Chapter 6 – The Portfolios: Seeking the Right Mix of Resources

After gathering information on the range of resources that might be added to City Light's existing resource portfolio, candidate portfolios were constructed subject to the following criteria:

- All proposed resource portfolios were constructed to meet the prescribed level of energy resource adequacy (95 percent).
- Several of the evaluated portfolios were constructed to conform to the requirements of Initiative 937. Other portfolios were not held to this restriction, to prepare for the possibility that I-937 would not pass.
- Portfolios were built to optimize the performance of individual resources. Attempts were made to minimize costs, defer capital investments for as long as possible, or seek out economies of scale and other cost preventitive measures.

Once the portfolios were created, their performance was evaluated. The Utility conducted two rounds of portfolio analysis to allow for a comprehensive review by Utility management and the stakeholder committee, and for public review and comment. Evaluating resource portfolios in two rounds provided valuable guidance for IRP staff and opportunities to promote consensus with stakeholders and the public.

In Round 1, nearly all the available resource types were included in at least one of eight candidate portfolios. Experience gained from this exercise informed the construction of portfolios in Round 2. Several resource types, primarily coal-fired generation technologies, were eliminated from further consideration. Round 2 focused on a smaller number of resource types, varying the sizing and timing of the most promising resources.

This chapter describes in detail the portfolios selected for each round of analysis, compares their performance in terms of the criteria defined in Chapter 5, summarizes the conclusions reached, and presents the recommended portfolio.

Round 1 Analysis

The purpose of the first round of portfolio analysis was threefold:

1. To evaluate how a varied mix of resource technologies with different fixed costs, marginal costs, and capacity factors would influence overall portfolio performance.
2. To eliminate from consideration the very worst performing resource technologies in order to simplify the number of alternatives under scrutiny for Round 2.
3. To utilize the capabilities of Global Energy Decisions (GED) Planning and Risk Model to approximate candidate resources within a defined quantitative framework.

To this end, Round 1 was successful. Many complexities of the resources and portfolios were uncovered. Nine resource portfolios were evaluated through the reference case and four future "scenarios," resulting in a wealth of performance data. With this data it was possible to gain insights into the importance of resource availability, resource sizing and scalability, transmission requirements, tradeoffs between generation resources and the optimal level of conservation resources, fuel risk and capitalization issues.

Round 1 Portfolios

The nine alternative portfolio designations are listed below and the resources in each portfolio by 2026 are given in Table 6-1:

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

Table 6-1. Total New Resources in Round 1 Portfolios
(Average Megawatts of Output, 2026)

Resource	Resource Portfolio								
	P1 Rely on Market	P2 Renewables	P3 Gas, 100% Block	P4 Gas, Wind, 50% Block	P5 Gas, Wind, Hydro	P6 Gas, Biomass, Wind	P7 Gas	P8 Gas, Coal	P9 Wind, IGCC
Conservation		140	140	140	140	140	140	140	140
Exchange*		100	100		100	100	100	100	100
Call Option*					50				
Hydro Contract		23			23				
Hydro Efficiency		10			10				
Wind		250	50	50	50	50			150
Geothermal		25							
Landfill Gas		25			25	25			
Biomass		25				50			
CHP (co-gen.)					25				
CC Turbine			600	350	100	100	300	150	
SC Turbine					125	50	50	75	
IGCC - Coal									300
PV Coal								150	
Total 2026	0	598	890	540	648	515	590	615	690

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

The quantity of resources included in each portfolio was based on energy resource adequacy, which is a measure of energy output rather than capacity. Therefore, the tables throughout this chapter show resources in average megawatts. The capacity factor is about 32 percent for wind resources, and about 50 percent for the hydro contract and hydro efficiency.

Common to all resource portfolios are 140 average megawatts of conservation and 100 average megawatts of exchange, although the exchange in Portfolio 4 (Gas, Wind and 50% Block) ends after 2011. Conservation and seasonal exchanges are cost-effective approaches to meeting seasonal resource needs.

Five of eight portfolios contain a seasonal capacity contract (a physical call option), with the amounts varying by portfolio. Physical call options provide a means for acquiring power under improbable but possible circumstances. As such, a physical call option is not likely to be exercised, but its purchase does 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. Physical call options provide reliability for a fraction of the cost of holding a firm generating resource or purchasing power in the spot market under high demand conditions.

Two hydro resources were considered: an 18-megawatt (10 aMW) efficiency upgrade to existing City Light's hydro capacity and a 50-megawatt (23 aMW) contract for existing hydro capacity from another utility. Wind resources are included in five portfolios, with the largest amount (750 megawatts or 250 aMW) as part of the Renewables portfolio.

One portfolio features a geothermal resource. Three portfolios have landfill gas, two have biomass, and one has cogeneration. All four of these resources are comparatively small, with output of only 25 average megawatts per unit.

Simple cycle and combined-cycle natural gas turbines are included in five portfolios. In three of these, natural gas turbines make up more than half of the total resources added. Conversion of the BPA Slice product to Block in the 100-percent Block portfolio results in less BPA-supplied power being available for the existing resources portion of the portfolio, because the potentially higher amounts of electricity available under the Slice product would be forgone. Additional new resources must be added to make up for the loss to existing hydro resources. The 100-percent Block portfolio contains the most natural gas turbine output, 600 average megawatts.

Portfolio 1: Rely on the Market (No Action)

In the No Action Case, no new generation or conservation resources are acquired. Instead, all new power requirements are met with short-term purchases in the Western wholesale power market. Short-term (spot) market purchases are made at the forecasted market price, set by the marginal generating unit in the West. From an environmental perspective, 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 percent of the time.

Portfolio 2: Renewables

The Renewables portfolio contains mainly renewable resources, plus a seasonal exchange and a physical call option. Four of the nine resources – biomass, landfill gas, the call option, and the exchange – emit pollutants. The biomass and landfill gas resources are treated as greenhouse gas neutral, but they have other 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 call option would operate only in rare situations where weather conditions, market instability or generation outages make it difficult to obtain reliable energy. The call option would not be exercised under normal weather and hydro conditions. Table 6-2 shows the schedule for new resource acquisition through 2026.

Table 6-2. Portfolio 2: Renewables – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Hydro Contract	Mid-C	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Call Option	Mid-C	100	100																		
Exchange	Mid-C		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Hydro Efficiency	W. WA		10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Wind	E. WA		50	50	50	50	50	50	50	50	50	50	50	100	100	200	200	200	200	200	250
Landfill Gas	W. WA							25	25	25	25	25	25	25	25	25	25	25	25	25	25
Geothermal	W. WA									25	25	25	25	25	25	25	25	25	25	25	25
Biomass	W. WA													25	25	25	25	25	25	25	25
Total		130	297	204	211	218	225	257	264	296	303	310	317	399	406	513	520	527	534	541	598

Portfolio 3: Gas and 100% Block

City Light purchases two products as part of its contract with the Bonneville Power Administration. One product is called "Slice," because it mimics ownership of a slice of the hydroelectric generation capacity on the BPA system. In good water years, City Light receives more megawatt-hours of generation than in bad water years. In buying the Slice product, City Light shares in the annual hydro risk that comes from the BPA hydroelectric system. A second product is called "Block," because it is taken as blocks of power. It is a firm product, where a pre-determined amount of generation is delivered by the BPA irrespective of what kind of water year occurs. The Block generation can be "shaped," or taken in different amounts at different times of the year, but does not vary from the contracted amount.

The 100 percent Block portfolio was intended to explore the effect of selecting 100 percent of City Light's BPA purchase as a Block product after 2011. It eliminates BPA's Slice product from the mix, instead taking all Block and assuming that the Utility can reshape its monthly allocation to take more firm power in the winter months. The advantage of a larger proportion of the Block product is that it allows City Light to match its BPA power purchase more closely to its needs.

However, City Light would receive considerably less total power from BPA because the Block product is based upon the 1937-38 water year. In trading Slice for Block, City Light would receive on average about one-third fewer megawatt-hours than from a corresponding amount of Slice. This means that more generation must be added sooner to the portfolio to offset the loss in BPA megawatt-hours. The additional generation comes from a combined-cycle combustion turbine. In total, there is 600 aMW of output from combined-cycle turbines. Table 6-3 shows the schedule for new resource acquisition through 2026.

Portfolio 4: Gas, Wind and 50% Block

This portfolio, with 50 percent Block and 50 percent Slice, allows analysis of a different mix of products than City Light currently purchases from BPA. The advantage of trading BPA Slice product for Block product is the presumption that BPA Block can be shaped to meet the seasonal loads of the Utility. In addition to the Block and Slice products, the portfolio contains a call option, 50 aMW of output from simple-cycle turbines, and 350 aMW from combined-cycle turbines. Table 6-4 shows the schedule for new resource acquisition through 2026.

Table 6-3. Portfolio 3: Gas and 100% Block – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Call Option	Mid-C	100	100	100	100	100															
Wind	E. WA		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
CCCT	W. WA						150	150	150	150	150	300	450	450	450	600	600	600	600	600	600
Total		107	264	271	278	285	342	349	356	363	370	527	684	691	698	855	862	869	876	883	890

Table 6-4. Portfolio 4: Gas, Wind, and 50% Block – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100															
CCCT	W. WA			150	150	150	150	150	150	150	250	250	250	250	250	350	350	350	350	350	350
Wind	E. WA						50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Total		107	114	271	278	285	242	249	256	263	370	377	384	391	398	505	512	519	526	533	540

Portfolio 5: Gas, Wind and Hydro

Like the Renewables portfolio, the Gas, Wind and Hydro portfolio contains many renewable resources. However, a significant difference is that it also contains three additions of natural gas-fired turbine capacity (in 2013, 2019 and 2021), for a total output of 225 aMW by the year 2021. Emissions come from the operation of the simple-cycle and combined-cycle turbines, the exchange contract, landfill gas, combined heat and power (CHP) and the call option. As mentioned above, landfill gas is treated as greenhouse gas neutral (no CO2 emissions). Table 6-5 shows the schedule for new resource acquisition through 2026.

Portfolio 6: Gas, Biomass and Wind

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

Table 6-5. Portfolio 5: Gas, Wind and Hydro – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Hydro Contract	Mid-C	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Hydro Efficiency	W. WA	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10	10
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Wind	E. WA		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Landfill Gas	W. WA			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
CHP	W. WA			25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
SCCT	W. WA							50	50	50	50	50	50	125	125	125	125	125	125	125	125
CCCT	W. WA															100	100	100	100	100	100
Call Option	Mid-C																			50	50
Total		140	197	254	261	268	275	332	339	346	353	360	367	449	456	563	570	577	584	641	648

Table 6-6. Portfolio 6: Gas, Biomass and Wind – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Call Option	Mid-C	50	50	50																	
Exchange	Mid-C		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Wind	E. WA			50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
SCCT	W. WA					50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Landfill Gas	W. WA					25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Biomass	W. WA									25	25	50	50	50	50	50	50	50	50	50	50
CCCT	W. WA															100	100	100	100	100	100
Total		57	164	221	178	260	267	274	281	313	320	352	359	366	373	480	487	494	501	508	515

Portfolio 7: Gas

In addition to the conservation and exchange present in all portfolios, the Gas portfolio contains only natural gas-fired turbines. It is assumed that the natural gas-fired turbines would be sited in western Washington, keeping transmission costs down. Emissions in the Gas portfolio come from the exchange, the two simple-cycle turbines, and the single combined-cycle turbine. Table 6-7 shows the schedule for new resource acquisition through 2026.

Portfolio 8: Gas and Coal

In addition to conservation and a long-term exchange, the Gas and Coal portfolio produces 225 aMW from natural gas turbines and 150 aMW from a coal-fired plant by 2022. Although the coal-fired plant uses conventional pulverized coal technology, total carbon dioxide emissions are lower than in the Wind and IGCC portfolio. The Wind and IGCC portfolio has twice as much coal-fired generation. Other resources with air emissions are the exchange, the simple cycle turbine, and the combined-cycle turbine. Table 6-8 shows schedule for new resource acquisition through 2026.

Table 6-7. Portfolio 7: Gas Portfolio – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CCCT	W. WA			150	150	150	150	150	150	150	150	300	300	300	300	300	300	300	300	300	300
SCCT	W. WA																50	50	50	50	50
Total		107	114	271	278	285	292	299	306	313	320	477	484	491	498	505	562	569	576	583	590

Table 6-8. Portfolio 8: Gas and Coal Portfolio – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Exchange	Mid-C	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
CCCT	W. WA			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
Coal	MT			150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150	150
SCCT	W. WA																75	75	75	75	75
Total	W. WA	107	114	421	428	435	442	449	456	463	470	477	484	491	498	505	587	594	601	608	615

Table 6-9. Portfolio 9: Wind and IGCC Portfolio – New Resources
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	35	42	49	56	63	70	77	84	91	98	105	112	119	126	133	140
Call Option	Mid-C	70	70	70	70																
Exchange	Mid-C		100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100	100
Wind	E. WA			50	50	50	100	150	150	150	150	150	150	150	150	150	150	150	150	150	150
IGCC	MT					150	150	150	150	150	150	150	150	300	300	300	300	300	300	300	300
Total		77	184	241	248	335	392	449	456	463	470	477	484	641	648	655	662	669	676	683	690

Portfolio 9: Wind and IGCC

The Wind and IGCC portfolio contains conservation, an exchange, a 70 aMW call option that expires in 2011, three wind plant additions and two additions of IGCC capacity. The IGCC capacity is assumed to be part of a future IGCC plant constructed in Montana. Emissions from this portfolio are from the exchange, the call option and the IGCC capacity additions. The IGCC technology has lower air emissions than conventional pulverized coal technology. It is assumed that the carbon dioxide emissions would not be sequestered. Therefore, the IGCC capacity would require the purchase of carbon dioxide emission offsets. Like the Renewables portfolio, this portfolio has a comparatively large amount of total generation, with 150 aMW of wind in addition to the 300 aMW of IGCC.

As described for the Gas, Biomass and Wind portfolio, more wind capacity is required because of the low capacity factor. Table 6-9 shows schedule for new resource acquisition through 2026.

Evaluation of Portfolios

As described in Chapter 5, measures were devised for the purpose of comparing the portfolios against four evaluation criteria: cost, environmental impact, risk and reliability. All portfolios meet the reliability criterion of 95 percent resource adequacy. The other criteria and corresponding measures are shown in Table 5-2. The results of the portfolios evaluations are displayed in Table 6-10.

Table 6-10. Round 1 Portfolio Comparison

	Fixed + Variable Costs	Environmental Impacts	Cost Risk	Market Risk	Revenue Less Cost
1. Rely on Market (Do Nothing)					
2. Renewables					
3. Gas, 100% Block					
4. Gas, Wind, 50% Block					
5. Gas, Wind, Hydro					
6. Gas, Biomass, Wind					
7. Gas					
8. IGCC, Wind					
9. Coal, Gas					

Best Performing
Mid Performing
Worst Performing

As shown in Table 6-10, the portfolios performing among the top third of portfolios across all five measures are:

- Renewables
- Gas, Wind and Hydro
- Gas

The top three portfolios in terms of net present value of net power costs (revenues net of costs) are:

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

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

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

Environmental Impact Summary

The environmental impacts of each of the nine Round 1 portfolios are described in detail in the Draft Environmental Impact Statement.

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

- Wind – due to potential high aesthetic impacts and possible impacts on birds and bats.
- Both coal-fired resources – due to several factors, including extensive ground-disturbing activities at a plant site as well as for fuel extraction and air pollutant emissions.
- Geothermal – potential physical disturbance to geologic structures, groundwater impacts and the possibility of development in pristine areas where land use and recreation impacts would be an issue.
- Biomass – potentially 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.
- Market transactions – high levels of air emissions and fuel extraction, based on the assumption of resources used in market transactions.

Conclusions from Round 1 Analysis

From the analysis of the nine initial portfolios, the following conclusions were reached:

1. City Light's energy resource adequacy requirement would not be well served by large capacity "must-run" baseload generation technologies (coal and large natural gas CCCT). Such resources would exacerbate the mismatch between the Utility's seasonal load shape and resource shape.
2. Resource technologies requiring large un-scalable capital projects (coal and large natural gas CCCT) also are not well suited to City Light's interests. The small but steady annual increases in energy need would be poorly met with large projects that would leave the Utility at first with decreasing oversupply and then increasing undersupply as years go by.
3. By holding to the City's policies on offsetting carbon emissions (CO2) and accounting for environmental externalities (emissions of SO2, NOx, particulate matter and mercury), resource technologies that are heavy polluters would be quickly discounted in value. This is especially true in future "scenarios" that contain a carbon tax.
4. Seasonal energy exchanges with utilities having non-congruent demand-resource balances are very cost efficient ways to acquire energy when needed, without capital investment. However, transmission availability limits the extent that this practice can be used. Also, in later years of the analysis, the supply of summer energy available for trade in an exchange may be insufficient unless there is some

modest investment in baseload generation and conservation that would increase energy availability in the summer.

5. When compared with the cost of generating resources, the level of cost-effective conservation is estimated to be just over 7 aMW per year.
6. In examining the possibility of altering the proportion of BPA products, additional restrictions on the monthly allocation of the BPA Block product were discovered, which led to the conclusion that reducing the proportion of City Light's BPA Slice product in favor of more Block product is not advantageous.

Round 2 Analysis

This section describes how City Light incorporated the findings of the Round 1 analysis in developing portfolios for Round 2, then describes the portfolios and gives the results of the portfolio evaluation based on the criteria of reliability, cost, risk and environmental impact.

Selecting Resources for Round 2

Based on the lessons learned in the Round 1 portfolio analysis, several decisions were made in developing Round 2 portfolios. Some resources were eliminated; choices were made about how market and generation resources would be used; some resources were included in all portfolios for the first nine years; several portfolios were designed to meet the requirements of Initiative 937; and two ways of phasing in conservation resources were included.

Resources Eliminated from Round 2

The two coal-fired generation technologies were eliminated from further consideration for several reasons. First, the environmental costs were high, given City policy to offset carbon dioxide emissions. Also, the Green World and Nuclear Resurgence scenarios suggest the risk of substantially higher costs of future carbon dioxide emissions. Second, the cost of new electric transmission capacity is high if the coal resources are located in Montana or Wyoming. Current transmission capacity is insufficient to bring new coal-fired generation west to Seattle. A third reason is related to scale. City Light's most pressing need is for seasonal resources, not large baseload generating plants.

Combined Heat and Power (CHP) and hydro efficiency upgrades both have desirable attributes, but were not included in Round 2 portfolios. The situational nature of these resources makes good information especially important. There is considerable uncertainty about potential amounts, costs and timing of these resources. A study of hydro efficiency upgrade potential for City Light is currently underway, but the results are not yet available. The cost and availability of both these resources will be further investigated in future updates of this Plan.

Use of Market and Generation Resources in Round 2

City Light's analysis shows that in the near-term years, the need for resources occurs only during the winter season. The acquisition of any year-round resource would add power during the rest of the year, and thus increase the market risk associated with disposing of surplus power. Therefore, Round 2 investigated seasonal power exchanges and call options, which are market resources that would help to match the resource profile to the load profile.

The best choices were seasonal exchanges and seasonal capacity contracts (physical call options). For City Light, seasonal exchanges are arrangements to receive power from a partner utility that has a winter surplus, and to deliver a like amount of power to the partner in the summer. The amount received is not necessarily exactly the same as the amount delivered.

A physical call option is an arrangement for the physical delivery of power under an agreed upon set of circumstances for an agreed upon price. The expectation is that the option would be exercised only when the Utility's other resources are hard-pressed to serve load. Such a circumstance would probably occur only during an extended cold spell combined with a prolonged drought. All Round 2 portfolios feature exchanges and call options in the near term.

Unless there is a substantial increase in conservation resources, City Light will need additional generating resources beginning in 2010. The Round 2 portfolios all have a landfill gas resource online in 2010, and six of them have 23 aMW of output from a hydro contract with another utility in 2012. As load continues

to grow, the landfill gas contract increases and a variety of other resources, mainly renewable resources, are added to the portfolios. One exception is Portfolio 4, which features a simple-cycle combustion turbine (SCCT). The SCCT in this portfolio is run as a "peaker." That is, it is only run for short periods in order to meet peak load. Even though its cost per megawatt-hour is relatively high, it would only be run when market prices are even higher.

The First Nine Years

For the first nine years of the study (2007-2015), increases in energy requirements sufficient to meet the resource adequacy targets can be met with a combination of seasonal exchanges, conservation, short term call options and purchased power agreements. Certain cost-effective resources were identified as "lost opportunities." City Light believes there is a time-limited opportunity to develop these resources at relatively low cost compared to the market. These resources include landfill gas generation, a contract for existing hydro resources, call options and new seasonal exchanges.

A combination of exchanges, call options, landfill gas and a hydro contract outperformed all other resource combinations evaluated on costs for the period 2007-2015. Accordingly, the same three resources (with variations for conservation) were used in all Round 2 portfolios for the first nine years. Based upon a common set of "front-end" resources, the focus in Round 2 is on intermediate and long-term variations in resource portfolios.

Initiative 937 – Conservation and Renewable Resource Standard

Portfolios were developed before details of Washington State Initiative 937 were known. The initiative, approved by voters in November, establishes requirements for the acquisition of conservation and renewable resources by qualifying utilities. Because the outcome of the initiative was unknown at the time the Round 2 portfolios were designed, some portfolios were specifically designed to meet the requirements of Initiative 937, and others were not.

In designing the portfolios, City Light incorporated its understanding of the initiative as written, recognizing that a process to interpret the new law, would ensue if it were passed. Now that the initiative has been approved, clarification will occur in subsequent discussions and rulemaking by the State Department of Community, Trade, and Economic Development (CTED), which will oversee implementation. Failure to comply with initiative requirements results in a $50 fine for each megawatt-hour a utility is below the requirement.

Requirement to Purchase Renewable Resources

Initiative 937 has a large impact upon the design of future City Light resource portfolios. Most importantly, it requires more renewable resource purchases than current forecasts suggest will be needed after 2015. Portfolios that conform to Initiative 937 require the acquisition of new generating resources three to five years earlier than needed to meet the established resource adequacy target.

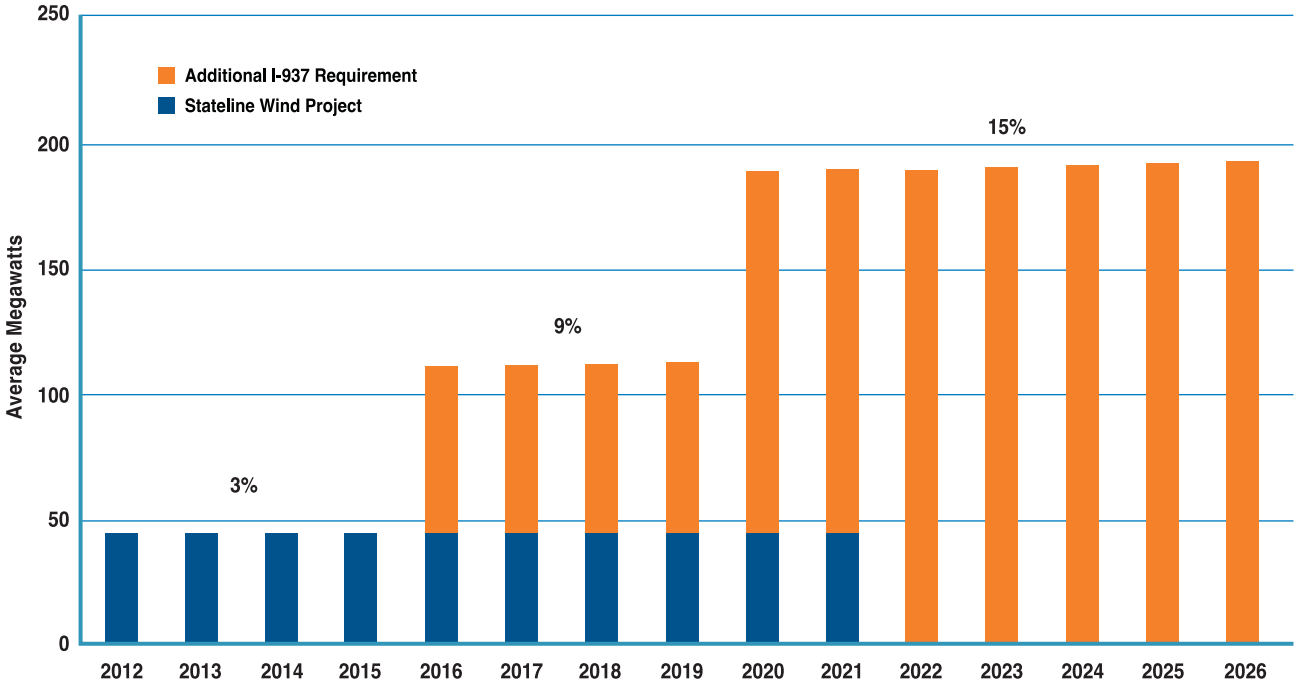
Adherence to Initiative 937 defines specific types of resources that can count toward the renewable resource requirement. For example, a cost-effective use of seasonal resource purchases or seasonal exchanges does not provide sufficient new renewable energy purchases to meet the percentage requirement of total year-round purchases. Substituting compliant resources for non-compliant resources on an accelerated schedule increases the costs of Initiative 937-compliant portfolios compared to the more seasonally tailored, non-compliant portfolios. For the most part, these incremental resource additions occur after 2015.

Following is a summary of the major components of the initiative that most affect City Light's resource planning: the requirement to purchase renewable resources, and options for compliance with the initiative.

The initiative requires that 3 percent of retail load be obtained from qualifying renewable energy by 2012, 9 percent by 2016 and 15 percent by 2020. Hydropower is not an eligible renewable resource, though certain efficiency upgrades are eligible. Based upon the current load forecast, it is estimated that City Light would need to acquire qualifying renewable resources beginning in 2016 in amounts shown in Figure 6-1: nearly 70 aMW in 2017-2019, about 145 aMW in 2020-2021, and about 190 aMW in 2022-2026.

Stateline Wind Project is expected to meet the 3 percent requirement from 2012 to 2016. The increase in the requirement from 145 to 190 average megawatts in year 2022 is caused by the expiration of the Stateline wind contract in 2021.

Figure 6-1. Renewable Resource Additions* Required Under Initiative 937



*Total annual difference compared to without Initiative 937.

Rate Increase Cap

If the difference between the cost of non-qualifying substitute resources and qualifying renewable resources has increased a utility's revenue requirement by 4 percent per year, the utility is considered in compliance. Given the renewable energy requirements, cost differentials, and typical financing mechanisms for new resources, it is not anticipated that City Light's renewable resource acquisitions would trigger this form of a 4 percent annual revenue requirement cap.

A utility may purchase Renewable Energy Credits (RECs) instead of qualifying renewable energy to be compliant with I-937. This compliance approach may be viable for City Light; however, future availability and cost for RECs are very uncertain. Many other Western states either have or will soon have renewable portfolio standards and can be in compliance using renewable resources from the Pacific Northwest. Some acquisitions of Pacific Northwest renewable resources by utilities outside the region have already begun, increasing uncertainty about future supplies and costs of RECs.

Conservation Acquisition Options

Although the specific rules for compliance with the Initiative 937 have not yet been established, discussions with the IRP Stakeholder group led to the assumption that the cost-effective constant pace of 7 aMW of conservation acquired annually is likely to meet I-937 requirements.

However, accelerating conservation acquisition was also examined in Round 2, to explore a potentially important strategy. City Light hypothesized that accelerating conservation could make a material difference in costs and offset the need for acquiring additional generating resources. Reducing retail demand with conservation also has the effect of reducing the I-937 requirements for purchasing new renewable generation, since the requirement is based upon a percentage of retail demand.

Three resource portfolios were designed with accelerated conservation. The results of modeling the accelerated conservation portfolios should be considered evidential, but non-conclusive. The modeling assumptions have several known, but unavoidable weaknesses. Foremost is that the same unit cost of conservation was applied to both the accelerated

conservation portfolios and the constant rate of conservation portfolios. Although accelerating the pace of conservation activities is expected to result in higher unit costs, no study of the extent of these added costs was available.

To avoid bias, conservation modeling for the IRP is viewed from a total societal cost perspective and does not address who pays which conservation costs in what proportion. Thus, the analysis did not address whether or not City Light would need to offer expanded incentives to achieve the accelerated conservation, or what proportion of costs would be paid by the Utility and what proportion by customers.

The IRP does not address the feasibility and timing of new program designs required to achieve the accelerated conservation. Program designs and the practicalities of implementation are not typically within the scope of an IRP, where the focus is on resource strategies.

Round 2 Portfolios

The eight alternative portfolio designations are listed below, indicating those that meet the conservation and renewable resource requirements of Initiative I-937. The resources in each portfolio by 2026 are given in Table 6-11.

1. No Action - Rely on the Market
2. I-937 – Hydro, Wind (55) and Biomass (15)
3. I-937 – Hydro and Wind
4. Non-I-937 – Hydro and SCCT
5. Non-I-937 – Hydro and Wind
6. I-937 – Wind
7. I-937 – Hydro, Wind (105) and Geothermal (50)
8. I-937 – Hydro, Geothermal (100) and Wind (55)

Table 6-11. Total New Resources in Round 2 Portfolios
(Average Megawatts of Output, 2026)

Resource	Resource Portfolio							
	P1 Rely on Market	P2 I-937 Hydro, Wind, Biomass	P3 I-937 Hydro, Wind	P4 Non-I-937 Hydro, SCCT	P5 Non-I-937 Hydro, Wind	P6 I-937 Wind	P7 I-937 Hydro, Wind, Geothermal	P8 I-937 Hydro, Geothermal, Wind
Conservation		141	141	142	142	141	142	142
Exchange*		50	50	140	145	100	100	100
Call Option*		45	40	20	30	10		
Hydro Contract		23	23	23	23		23	23
Wind		55	50		20	50	105	55
Geothermal		100	125	50	75		50	100
Landfill Gas		25	25	25	25	25	25	25
Biomass		15					15	15
SC Turbine				50				
2026 Total	0	454	454	450	460	326	460	460

Portfolio 1: No Action – Rely on the Market

In the No Action portfolio, no new conservation or generation resources are acquired. Instead, all new power requirements are met with short-term purchases in the Western wholesale power market. Short-term (spot) market purchases are made at the forecasted market price, set by the marginal generating unit in the West. From an environmental perspective, 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 point in time. Currently in the West, natural gas-fired generation is on the margin more than 90 percent of the time.

Portfolio 2: Hydro, Wind (55) and Biomass (15) – I-937

This portfolio meets the requirements of Initiative 937. Conservation is accelerated from the cost-effective constant rate. Seasonal exchanges and call options are used in order to meet the resource adequacy requirement in winter through 2009. After that, the Utility purchases the output from a landfill gas facility and enters into a contract with another regional utility to purchase a share of the output of an existing hydro facility. Farther out, a geothermal resource is added in 2016, and a wind resource replaces one of the seasonal exchanges in 2020, when a small biomass resource is also added. Table 6-12 shows the schedule for new resource acquisition through 2026.

Portfolio 3: Hydro and Wind – I-937

Through 2019, Portfolio 3 is similar to Portfolio 2. In 2020, the geothermal resource that begins in 2016 is increased five-fold, taking up some the slack from the elimination of one seasonal exchange. In 2022 50 aMW of wind generation is added. In order to meet resource adequacy in 2026, a physical call option is added. Table 6-13 shows the schedule for new resource acquisition through 2026.

Table 6-12. Hydro, Wind (55) and Biomass (15) – I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	15	24	34	45	55	66	76	87	98	108	119	129	131	132	134	136	138	139	141
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50							
Call Option	Mid-C			30	10			5													45
Landfill Gas	W. WA				10	10	10	10	10	25	25	25	25	25	25	25	25	25	25	25	25
Hydro Contract	Mid-C						23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Geothermal	W. WA										25	25	25	25	50	50	100	100	100	100	100
Wind	E. WA														55	55	55	55	55	55	55
Biomass	W. WA														15	15	15	15	15	15	15
Total		57	115	154	154	155	188	204	209	235	271	281	292	302	349	350	402	404	406	407	454

Table 6-13: Hydro and Wind – I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	15	24	34	45	55	66	76	87	98	108	119	129	131	132	134	136	138	139	141
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50							
Call Option	Mid-C			30	10			5													40
Landfill Gas	W. WA				10	10	10	10	10	25	25	25	25	25	25	25	25	25	25	25	25
Hydro Contract	Mid-C						23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Geothermal	W. WA										25	25	25	25	125	125	125	125	125	125	125
Wind	E. WA																50	50	50	50	50
Total		57	115	154	154	155	188	204	209	235	271	281	292	302	354	355	407	409	411	412	454

Portfolio 4: Hydro and SCCT – Non-I-937

Portfolio 4 is similar to Portfolios 2 and 3 through 2014. A small amount of geothermal is added in 2015, and doubled in 2021. In 2019, a simple cycle combustion turbine (SCCT) is added. This resource would be run as a "peaker;" that is it would only be run during peak demand hours when market prices are high. A third seasonal exchange is added in 2022, and both of the earlier exchanges continue through to the end of the planning period. This is the only portfolio that has a fossil fuel resource, and does not comply with I-937. Table 6-14 shows the schedule for new resource acquisition through 2026.

Portfolio 5: Hydro and Wind – Non-I-937

Portfolio 5 is similar to Portfolio 4, but instead of a SCCT, it uses a combination of expanded geothermal and a small amount of wind in the later years. Like Portfolio 4, this portfolio adds a small amount of geothermal in 2015, but instead of an SCCT in 2019, the geothermal resource is expanded, followed by the addition a third seasonal exchange in 2021 and a small amount of wind resource in 2022. In certain years, there are call options to assure that the resource adequacy target is met. Portfolio 5 also does not meet I-937 requirements, even though it does not include any fossil fuel resources. Table 6-15 shows the schedule for new resource acquisition through 2026.

Table 6-14. Hydro and SCCT – Non-I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	36	43	50	57	64	71	78	85	93	100	107	114	121	128	135	142
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Call Option	Mid-C			30				5													20
Landfill Gas	W. WA				25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Hydro Contract	Mid-C						23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Geothermal	W. WA									25	25	25	25	25	25	50	50	50	50	50	50
SCCT	W. WA													50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C																40	40	40	40	40
Total		57	114	151	153	161	191	203	205	237	244	251	258	316	323	355	402	409	416	423	450

Table 6-15. Hydro and Wind – Non-I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	36	43	50	57	64	71	78	85	93	100	107	114	121	128	135	142
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Call Option	Mid-C			30				5				5		15	10	10	5				30
Landfill Gas	W. WA				25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Hydro Contract	Mid-C						23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Geothermal	W. WA									25	25	25	25	50	50	50	75	75	75	75	75
Seasonal Exchange	Mid-C															45	45	45	45	45	45
Wind	E. WA																20	20	20	20	20
Total		57	114	151	153	161	191	203	205	237	244	256	258	306	308	360	407	409	416	423	460

Portfolio 6: Wind – I-937

Like Portfolios 2 and 3, Portfolio 6 complies with the requirements of I-937 and has accelerated conservation. It differs from them by adding a larger amount of the landfill gas resource in 2010, and it does not include a hydro contract. It starts with a small amount of geothermal in 2016, which is quadrupled in 2019, and increased yet again in 2025. Beginning in 2022, a wind resource is added. Table 6-16 shows the schedule for new resource acquisition through 2026.

Portfolio 7: Hydro, Wind (105) and Geothermal (50) – I-937

Portfolio 7 has the more wind generation than any of the other portfolios. This wind resource is not added until 2019, but it doubles in 2022. Conservation is acquired at a constant rate of 7 aMW per year. A small amount of geothermal is added in 2015, and doubles in 2020. In 2016 a small amount of biomass is added. Table 6-17 shows the schedule for new resource acquisition through 2026.

Table 6-16. Wind – I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	15	24	34	45	55	66	76	87	98	108	119	129	131	132	134	136	138	139	141
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Call Option	Mid-C			30				10		15											10
Landfill Gas	W. WA				25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Geothermal	W. WA										25	25	25	100	100	100	100	100	100	125	125
Wind	E. WA																50	50	50	50	50
Total		57	115	154	159	170	180	201	201	227	248	258	269	354	356	357	409	411	413	439	451

Table 6-17. Hydro, Wind (105) and Geothermal (50) – I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	36	43	50	57	64	71	78	85	93	100	107	114	121	128	135	142
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Call Option	Mid-C			30				5													
Landfill Gas	W. WA				25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Hydro Contract	Mid-C						23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Geothermal	W. WA									30	30	30	30	30	50	50	50	50	50	50	50
Biomass	W. WA										15	15	15	15	15	15	15	15	15	15	15
Wind	E. WA													55	55	55	105	105	105	105	105
Total		57	114	151	153	161	191	203	205	242	264	271	278	341	368	375	432	439	446	453	460

Table 6-18. Hydro, Geothermal (100) and Wind (55) – I-937
(Average Megawatts of Output, 2007-2026)

Resource (aMW)	Location	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026
Conservation	W. WA	7	14	21	28	36	43	50	57	64	71	78	85	93	100	107	114	121	128	135	142
Seasonal Exchange	Mid-C	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Seasonal Exchange	Mid-C		50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50	50
Call Option	Mid-C			30				5													
Landfill Gas	W. WA				25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25	25
Hydro Contract	Mid-C						23	23	23	23	23	23	23	23	23	23	23	23	23	23	23
Geothermal	W. WA									30	30	30	30	50	50	50	100	100	100	100	100
Biomass	W. WA										15	15	15	15	15	15	15	15	15	15	15
Wind	E. WA														55	55	55	55	55	55	55
Total		57	114	151	153	161	191	203	205	242	264	271	278	306	368	375	432	439	446	453	460

Portfolio 8: Hydro, Geothermal (100) and Wind (55) – I-937

Portfolio 8 relies on geothermal rather than wind in the final five years of the planning period. In 2019, the geothermal resource is doubled, and then doubled again in 2022. A small amount of wind is added in 2020. Conservation is acquired at a constant rate of 7 aMW per year. Table 6-18 shows the schedule for new resource acquisition through 2026.

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. In addition, 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

Differences in generation strategies are most pronounced late in the planning period, creating most of the cost variation among portfolios. Beyond 2016, I-937 requirements are likely to drive the amount of resource additions, since they exceed the Utility's forecasted resource adequacy requirements. The major difference in the non-compliant portfolios (P4, P5) is that they are less capital-intensive and more tailored to seasonal demand, leading to lower net power costs. All non-compliant portfolios were dropped from consideration after approval of I-937 in the November 2006 election.

The accelerated conservation portfolios (P2, P3, P6) examine a potentially important strategy for complying with I-937. As explained above, these portfolios are likely to overestimate the benefits of accelerating conservation, because the full costs of accelerating conservation have not been determined. Nonetheless, it was deemed useful to explore the concept of accelerating conservation to see if it could be a wise resource strategy under I-937. While the results of modeling the accelerated conservation portfolios cannot be viewed as definitive, they strongly suggest that further investigation of this strategy is merited. Conceptually, accelerating conservation leads to reducing costs in all three of the portfolios tested by over $100 million NPV during the entire 20-year period.

The wind-dominant Portfolio 7 and the geothermal-dominant Portfolio 8 are the two main candidates for meeting I-937 requirements in the 2006 IRP. Portfolio 7 requires more capital costs for plant and transmission and has higher variable operation and maintenance costs. Table 6-19 highlights comparable costs, displaying the most important differences between the portfolios.

Table 6-19. Cost Comparison of Round 2 Portfolios

20-yr. NPV of Costs ($1000s)	P2 Accelerated Conservation	P3 Accelerated Conservation	P4 Not I-937 Compliant	P5 Not I-937 Compliant	P6 Accelerated Conservation	P7 I-937 Compliant	P8 I-937 Compliant (Preferred)
Generation PPA	$ 716,103	$ 745,895	$452,503	$522,619	$596,466	$ 830,573	$ 783,065
Conservation	$ 262,900	$ 262,900	$222,123	$222,123	$262,900	$ 222,123	$ 222,123
Transmission	$ 21,411	$ 19,381	$ 12,011	$ 16,775	$ 12,042	$ 31,444	$ 21,487
Total Cost	$1,000,414	$1,028,176	$686,637	$761,517	$871,408	$1,084,140	$1,026,676
Wholesale Revenue (minus)	$ 941,576	$ 959,266	$741,483	$745,091	$813,909	$ 865,909	$ 855,740
Net Power Cost	$ 58,838	$ 68,910	($ 54,846)	$ 16,426	$ 57,499	$ 218,231	$ 170,936

The capacity factor of geothermal energy (95 percent) affects both Purchased Power Agreement (PPA) costs and the transmission costs. The high capacity factor helps to lower average costs of production for geothermal. Transmission for geothermal resources is expected to require less construction of new transmission assets because of shorter distances to Seattle. It is also expected to have a lower cost per megawatt-hour for firm transmission than wind resources, again because of the higher capacity factor. Wholesale revenues for Portfolio 7 are $10 million (NPV) higher, but not enough to offset the cost advantages of Portfolio 8. Portfolio 8 has a net power cost NPV that is $47 million lower than Portfolio 7.

Risk

Two measures of risk were used to evaluate resource portfolios, based upon Monte Carlo analysis (see Chapter 5). The coefficient of variation measures deviation from the mean of a sampled population under different stochastic conditions. A second measure is the value at the 5 percent and 95 percent tails of the probability distribution. This measure illustrates the severity of changes under rare circumstances, on the borders of the planning envelope. The range of the values can give useful information about the "downside" and "upside" of a particular variable.

For both of these risk measures, the portfolios in Round 2 show few differences. The reason is straightforward. The Round 2 portfolios are almost entirely comprised of conservation and renewable resources. Only Portfolio 4 has a fossil-fueled resource: a natural gas-fired, simple cycle turbine.

Fossil fuels, particularly natural gas, are subject to significant price uncertainty that can lead to material differences in risk exposure between portfolios, as seen in the Round 1 analysis. An absence of fossil fuels and reliance on renewable resources in Round 2 leads to mainly insignificant differences in risk exposure between the portfolios in the base forecast. For a discussion of the performance of Round 2 portfolios in the future scenarios described in Chapter 5, see Appendix D.

For generating resources, a distinguishing risk factor is often the variable costs of operation. Variable costs in the table below are comprised of variable O&M, start-up costs, fuel costs, and CO2 offset costs. Table 6-20 displays the coefficient of variation for variable costs in Round 2 portfolios, as well as the 5 percent and 95 percent tails of the variable cost probability distribution.

Table 6-20. Variable Cost Risk Measures for Round 2 Portfolios

	Coefficient of Variation	P = .05*	P = .95*
P2	77%	$171,562	$195,845
P3	77%	$207,071	$212,490
P4	81%	$125,893	$180,744
P5	81%	$132,776	$135,072
P6	79%	$181,051	$183,956
P7	79%	$195,689	$227,531
P8	80%	$203,754	$234,559

*NPV in thousands of dollars, 3% real discount rate.

While the coefficient of variation measure indicates little relative differentiation between the portfolios, the 5 percent and 95 percent tails display some interesting differences. Portfolio 4 has by far the widest range of variable costs, indicating the

highest risk. It contains 50 aMW of natural gas-fired combustion turbine generation, with all other portfolios containing only renewable resources. Fuel brings most of the risk to Portfolio 4 variable costs.

The portfolios with accelerated conservation also have a relatively low range of variable costs. They require less generating resources, helping to minimize the range of variable costs. Portfolios 7 and 8 have approximately the same degree of risk associated with variable costs.

Environmental Impacts

The Draft EIS provided an extensive review of impacts to air, land, water, aesthetics and the economy for all Round 1 portfolios. In Round 2, Portfolios 7 and 8 emerged as the most promising of the seven portfolios examined, so the Final EIS focuses on these two portfolios.

For all Round 1 and Round 2 portfolios, air emissions were measured for carbon dioxide, sulfur dioxide, nitrogen oxide, mercury and particulates. Control costs for these emissions serve as a proxy for environmental impacts to the air.

Carbon Dioxide Emissions

In evaluating air emissions, carbon dioxide dominates the control cost financial measure used in the analysis. It is also important in evaluating greenhouse gas offset costs that would be incurred under City of Seattle policy. Table 6-21 shows the total tons of carbon dioxide emissions expected from each Round 2 resource portfolio over the 20-year planning period.

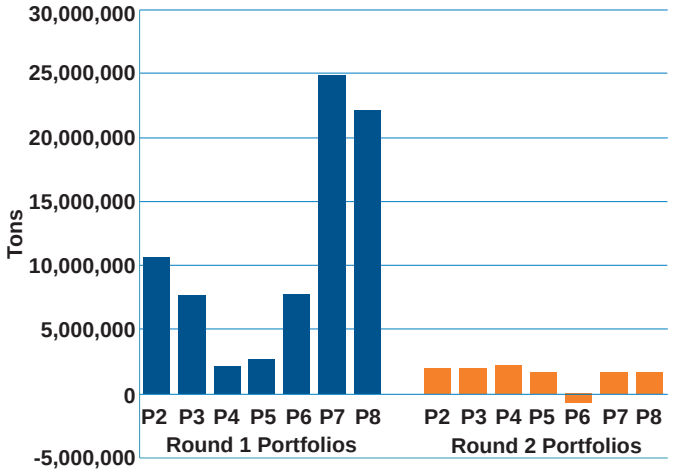
Table 6-21. Carbon Dioxide Emissions for Round 2 Portfolios, 2007-2026

Portfolio		Tons of CO2
P2	Hydro, Wind (55) and Biomass (15)	1,967,686
P3	Hydro and Wind	1,967,686
P4	Hydro and SCCT	2,245,312
P5	Hydro and Wind	1,695,872
P6	Wind	(712,067)
P7	Hydro, Wind (105) and Geothermal (50)	1,732,147
P8	Hydro, Geothermal (100) and Wind (55)	1,732,147

Carbon dioxide emissions in Round 2 portfolios are caused by market purchases and hydro contracts from existing resources. Market purchases are assessed carbon dioxide emissions at the rate of the marginal unit in the Western market, typically a natural gas-fired turbine. The hydro contract is assessed carbon dioxide emissions under the premise that utilizing an existing hydro resource from another utility will force another potential buyer to go into the market for an equivalent amount of energy. Portfolio 6 has the lowest carbon dioxide emissions, simply because it does not have a hydro contract.

In general, the emissions in Round 2 portfolios are substantially lower than Round 1 portfolios as a result of portfolio design. Figure 6-2 compares 20-year total carbon dioxide emissions for Round 1 and Round 2 portfolios.

Figure 6-2. Carbon Dioxide Emissions – Round 1 and Round 2 Portfolios (2007-2026)*



*This graph illustrates the relative difference between Round 1 and Round 2 portfolios. Specific portfolios are not directly comparable.

Other Environmental Impacts

Other environmental impacts of Portfolios 7 and 8 were also examined in the Final EIS.

Both portfolios contain landfill gas and biomass resources. Landfill gas generation is fueled by methane seeping from landfills, reducing emissions of this extremely potent greenhouse gas. Biomass generation is assumed to be carbon dioxide neutral, since it is fueled by plants or wood waste that has captured the carbon dioxide. In combination, these two resources are expected to emit approximately 992 tons of nitrogen oxides and 183 tons of particulate matter over a 20-year period in each portfolio. While these emissions are low compared to many fossil fuel generation plants, landfill gas and biomass are not free of emissions.

Geothermal resources, featured in Portfolio 8, can impact aesthetics if they are sited in or near pristine areas, and they can also affect groundwater. Wind resources, featured in Portfolio

7, can impact aesthetics and bird mortality. For a thorough discussion of the environmental impacts of Portfolios 7 and 8, see the Final EIS, online at http://www.seattle.gov/light/news/issues/irp/.

The Preferred Portfolio

Both Portfolios 7 and 8 meet Initiative 937 requirements, satisfy the prescribed level of resource adequacy, and uphold a longstanding commitment to conservation. In the first nine years, these two portfolios call for:

- Continued acquisition of cost effective conservation at a rate of 7 aMW per year.
- Two low-cost seasonal exchanges to better match the shape of resources to load.
- Seasonal capacity contracts (physical call options) when advantageous.
- Output from a landfill gas facility.
- Output from an existing hydro facility.

After the first nine years, Portfolio 7 opts for greater use of wind resources, while Portfolio 8 opts for greater use of geothermal resources. Both wind and geothermal resources are "scalable." They can be gradually developed at the same location according to the timing of the need. This allows for cost efficiencies from improved timing and scale of resource additions, reduced development costs, and the ability to more fully utilize transmission and substations interconnections.

Comparing Portfolios 7 and 8 on the four evaluative criteria, Portfolio 8 has $47 million lower NPV of costs. It has slightly lower risk, the same degree of reliability, and there is no significant difference in environmental performance. Portfolio 8 is the preferred portfolio, shown in Figure 6-3.

Figure 6-3. Preferred Portfolio