in this year's IRP.

**Wholesale Power Market**

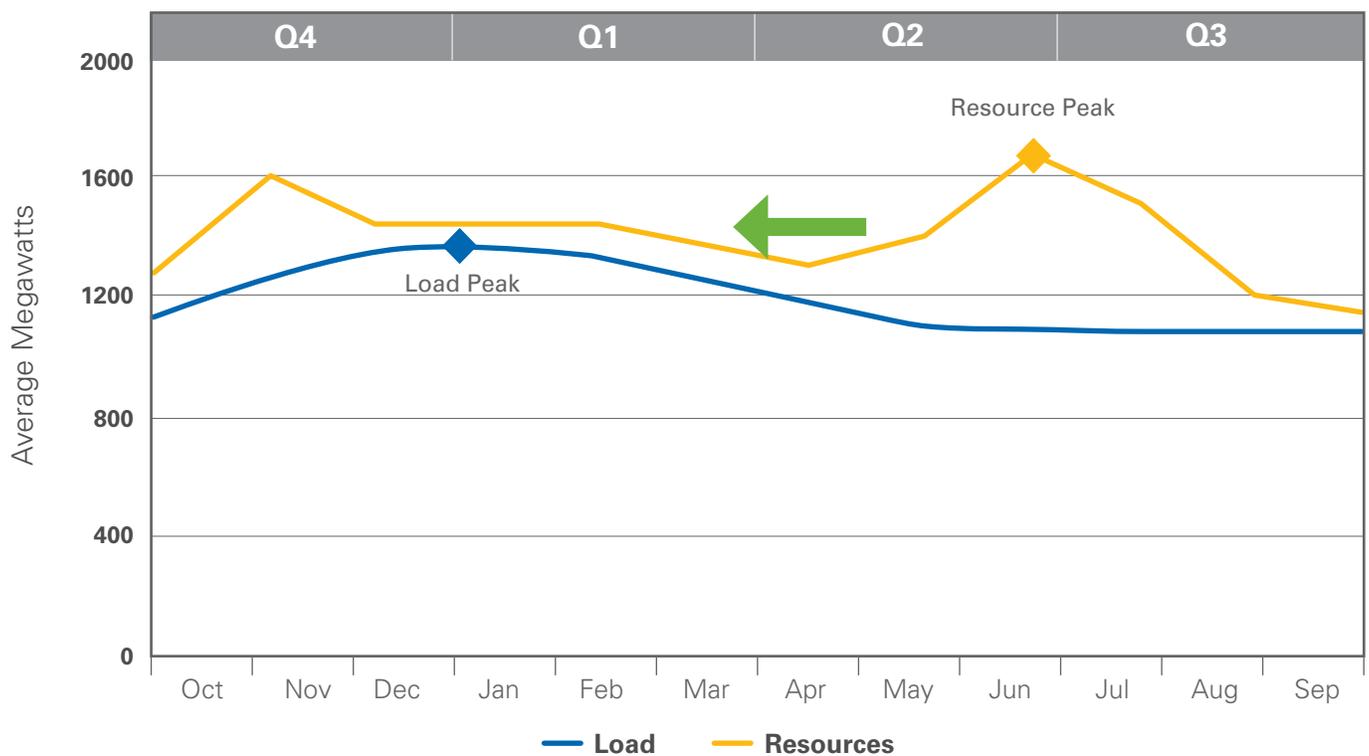
Seattle City Light expects to have sufficient resources to fulfill customers' needs until 2020. However, short-term or seasonal shortages caused by low precipitation and below-normal stream flow can occur. Wholesale market purchases, including seasonal exchanges, are a cost-effective way to serve load during these times. Figure

**FIGURE 8: NORTH AMERICAN SHALE GAS PLAYS, 2011**



9 illustrates the mismatch between load and resources. Exchanges and purchases can help reshape the utility's annual surplus to better meet the firm requirements of its customers without the expense of acquiring higher-cost generation resources.

**FIGURE 9: EXPECTED LOAD AND RESOURCES MISMATCH, OCTOBER TO SEPTEMBER 2011-2012**



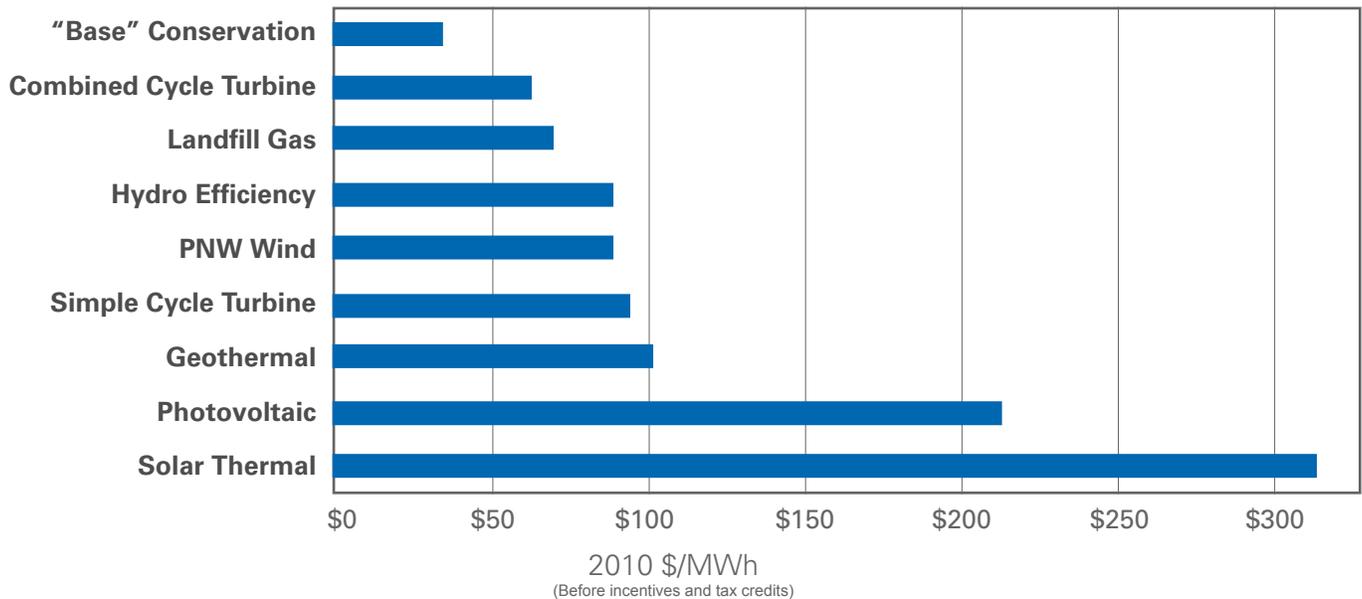


In partnership with Seattle City Light, the Woodland Park Zoo installed solar panels on the roof of the historic carousel pavilion to offset the electricity required to power the ride.

### OTHER RESOURCE TYPES

City Light monitors developments in other resource technologies for their cost and commercial availability, taking into account policy direction from local, state, and federal government. These resources, and their estimated contract costs per megawatt-hour (MWh), are listed in Figure 10. Another unit of measure for power costs is cents per kilowatt-hour (kWh), where for example, utility-scale solar’s \$190/MWh equals 19 cents per kWh. All costs for new renewable resources are considerably higher than City Light’s existing hydro resources, which average less than 3.5 cents per kWh.

FIGURE 10: ESTIMATED COSTS OF NEW RESOURCES



# PLANNING & REGULATORY REQUIREMENTS

***A critical element of the IRP is considering the planning and regulatory context.***

Seattle City Light operates within a complex wholesale power market. Federal, state, and local regulations, including policies enacted in other states, shape the planning and regulatory environment.

## **ENERGY INDEPENDENCE ACT (INITIATIVE 937)**

Approved by voters in 2006, the Energy Independence Act (I-937) requires major utilities in Washington state to increase the amount of new, renewable resources (including wind, solar, geothermal energy, landfill and sewage gas, wave and tidal power, and certain biomass and biodiesel fuel) in their electricity supply to three percent in 2012, nine percent in 2016, and 15 percent in 2020. Electricity produced from an eligible renewable resource must be generated in a facility that started operating after March 31, 1999, and the facility must either be located in the Pacific Northwest or the electricity from the facility must be delivered into the state on a real-time basis. Hydropower is not considered a renewable power source as defined by I-937. However, incremental electricity produced from efficiency improvements at hydropower facilities owned by qualifying utilities is eligible if the improvements were completed after March 31, 1999.

## **Renewable Energy Credits (RECs)**

Utilities may comply with I-937 by purchasing Renewable Energy Credits (RECs). RECs are tradable, non-tangible energy commodities that represent proof that one megawatt-hour (MWh) of electricity was generated from naturally replenishing (renewable) resources such as modern biomass, wind, solar, geothermal, and biofuels. Washington state law specifically excludes hydropower from creating RECs, but hydro efficiencies can create RECs.

## **Policies Affecting RECs**

City Light's planning environment is also shaped by other states' energy policies. California bill SBX1-2 increases California's renewable portfolio standard requirements to 33 percent by 2020. It also limits the use of tradable renewable energy credits (TRECs) to 25 percent of California utilities' renewable portfolio standard



City Light is a recognized leader in energy efficiency, environmental stewardship, and conservation.



Seattleites cherish the natural environment, and their electric utility shares this core value.

## **What's a REC?**

***Renewable Energy Credits or RECs are tradable, non-tangible energy commodities*** that represent proof that one MWh of electricity was generated from naturally replenishing (renewable) resources. Under Washington state law, RECs may include biomass, wind, solar, geothermal, and biofuels. Hydropower is specifically excluded from creating RECs, but hydro efficiencies can create RECs.

requirements. In 2017 the cap tightens to 10 percent. In addition, a 2012 decision by the California Public Utilities Commission (CPUC) capped the amount of RECs that can be purchased from outside California.

Wind resources in the Pacific Northwest had been targeting the sale of renewable energy and/or RECs to the very large California market. But with transmission constraints and a cap on the use of TRECs in California, Pacific Northwest wind projects faced greatly reduced market opportunities. At the same time, many wind project owners needed to secure long-term revenues to support repayment of debt financing on their projects, so many owners sold RECs at low prices resulting in a significant price drop in an increasingly competitive REC market.

The REC market is important in the 2012 IRP because new natural gas generation does not comply with I-937 unless qualifying RECs are purchased along with it. Prospective resource portfolios containing natural gas-fired generation are very cost competitive in the 2012 IRP because of the fall in the price of RECs and the large decline in the price of natural gas.



I-937 requires the state's large electric utilities to obtain 15 percent of their power from renewable energy resources by 2020.

The 2012 IRP action plan includes the acquisition of RECs to meet I-937 requirements. All of the resource portfolios in the 2012 IRP contain sufficient renewable resources and/or RECs to meet future I-937 requirements.



Columbia Ridge Landfill Gas project and Stateline Wind Project (pictured) are two existing renewable generating resources.

# PORTFOLIOS

*In developing the 2012 IRP, City Light designed eight portfolios that meet both the resource adequacy (reliability) and I-937 (regulatory) requirements for renewable resources and conservation. These criteria differ in amounts and timing throughout the 20-year planning horizon.*

Each prospective portfolio is structured to test several strategies (see Figure 11). These include varying the amounts and the pace of acquiring conservation resources (1-4); a wind-rich portfolio with natural gas generation (5); a highly diverse resource mix (6); a portfolio that excludes waste wood biomass (7); and an all-natural gas and conservation portfolio (8). A more complete description of the candidate portfolios is included in Appendix 9: analysis of candidate resource portfolios.

The eight resource portfolios studied in the 2012 IRP have little or no new generation before 2020. By 2025, substantial amounts of new generation are being acquired in all the portfolios to accommodate variability in hydro conditions, replace expiring contracts, and to keep pace with load growth.

In contrast to new generation resources, conservation efforts are substantial throughout the first decade in all the portfolios, with 125 MWh or more being acquired in six of eight portfolios by 2020. These portfolios typically have 10 times more new conservation resources being acquired through 2020 as new generating resources. This represents a sustained effort to acquire lower-cost, lower-risk conservation resources, before more expensive new generation resources.

**FIGURE 11: PORTFOLIO SUMMARY**  
(Cumulative Average MW)

	2016	2021	2026
<b>1. Renewables: Base Conservation</b>			
Conservation	69	139	205
Renewable Generation	0	8	178
Natural Gas Generation	0	0	0
<b>2. Renewables: Lower Conservation</b>			
Conservation	59	117	171
Renewable Generation	0	28	203
Natural Gas Generation	0	0	0
<b>3. Renewables: Higher Conservation</b>			
Conservation	77	157	207
Renewable Generation	0	0	168
Natural Gas Generation	0	0	0
<b>4. Renewables: Constant Rate Conservation</b>			
Conservation	62	120	179
Renewable Generation	0	33	198
Natural Gas Generation	0	0	0
<b>5. Wind and Gas</b>			
Conservation	69	139	205
Renewable Generation	0	0	128
Natural Gas Generation	0	0	90
<b>6. Mixed Resources</b>			
Conservation	69	139	205
Renewable Generation	0	13	128
Natural Gas Generation	0	0	50
<b>7. Renewables: No Waste Wood Biomass</b>			
Conservation	69	139	205
Renewable Generation	0	8	178
Natural Gas Generation	0	0	0
<b>8. Natural Gas</b>			
Conservation	69	139	205
Renewable Generation	0	0	0
Natural Gas Generation	0	5	175

# PORTFOLIO ANALYSIS

**The IRP evaluated resource portfolios in two rounds. The initial evaluation simulated the operations of all prospective portfolios and identified the best performing portfolios to carry forward to the next round of analysis. The second round evaluated the top five portfolios and culminated in the identification of three final candidate portfolios.**

## INITIAL EVALUATION

A detailed power market model (AURORAmp®) was used to simulate operations of the candidate portfolios. The simulation considered City Light operations within the Pacific Northwest for 20 years and included factors such as generation costs, revenues, air-emissions costs, transmission, market purchases, and market sales. The data collected during the deterministic simulation of each resource portfolio yields the performance measures described below.

### Portfolio Performance Measures

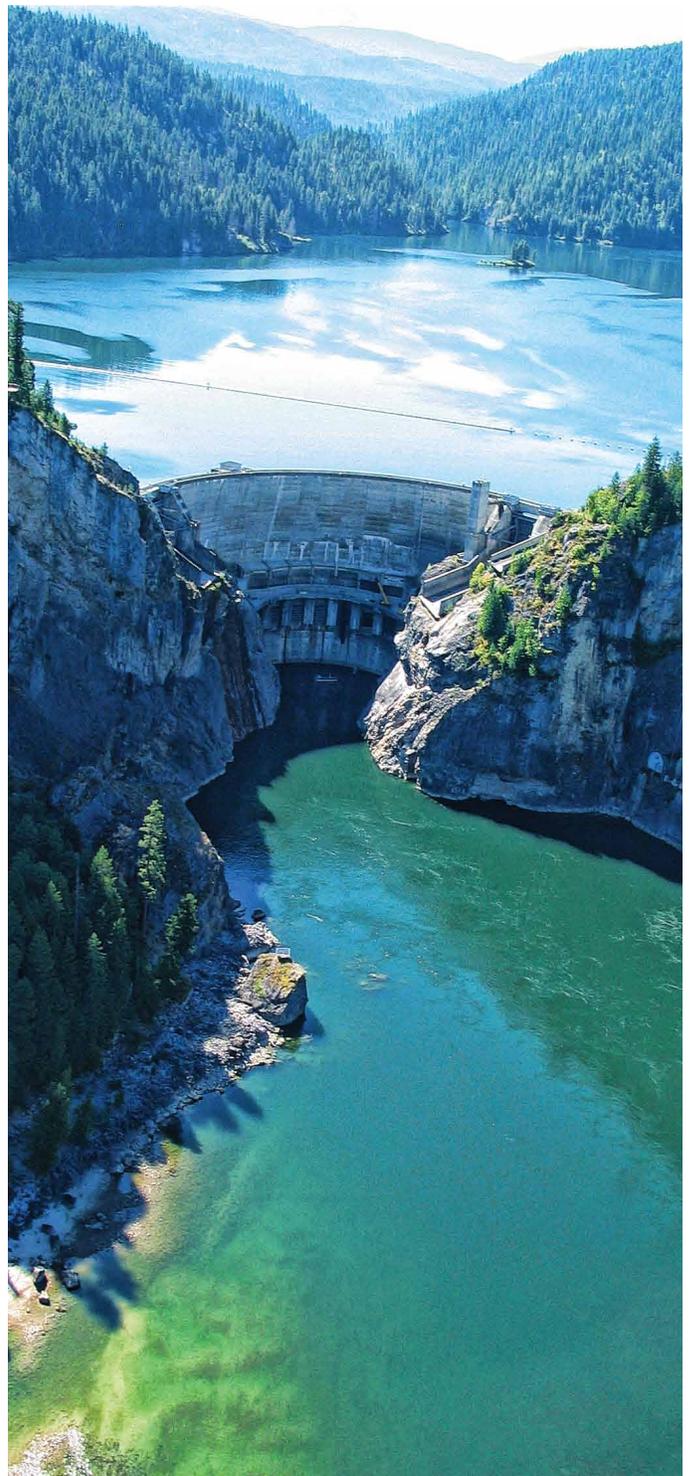
In the analysis, resource portfolios were measured on cost, risk, and environmental performance. The performance measures are defined in Figure 12.

**FIGURE 12: PERFORMANCE MEASURES FOR CANDIDATE RESOURCE PORTFOLIOS**

Measure	Definition
<b>Cost</b>	20-year net present value (NPV) of the resource portfolio costs
<b>Risk</b>	Volatility in resource portfolio costs (deterministic and probabilistic measures)*
<b>Environmental Performance</b>	Air emissions of CO <sub>2</sub> , SO <sub>2</sub> , NO <sub>x</sub> , mercury, and particulate**

\* Portfolio risk is represented by the mean absolute deviation in costs. This indicates cost variation for each portfolio. Later in the process, a stochastic risk analysis is developed for the top three candidate portfolios.

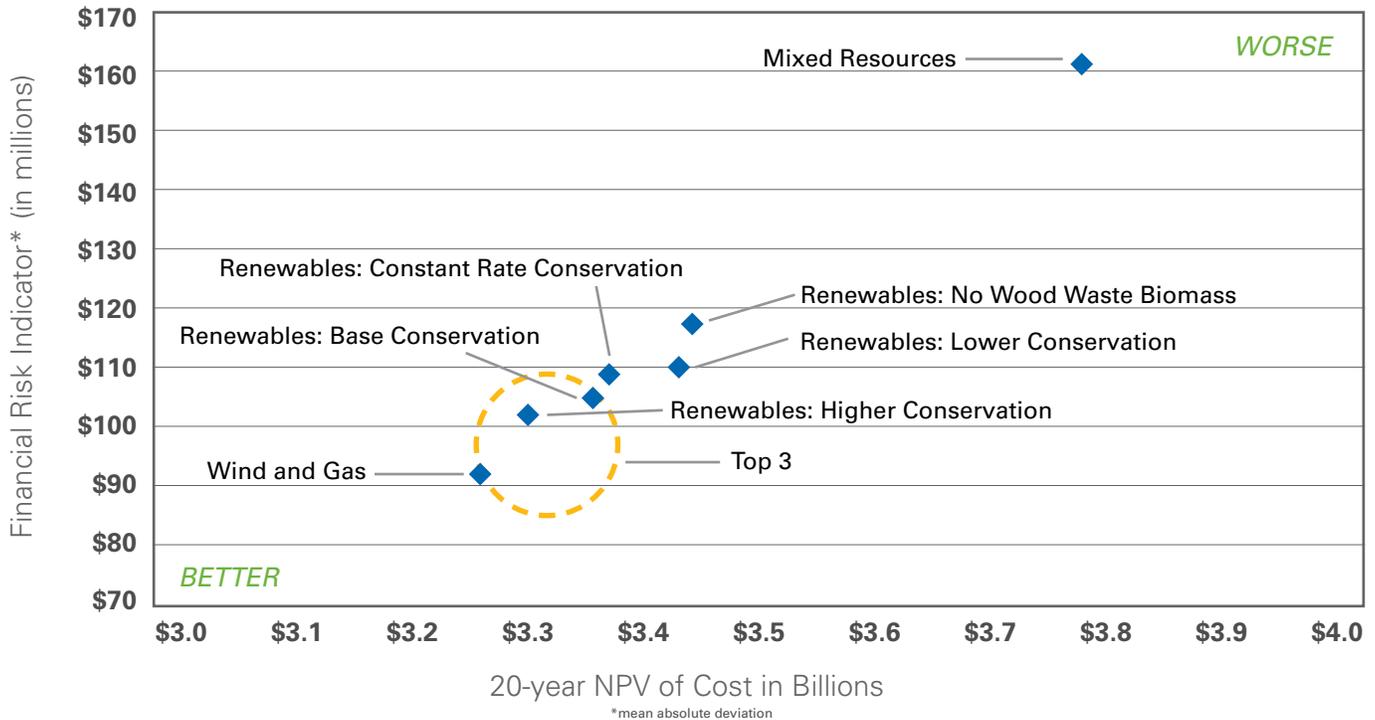
\*\* Other environmental impacts to land, air, water, soil, geology, plants, animals, employment, aesthetics, recreation, and culture are evaluated in the Environmental Impact Statement (EIS).



The Boundary Dam and powerhouse was first licensed in 1961 for a 50-year period, to 2011.

Detailed power market simulations tested portfolios within a complex environment and included factors such as generation costs, revenues, air emissions, transmission, market purchases, and market sales.

FIGURE 13: CANDIDATE RESOURCE PORTFOLIO EVALUATION



**Initial Evaluation Findings**

Figure 13 describes the initial evaluation findings. The resource portfolio containing a highly diverse resource mix performed considerably worse than the other seven portfolios. This mixed resources strategy aimed to create a large diversity of new resources. It added the same amount of resources but was not designed with a linear optimization to minimize costs. It suggests a resource acquisition strategy that on its face seems logical, but is not well planned and results in substantial, unnecessary costs.

Based on low-net present value (NPV) of costs and a low-coefficient of variation, five of the eight candidate portfolios were carried forward for further analysis:

1. Natural gas
2. Wind and gas
3. Renewables: higher conservation
4. Renewables: base conservation
5. Renewables: lower conservation

**PORTFOLIO RISK ANALYSIS**

The second round of analysis focused on evaluating the top five candidate resource portfolios. A stochastic risk analysis tested the portfolios against three important risk factors: changes in hydro conditions, changes in demand, and changes in natural gas prices. Stochastic risk analysis examines the performance of the candidate portfolios under multiple stressful conditions, simultaneously.

The stochastic risk analysis evaluated the potential variability of each of the top five candidate portfolios’ costs. The analysis used Latin hypercube sampling, a statistical technique comparable to Monte Carlo, but designed for greater efficiency. The technique “shocks” each portfolio with risk factors. A discussion of these factors follows.

**Hydro Conditions**

City Light’s strong reliance on hydropower makes hydro variability a significant concern to the utility. Much like the weather it depends upon, hydro conditions are difficult to predict. La Niña conditions in 2011 and 2012 produced above average water supply. But El Niño conditions in 2000 and 2001 marked the lowest annual hydro conditions on historical record.

Hydro conditions on different river systems can be very different within the same year and City Light depends on multiple river systems. City Light receives substantial power from the Bonneville Power Administration, making hydro conditions on the Columbia River system very important. The Pend Oreille River is a tributary to the Columbia River, so City Light’s Boundary plant on the Pend Oreille is correlated to Columbia River hydro conditions. The Skagit River, where City Light’s Ross, Diablo, and Gorge plants are situated, is not a Columbia River tributary and has a weaker correlation to Columbia River hydro conditions. For the risk analysis, the model randomly

samples levels of City Light's total hydroelectric production, maintaining the inter-relationships between the Skagit, Boundary, and Columbia River systems.

### Electricity Demand

City Light is a winter-peaking utility and pays particular attention to electricity demand during the coldest winter months. Seattle enjoys a relatively moderate marine climate, yet its location on the 47th parallel means that winter storms from the arctic or the Midwest can bring cold temperatures for periods typically lasting from several days to more than a week. In addition to winter storms temporarily affecting electricity demand, growth in the Seattle-area economy drives long-term growth in electricity demand.

### Natural Gas Prices

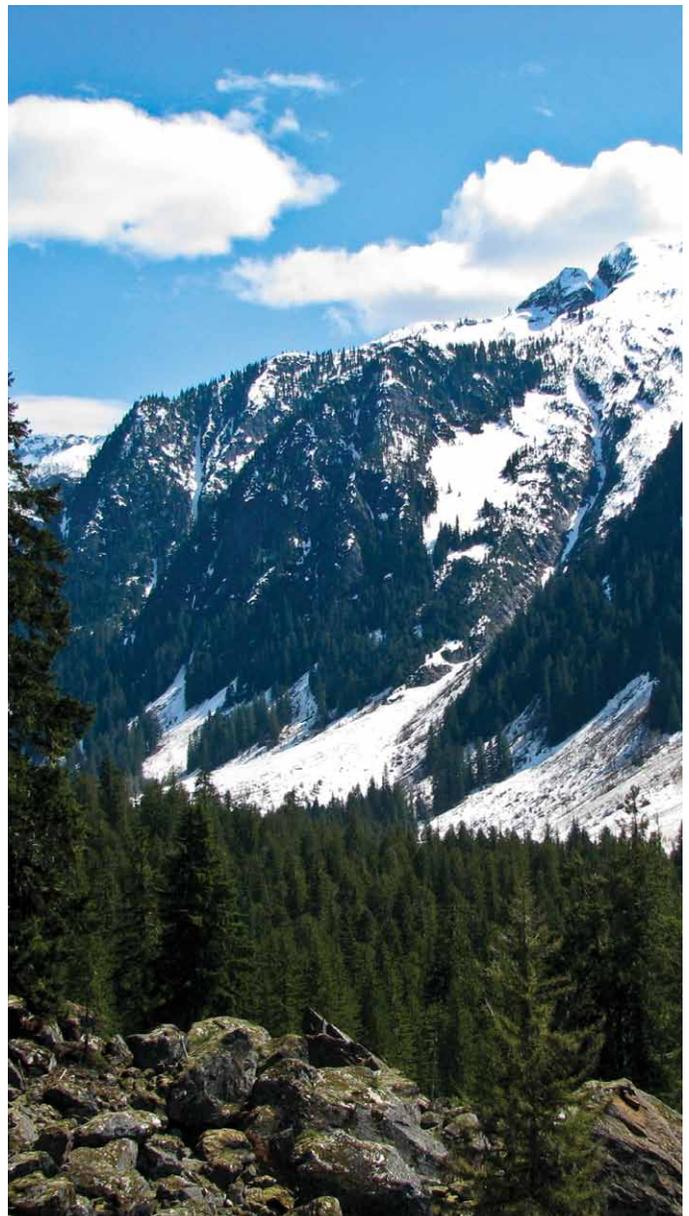
Indirectly, natural gas prices have already had a large impact on City Light finances. With natural gas-fired generation as the price-setter for most hours in western power markets, power market prices and City Light's wholesale revenues tend to move up and down with natural-gas prices. In 2008, natural gas prices reached \$12 per million British Thermal Units (MMBTU), but the recession and improved technology for recovery of shale gas have combined to drive prices down to the \$2 to \$4 per MMBTU range. In the 2012 IRP natural-gas price outlook, natural gas prices do not reach the 2008 highs within the 20-year planning period.

The 2011 long-term forecast used for the 2012 IRP has higher prices than currently being observed. Shale gas production has occurred at a rate faster than demand for natural gas can now absorb. Natural gas storage is full, yet production continues. This natural gas market imbalance is occurring because hydraulic fracturing of shale can produce joint products of natural gas liquids and oil, both of which have a much higher market value than natural gas. Pursuit of natural gas liquids and oil from shale has led to the lowest natural gas prices seen in decades. However, even a modest economic expansion could begin to deplete natural gas storage inventories and push up natural gas prices to the \$4 to \$5 range. This price level is expected to provide sufficient long-term financial returns to natural gas producers to stabilize production independent of natural gas liquids and oil.

### FINAL THREE CANDIDATE PORTFOLIOS

Later in the process, the natural gas portfolio was eliminated from further consideration because of its incompatibility with Seattle City Council resolution 30144, which established a city policy prioritizing the use of conservation and renewable energy to meet load growth. The natural gas portfolio was studied to comply with RCW 19.280, which states that IRPs should evaluate a wide range of resources. The renewables: lower conservation portfolio was also eliminated for performance reasons, leaving the top three candidate resource portfolios:

1. Wind & gas;
2. Renewables: higher conservation; and
3. Renewables: base conservation.



The IRP identifies how much additional seasonal power the utility needs in the winter (when highest demand occurs) through 2031.

# CARBON DIOXIDE EMISSIONS COST SCENARIOS

**Scenario analyses are used to consider possible future conditions. The 2012 IRP includes carbon dioxide emissions cost scenarios.**

There appears to be little likelihood of new federal regulations for CO<sub>2</sub> emissions (cap and trade) in the near future. The base case for the 2012 IRP continues to include a cost for CO<sub>2</sub> emissions. However, the base case cost for CO<sub>2</sub> emissions is both delayed and lowered from those assumed in the 2010 IRP and is represented in Figure 14 as the “CO<sub>2</sub> Medium Price.”

If a cost for emitting CO<sub>2</sub> is imposed by law, wholesale power market prices will reflect the added costs for large amounts of electricity generation in the West, making City Light’s hydro and renewable resource portfolio more cost competitive. However, with little or no costs for CO<sub>2</sub> emissions, City Light faces an increased risk that surplus energy from new, renewable resource acquisitions may not fetch a high enough price in the wholesale power market to prevent financial losses.

This risk is borne out in the CO<sub>2</sub> scenario, which shows that the worst case for the City Light candidate portfolios is the low CO<sub>2</sub> cost scenario. All three of the final candidate portfolios perform the worst under the low CO<sub>2</sub> cost scenario and best under the high CO<sub>2</sub> cost scenario.

## The Challenge of Climate Change

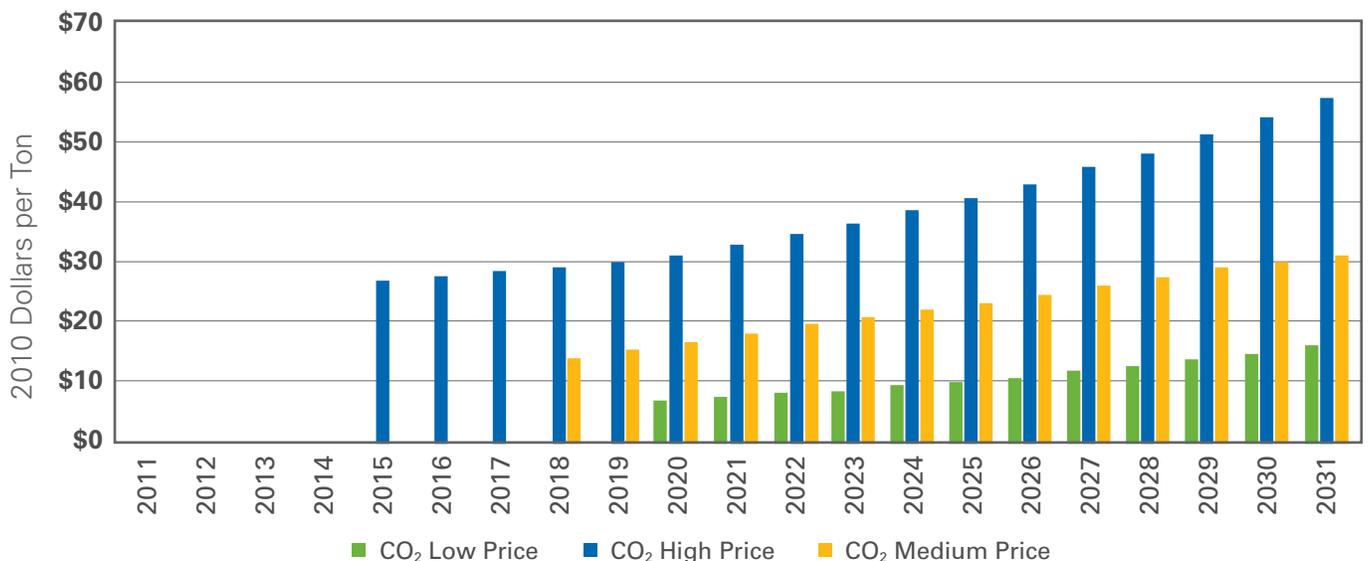
With its large amount of hydropower, climate change will create special long-term challenges for City Light.

- Warmer temperatures will affect seasonal electricity and demand for heating and cooling;
- The winter snowpack will melt earlier, affecting seasonal generating capability;
- Melting glaciers will cause changes in river flows;
- An increase in heavy precipitation will cause spills at dams; and
- Rising sea levels will pose a long-term threat to some underground vaults and other distribution facilities near the coastline.



As glaciers in our watershed recede and thin, their contribution to summer flows decrease.

FIGURE 14: CARBON DIOXIDE EMISSIONS COST SCENARIOS



# THE PREFERRED PORTFOLIO

*The 2012 IRP identifies the top three candidate resource portfolios and narrows them to recommend the best resource portfolio for Seattle City Light: the preferred portfolio.*

## Top Three Candidate Portfolios

1. Wind and gas
2. Renewables: higher conservation
3. Renewables: base conservation (preferred portfolio)

In 2008, the Seattle City Council requested that City Light’s IRP forward three candidate resource portfolios for evaluation instead of one. The purpose was to enable policy issues to be more fully considered within a process that was strongly quantitative in nature. In finalizing the 2012 IRP, the stakeholders and City Light identified serious disadvantages with two of the top three candidate portfolios.

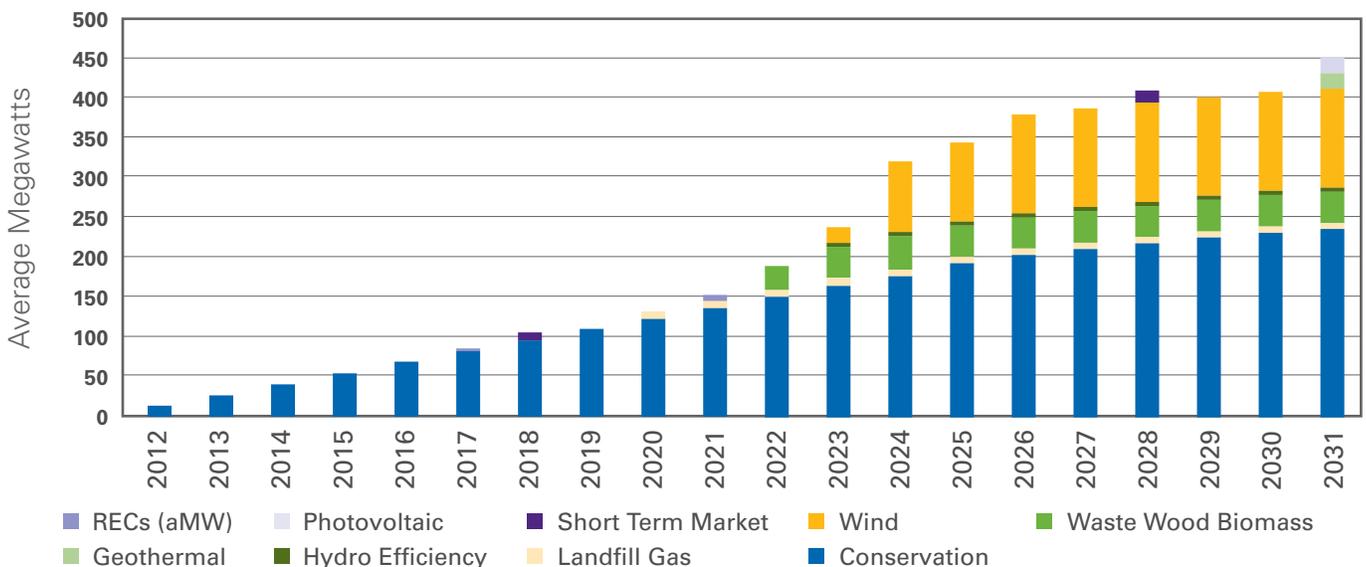
Some IRP stakeholders viewed the wind and gas portfolio as inconsistent with environmental objectives and council resolution 30144. In addition, the dependence on production of shale gas was seen as subject to unquantifiable risks, driven by regulatory issues, supply uncertainty, historical price volatility, environmental impacts, and potential pipeline capacity constraints.

The renewables: higher conservation portfolio was problematic because it would require a new rate increase to fund levels of conservation exceeding the accelerated conservation plan currently being pursued by Seattle City Light. Seattle’s painfully slow economic recovery and depressed wholesale power prices limit the benefits of increasing surplus energy and reselling it in the wholesale power market for years to come.

The renewables: base conservation portfolio was found to have several advantages over the other two portfolios. While the plan is forecast to be somewhat higher cost over a 20-year period, it has little cost difference with the top performing wind and gas portfolio during the first decade. It continues to pursue the accelerated conservation plan adopted by Seattle City Council and is already budgeted. This plan pursues accelerated annual conservation goals that are double pre-2008 levels. This portfolio is consistent with City policy and council 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 power needs with net zero greenhouse-gas emissions. This portfolio is also consistent with Seattle City Light’s adopted Strategic Plan.

Seattle City Light’s preferred portfolio for the 2012 IRP is renewables: base conservation (see Figure 15).

FIGURE 15: 2012 IRP PREFERRED PORTFOLIO, RENEWABLES: BASE CONSERVATION



# TWO-YEAR ACTION PLAN

## *The 2012 IRP includes City Light's two-year plan for resource acquisition, transmission, and planning.*

The recommended resource strategy is a continuation of the utility's policy of obtaining low-cost power with low environmental impacts for its ratepayers and owners while making the most of its existing resources. Conservation is the first-choice resource.

After 2020, the utility plans to continue acquiring a combination of renewable resources and RECs sufficient to meet both I-937 and resource adequacy (the ability to serve customers' electrical demand and energy requirements at all times). Power will be purchased from the wholesale

market when needed and acquiring new resources is not justified. When necessary, City Light will acquire new resources in the most cost-effective manner for customers, taking into account the full cost of the resource and the total value of any associated RECs and power.

The IRP will be updated over the next two years, culminating in the 2014 IRP. In the meantime, Seattle City Light will follow through on the findings of the 2012 effort. The action plan for this year and next is outlined in Figure 16.

**FIGURE 16: IRP ACTION PLAN, 2012-2013**

<b>Actions</b>	<b>2012</b>	<b>2013</b>
<b>Resource Plan Implementation</b>		
Pursue accelerated conservation in the amounts targeted in the renewables: base conservation portfolio, as budget allows	14 aMW by end of 4th Quarter	14 aMW more by end of 4th Quarter
Continue to acquire RECs, per the resource acquisition strategy, in order to meet I-937 requirements	Acquire an annual average of 7.3 aMW	Acquire an annual average of 7.3 aMW
Work to ensure sufficient transmission transfer capability for City Light to support serving peak customer demand	Ongoing	Ongoing
Serve retail load with market purchases, short-term exchanges, and transactions to reshape seasonal energy as needed	Ongoing	Ongoing
<b>Future Resource Costs</b>		
Complete a new conservation resource potential assessment for use in integrated resource planning and I-937 compliance	Complete project design and contracting	Complete study and report results for use in 2014 IRP and I-937
Engage BPA to limit the cost drivers in the FY 2013-14 rate case	Ongoing	Ongoing
Investigate the development status, costs, and commercial availability of resources	Ongoing	Ongoing
Continue to refine forecasts, modeling, and assumptions	Ongoing	Ongoing
Continue participation in and evaluation of climate change research for impacts to hydro operations and fish populations	Ongoing	Ongoing

# APPENDICES

1. Regulations impacting resource environment
2. Public involvement
3. Impact of electric vehicles on system load
4. Load forecast for IRP
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8. AURORAxmp® Electric Market Model
9. Analysis of candidate resource portfolios
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**Seattle City Light**

700 Fifth Avenue, Suite 3200  
PO Box 34023  
Seattle, WA 98124-4023

[www.seattle.gov/light](http://www.seattle.gov/light)