Appendix 9

ANALYSIS OF CANDIDATE RESOURCE PORTFOLIOS

This appendix provides an overview of the analytical process for evaluating prospective resource portfolios. Additional details can be found in the appendices on load forecast (4), resource adequacy (6), AURORAxmp® market model (8), risk measure (10), air emissions rates and costs (12), and conservation potential assessment (13).

PORTFOLIO STRUCTURE

The initial eight resource portfolios were designed to test various resource strategies, while meeting requirements for resource adequacy and compliance with Initiative 937 (I-937), Washington's renewable portfolio standard. Since City Light's current resources average about 90 percent low-cost hydropower, the eight resource portfolios each contain all of the resources currently in the base (existing) portfolio. As determined by the resource needs shown in the resource adequacy study (Appendix 6), each portfolio also contains different mixes of new power contracts for new resources and conservation. The new resources in each portfolio were designed using a linear optimization, with one exception. The mixed resources portfolio was designed to have a highly diverse set of resources in the same total amounts while meeting the same requirements as the other portfolios. However, there was not a linear optimization of this portfolio.

The performance of each of the portfolios under expected demand and hydro conditions is evaluated based upon costs (including emissions-related environmental costs) and financial risk. The portfolios are presented as tables at the end of this appendix.

The following resources are combined to construct the initial resource portfolios.

- Conservation
- Biomass (waste wood cogeneration)
- Geothermal (binary)
- Wind
- Landfill gas
- Combined cycle turbine
- Hydro efficiency
- Solar thermal
- Solar photovoltaic (PV)

The eight portfolios were named to reflect the resource strategy, or a dominant new resource. The portfolios were designed with the following objectives.

Produce portfolios that will meet the resource adequacy requirement (Appendix 6) and I-937 renewable portfolio standard requirements;

- Use lower cost resources (if possible) in the early years to maximize portfolio value;
- Avoid large resource commitments in the early years by using exchanges, market purchases and sales, and conservation;
- Use scalable resources when possible as opposed to separate projects (e.g. wind, geothermal, combustion turbines);

Table 1: Summary of Initial Portfolios at 5-, 10-, and 20-Years (aMW)

Plans (Contract Amounts)	5-Years		10-Years		20-Years	
	2017 Conservation	2017 Renewables	2022 Conservation	2022 Renewables	2031 Conservation	2031 Renewables
Renewables: Base Conservation (Accelerated)	83	0	153	38	237	218
Renewables: Lower Conservation (Accelerated)	71	0	128	62	206	248
Renewables: Higher Conservation (Accelerated)	93	0	173	18	237	218
Renewables: Constant Rate Conservation	74	0	132	58	237	218
Wind and Gas	83	0	153	35	237	125
Mixed Resources	83	0	153	43	237	168
Renewables: No Wood Waste Biomass	83	0	153	38	237	218
Natural Gas	83	0	153	0	237	0

- Ensure that there is sufficient generation in summer months to meet load growth and proposed seasonal exchanges; and
- Avoid resources in the early years that would require new transmission to be constructed on an unreasonably short timeline.

RENEWABLE ENERGY CREDITS (RECS)

Evaluation of REC strategies was an important issue in the 2010 Integrated Resource Plan (IRP). Since then, sufficient RECs have been acquired to meet expected requirements under I-937 through the year 2020. Targets for compliance with I-937 were established based upon the formula and information stated within the 2006 legislation (RCW 19.285), rulemaking, and City Light's system load forecast.

REC prices in the Pacific Northwest (PNW) have fallen precipitously as the result of legislation, regulatory decisions in California and transmission congestion. California's SBX1-2 increases its requirements for renewable energy under the renewable portfolio standard, but at the same time it limits the use of tradable renewable energy credits (TRECs) to 25 percent of a utility's requirement. By 2017, the cap on the use of TRECs will tighten to 10 percent. In a 2012 decision by the California Public Utilities Commission, the amount of RECs that can be purchased from outside California was capped. Pacific Northwest wind generators are also constrained from selling wind energy (including the RECs) in California by transmission congestion. The combined effects of the regulatory decisions and transmission congestion are that the California market for RECs sourced from the Pacific Northwest is greatly diminished. This has prompted wind project developers in the Pacific Northwest to begin selling surplus RECs at reduced prices.

As a result of the regulatory actions in California, City Light's estimated long-term cost of RECs is now expected to be roughly half of what it was forecast to be in the 2010 IRP. The IRP portfolio analyses included the estimated cost of any incremental RECs beyond those already acquired. These additional REC costs were small in comparison to total portfolio costs and had no impact on the relative portfolio rankings.

PERFORMANCE MEASURES

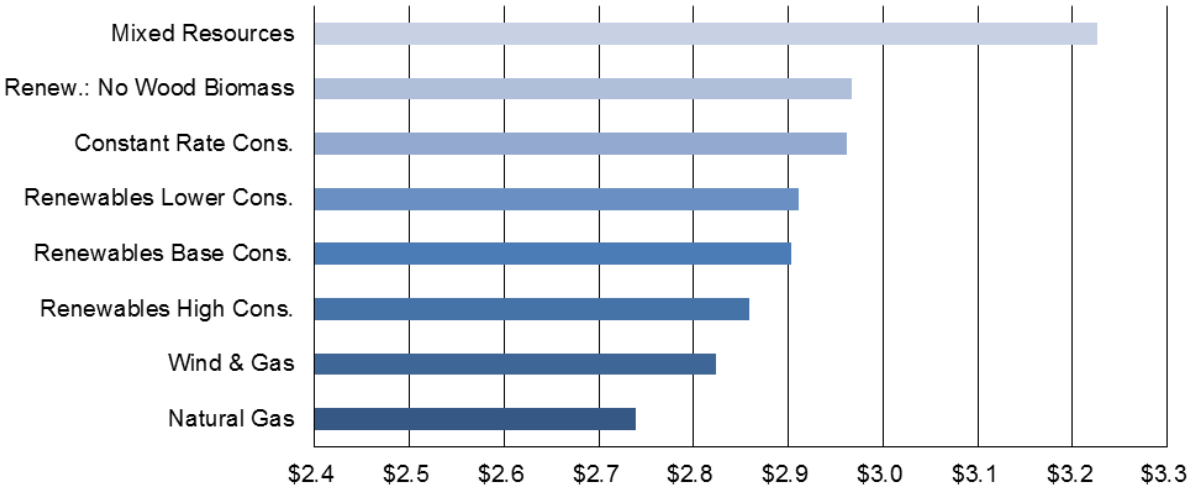
Financial measures of performance are used to evaluate the portfolios. A key measure is the net present value (NPV) of net power costs (NPC) of the portfolios over the 20-year study period. The net power costs are the total costs of the portfolio, less the revenues received from any surplus power sales. The net power costs of the portfolio include costs for emissions (if applicable) of carbon dioxide, sulfur dioxide, mercury, and particulate. Another measure used in initial evaluations of the portfolios was the mean absolute deviation. This measure is an indicator of the risk to the financial performance of the portfolio. It measures the deviation from the mean, or the degree of variation from expected financial performance in dollar terms.

PORTFOLIO PERFORMANCE

The IRP puts the portfolios through a screening process based upon portfolio performance measures and City of Seattle energy policies that result in the selection of a preferred portfolio. The preferred portfolio, with an action plan, becomes the IRP.

Initially, deterministic studies of all the portfolios for the years 2012 through 2031 were completed. The 20-year net present value of the net power costs was calculated to determine performance under the expected demand, hydro conditions, and operating constraints (Figure 1). The net power costs of the portfolios were reviewed under alternative discount rates and time spans to test the sensitivity of the rankings. In

Figure 1: Net Present Value of the Net Power Cost by Portfolio



addition, the mean absolute deviation was calculated by portfolio.

Using the measures calculated in this step, City Light eliminated three of the portfolios. The eliminated portfolios were mixed resources, renewables: no waste wood biomass, and natural gas. The remaining five portfolios were advanced to the next stage of analysis. One of the portfolios was dropped from further consideration not for performance reasons, but because it did not comply with City of Seattle policy. The natural gas portfolio was eliminated from further consideration because it was in conflict with City Council resolution 30144. This portfolio was known to be inconsistent with City policy from the start, but was included in the IRP analysis to comply with state law, which directs utilities to evaluate both nonrenewable and renewable resources in their IRPs.

SECOND ROUND OF ANALYSIS

A stochastic risk analysis was completed to provide improved information about the degree of risk in each of the remaining five portfolios. The stochastic risk analysis (Appendix 10) evaluated the impacts of volatility in hydro, demand, and fuel prices for each of the five remaining portfolios. With the cost comparison already available from previous analysis, adding detailed information about the risk inherent in each portfolio made the relative performance of the portfolios more evident. Two more portfolios, renewables: lower conservation, and renewables: constant rate conservation, were dropped from further consideration.

To consider uncertainty in future national policy on climate change, scenarios were constructed using a low, expected, and high cost per ton of carbon dioxide emissions. The remaining top three portfolios were evaluated in the context of the three scenarios for carbon dioxide emissions costs, yielding the result that their relative ranking remained the same under all three scenarios.

The scenarios showed that the worst case for all three of the top performing portfolios is the low carbon dioxide emissions cost scenario. In this scenario, non-renewable generating resources in the electricity marketplace maintain a significant cost advantage over City Light's proposed new resources. Given that the portfolios consist mostly of conservation and renewable resources, there was no surprise that the top three portfolios all performed best in the high carbon dioxide emissions cost scenario.

The Seattle City Light IRP process includes providing the Seattle City Council with the top three candidate resource portfolios. Providing three portfolios instead of a single recommended portfolio is to ensure that the City Council is given more perspective on the available resource choices and to allow policy issues to be brought into a process that is otherwise quantitative in nature. With the support of the IRP stakeholder committee, the remaining top three portfolios in performance were submitted to the Seattle City Council for their consideration. These portfolios, in order of performance, were:

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

At this stage in the 2012 IRP, Seattle City Light, the 2012 IRP stakeholders, and the Seattle City Council began to qualitatively evaluate the top three portfolios based upon a variety of factors. These factors included potential rate impacts, consistency with the Seattle City Light strategic plan, consistency with City of Seattle policies on greenhouse gas emissions, and potential (unquantified) risks associated with selecting natural gas-fired generation as a resource. Many of these factors are discussed in the attached letter to the Seattle City Council from 2012 IRP Stakeholders.

With the approval of the Seattle City Council, the renewables: base conservation portfolio was selected as the 2012 preferred portfolio.

Figure 2: Resource Portfolios Evaluated in the 2012 IRP
Renewables: Base Conservation
(Average Megawatts)

	Conservation	Landfill Gas	W. Waste Biomass	Hydro Efficiency	Wind	Geothermal	Photovoltaic	Short-Term Market	RECs	Total RECs & Resources
2012	14									14
2013	27									27
2014	41									41
2015	55									55
2016	69									69
2017	83								3	86
2018	97							10		107
2019	111									111
2020	125	8								133
2021	139	8							7	154
2022	153	8	30							191
2023	167	8	40	5	20					240
2024	181	8	40	5	90					323
2025	194	8	40	5	100					347
2026	205	8	40	5	125					382
2027	213	8	40	5	125					390
2028	220	8	40	5	125			15		412
2029	227	8	40	5	125					404
2030	233	8	40	5	125					410
2031	237	8	40	5	125	20	20			455

Figure 3: Resource Portfolios Evaluated in the 2012 IRP
Renewables: Lower Conservation
(Average Megawatts)

	Conservation	Landfill Gas	W. Waste Biomass	Hydro Efficiency	Wind	Geothermal	Photovoltaic	Short-Term Market	RECs	Total RECs & Resources
2012	13									13
2013	25									25
2014	36									36
2015	48									48
2016	59									59
2017	71								3	74
2018	82	8						15		106
2019	94	8								102
2020	105	8						5		118
2021	117	8	20						7	152
2022	128	8	40	5	10					191
2023	140	8	40	5	45					238
2024	151	8	40	5	115					319
2025	163	8	40	5	125	5				346
2026	171	8	40	5	125	20	5			374
2027	179	8	40	5	125	20	5			382
2028	186	8	40	5	125	20	15	10		409
2029	193	8	40	5	125	20	15			406
2030	200	8	40	5	125	20	15			413
2031	206	8	40	5	125	20	50			454

Figure 4: Resource Portfolios Evaluated in the 2012 IRP
Renewables: Higher Conservation
(Average Megawatts)

	Conservation	Landfill Gas	W. Waste Biomass	Hydro Efficiency	Wind	Geothermal	Photovoltaic	RECs	Total RECs & Resources
2012	14								14
2013	29								29
2014	45								45
2015	61								61
2016	77								77
2017	93								93
2018	109								109
2019	125								125
2020	141								141
2021	157							13	170
2022	173	8	10						191
2023	182	8	40	5					235
2024	191	8	40	5	75				319
2025	199	8	40	5	95				347
2026	207	8	40	5	115				375
2027	214	8	40	5	115				382
2028	221	8	40	5	125	10			409
2029	227	8	40	5	125	10			415
2030	232	8	40	5	125	10			420
2031	237	8	40	5	125	20	20		455

Figure 5: Resource Portfolios Evaluated in the 2012 IRP
Wind & Gas
(Average Megawatts)

	Conservation	Wind	Natural Gas C.C. Turbine	Short-Term Market	RECs	Total RECs & Resources
2012	14					14
2013	27					27
2014	41					41
2015	55					55
2016	69					69
2017	83					83
2018	97			10		107
2019	111					111
2020	125					125
2021	139			5	15	159
2022	153	35				188
2023	167	70				237
2024	181	70	75			327
2025	194	70	90			354
2026	205	90	90			384
2027	213	90	90			392
2028	220	100	90			410
2029	227	100	90			417
2030	233	100	90			423
2031	237	125	93			455

Figure 6: Resource Portfolios Evaluated in the 2012 IRP
Mixed Resources
(Average Megawatts)

	Conservation	Landfill Gas	W. Waste Biomass	Hydro Efficiency	Wind	Nat. Gas C.C. Turbine	Geothermal	Solar Thermal	Short-Term Market	RECs	Total RECs & Resources
2012	14										14
2013	27										27
2014	41										41
2015	55										55
2016	69										69
2017	83										83
2018	97								10		107
2019	111	8		5							124
2020	125	8		5							138
2021	139	8		5						2	154
2022	153	8	20	5			10				196
2023	167	8	20	5	35		10				245
2024	181	8	20	5	35	25	10	50			334
2025	194	8	20	5	35	25	10	50			347
2026	205	8	20	5	35	50	10	50			382
2027	213	8	20	5	35	50	10	50			390
2028	220	8	20	5	35	65	10	50			412
2029	227	8	20	5	35	50	10	50			404
2030	233	8	20	5	35	50	10	50			410
2031	237	8	20	5	35	50	20	80			455

Figure 7: Resource Portfolios Evaluated in the 2012 IRP
No Waste Wood Biomass
(Average Megawatts)

	Conservation	Landfill Gas	Hydro Efficiency	Wind	Geothermal	Solar Thermal	Short-Term Market	RECs	Total RECs & Resources
2012	14								14
2013	27								27
2014	41								41
2015	55								55
2016	69								69
2017	83								83
2018	97						10		107
2019	111								111
2020	125								125
2021	139	8						7	154
2022	153	8	5	25					191
2023	167	8	5	55					235
2024	181	8	5	125					319
2025	194	8	5	125	20				352
2026	205	8	5	125	20	20			383
2027	213	8	5	125	20	20			391
2028	220	8	5	125	20	20			398
2029	227	8	5	125	20	20			405
2030	233	8	5	125	20	20			411
2031	237	8	5	125	20	50	10		455

Figure8: Resource Portfolios Evaluated in the 2012 IRP
Natural Gas
(Average Megawatts)

	Conservation	Natural Gas C.C. Turbine	Short-Term Market	RECs	Total RECs & Resources
2012	14				14
2013	27				27
2014	41				41
2015	55				55
2016	69				69
2017	83				83
2018	97		10		107
2019	111				111
2020	125				125
2021	139	5		15	159
2022	153	35		16	204
2023	167	70		18	255
2024	181	140		19	340
2025	194	155		21	370
2026	205	175		22	402
2027	213	175		24	412
2028	220	190		25	435
2029	227	175		30	432
2030	233	180		32	445
2031	237	220		34	491

Figure 9: Resource Portfolios Evaluated in the 2012 IRP
Constant Rate Conservation
(Average Megawatts)

	Conservation	Landfill Gas	W. Waste Biomass	Hydro Efficiency	Wind	Geothermal	Photovoltaic	Short-Term Market	Total RECs & Resources
2012	14								14
2013	27								27
2014	41								41
2015	50								50
2016	62								62
2017	74								74
2018	85	8						15	109
2019	97	8							105
2020	108	8			5				121
2021	120	8	20		5				153
2022	132	8	40	5	5				189
2023	143	8	40	5	40				236
2024	155	8	40	5	115				323
2025	167	8	40	5	120	5			345
2026	179	8	40	5	125	20			376
2027	190	8	40	5	125	20			388
2028	202	8	40	5	125	20	10		410
2029	214	8	40	5	125	20	10		421
2030	225	8	40	5	125	20	10		433
2031	237	8	40	5	125	20	20		455