

## CANDIDATE RESOURCE PORTFOLIO DEVELOPMENT

This appendix provides an overview of the process for developing resource portfolios to meet power supply needs for the utility during the next 20 years. When constructing the resource portfolios the following items are taken into account to develop potential resource combinations (“candidate portfolios”): the load forecast, regulations, resource adequacy, air emissions rates and costs, energy efficiency potential assessment, resource options, and public involvement.

Before selecting a single resource plan to meet the power supply needs as an Integrated Resource Plan (IRP) does, it is necessary to evaluate available resource options to meet these needs and develop candidate portfolios. The Resource Options appendix describes in more depth the resource options considered in this IRP that are used in the development of candidate portfolios.

To develop candidate portfolios City Light uses an optimization tool. The optimization tool constructs the lowest cost possible combinations of alternative resource combinations to meet resource needs that consider regulatory requirements and commercially available technologies. Constraints are set up to take into account City of Seattle, stakeholder, and customer preferences for resource mixes. This approach provides the ability to look at a broad range of options before recommending an IRP preferred plan for meeting resource needs.

### Constructing Portfolios

The candidate resource portfolios each contain all of City Light’s current resources (owned generation and contracts). Contracts are assumed to end at their current expiration date. One key change from previous IRPs, is how City Light is treating the Bonneville Power Administration (BPA) contract. In the past, it was assumed that the BPA contract would be renewed, being that it is anywhere from 39 to 41 percent of the current resources portfolio on average. In the 2016 IRP, the contract is dropped in September of 2028 for seven of the nine portfolios evaluated to evaluate its competitiveness. During portfolio development, different resource options were evaluated as potential replacements for the BPA contract. As determined by the resource needs shown in the resource adequacy study, each portfolio also contains different mixes of new power contracts and energy efficiency. The new resources in each portfolio were designed using an optimization program with criteria.

All candidate resource portfolios were designed to meet requirements for resource adequacy and compliance with the Washington State renewable portfolio standard (RPS). Targets for RPS compliance were established based upon the formula and information stated within the 2006 legislation (RCW 19.285), rulemaking, and City Light’s system long-range load forecast. RCW 19.285 requires electric utilities to have 15 percent of their energy provided by new, renewable resources by 2020. Given the renewable portion of City Light’s current resource portfolio mix, the utility has acquired renewable resources and sufficient RECs to meet RPS requirements through the year 2024. After developing candidate resource portfolios their performance is tested, which is discussed in the Portfolio Analysis appendix. The nine candidate resource portfolios are presented as tables at the end of this appendix.

Based on the screening of resource options, the following resources were available to the optimization program to construct the candidate resource portfolios:

- Base Energy Efficiency
- High Achievement of Energy Efficiency
- Biomass Cogeneration
- Biomass CHP Gasification
- Biomass Landfill Gas
- Geothermal
- Wind
- Combined - Cycle Combustion Turbine (CCCT)
- Simple - Cycle Combustion Turbine (SCCT)
- BPA Hydro (for the portfolios where the existing BPA contract was not extended)
- Small Hydro
- Solar - Thermal
- Solar - Photovoltaic (PV)
- Renewable Energy Credits (RECs)
- Market purchase flexibility (up to 200 MW)

The portfolios were designed with the following objectives:

- Ensure that the resource adequacy and Energy Independence Act requirements are always met each year, and use RECs as needed to fill in short-term deficits.
- Use at a minimum all cost-effective energy efficiency identified in the most recent Conservation Potential Assessment as the first available resource;
- Maximize the use of cost-effective renewable resources in accordance with the Energy Independence Act requirement;
- Resources options are assumed to be Power Purchase Agreement (PPA) contracts with firm energy, such as a shaped BPA block. Since resource options are generic at the time of acquisition of resources the utility would need to decide whether contracts or owning resources make the most sense during the acquisition process.

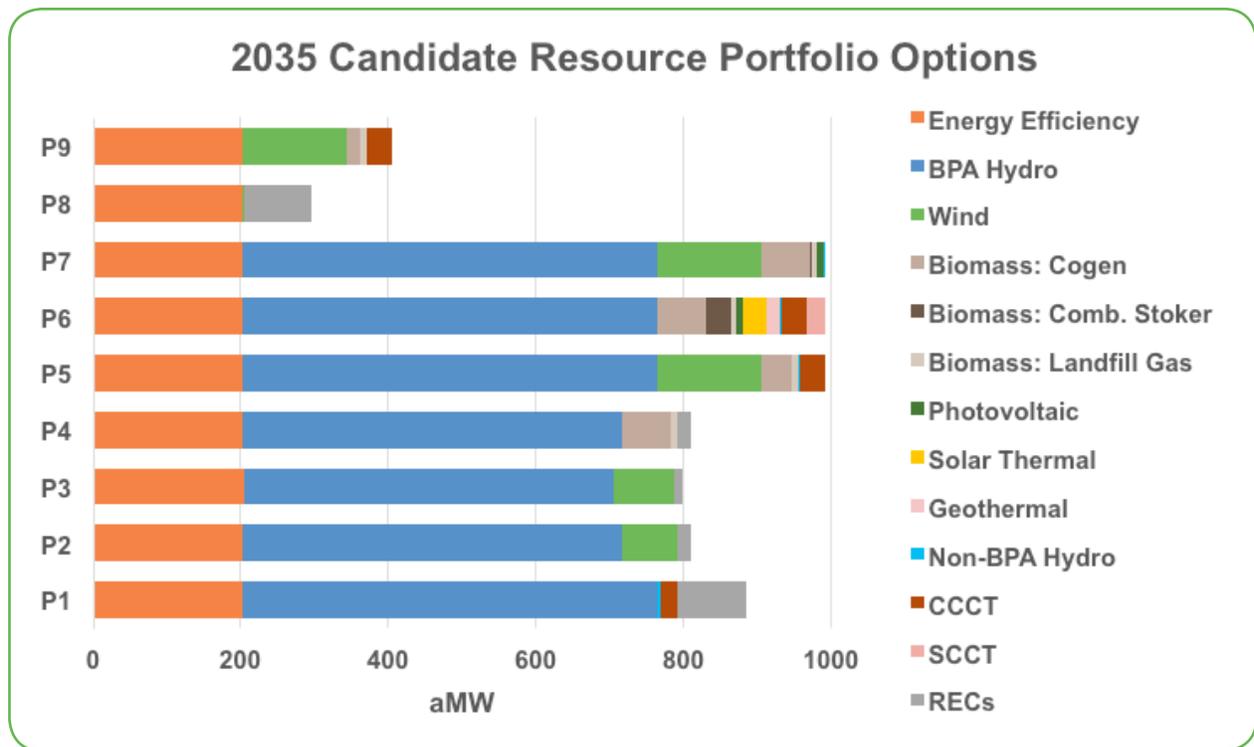
## PORTFOLIO OPTIONS

Using a multi-objective optimization process and considering stakeholder, customer, and City of Seattle preferences the following resource portfolio options were identified:

- BPA contract extension or consideration of a new smaller BPA hydro contract
- Presence or absence of 200 MW of market purchase flexibility
- Level of diversity in portfolios
- Base or high achievement of energy efficiency
- With and without natural gas fired generation (CCCT or SCCT)

Based on the preceding sections, Figure 1 compares the nine City Light’s candidate resource portfolios for the 2016 IRP. All candidate portfolios show cumulative energy at the year ending 2035, with the exception of the RECs which are consumed each calendar year. The candidate resource portfolios were named to reflect the resource strategy, or a dominant new resource. Tables 1 to 9 identify resource additions by calendar year and technology type in cumulative average megawatts, with the exception of the RECs as explained.

**Figure 1: Summary of Candidate Portfolio Options at year ending 2035 (cumulative aMW)**



**Table 1: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 1: Natural Gas with 200 Market Purchase Flexibility**  
**(Average Megawatts)**

	Energy Efficiency	Small Hydro	CCCT	BPA Hydro	RECs	Total RECs & Resources
<b>2016</b>	13					13
<b>2017</b>	25					25
<b>2018</b>	38					38
<b>2019</b>	50					50
<b>2020</b>	63					63
<b>2021</b>	75					75
<b>2022</b>	88					88
<b>2023</b>	100					100
<b>2024</b>	113				11	124
<b>2025</b>	125				13	138
<b>2026</b>	138				12	150
<b>2027</b>	149				57	206
<b>2028</b>	158	3	2	563	56	782
<b>2029</b>	167	3	10	563	61	804
<b>2030</b>	174	3	10	563	68	818
<b>2031</b>	181	3	10	563	75	832
<b>2032</b>	187	3	10	563	75	838
<b>2033</b>	192	3	10	563	76	844
<b>2034</b>	197	3	10	563	93	866
<b>2035</b>	202	3	24	563	93	885

**Table 2: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 2: Wind with 200 Market Purchase Flexibility**  
**(Average Megawatts)**

	Energy Efficiency	Wind	BPA Hydro	RECs	Total RECs & Resources
<b>2016</b>	13				13
<b>2017</b>	25				25
<b>2018</b>	38				38
<b>2019</b>	50				50
<b>2020</b>	63				63
<b>2021</b>	75				75
<b>2022</b>	88				88
<b>2023</b>	100				100
<b>2024</b>	113			11	124
<b>2025</b>	125			13	138
<b>2026</b>	138			12	150
<b>2027</b>	149			57	206
<b>2028</b>	158	56	512		726
<b>2029</b>	167	61	515		743
<b>2030</b>	174	61	515	7	757
<b>2031</b>	181	61	515	14	771
<b>2032</b>	187	61	515	14	777
<b>2033</b>	192	61	515	15	783
<b>2034</b>	197	61	515	32	805
<b>2035</b>	202	75	515	19	811

**Table 3: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 3: High Achievement of Energy Efficiency with 200 Market Purchase Flexibility**  
**(Average Megawatts)**

	Energy Efficiency	Wind	BPA Hydro	RECs	Total RECs & Resources
<b>2016</b>	14				14
<b>2017</b>	29				29
<b>2018</b>	46				46
<b>2019</b>	61				61
<b>2020</b>	78				78
<b>2021</b>	94				94
<b>2022</b>	108				108
<b>2023</b>	121				121
<b>2024</b>	133			2	135
<b>2025</b>	143			12	155
<b>2026</b>	152			11	163
<b>2027</b>	160			56	216
<b>2028</b>	167	56	492		715
<b>2029</b>	175	60	500		735
<b>2030</b>	182	60	500	8	750
<b>2031</b>	188	60	500	14	762
<b>2032</b>	193	60	500	15	768
<b>2033</b>	197	60	500	15	772
<b>2034</b>	201	66	500	27	794
<b>2035</b>	205	83	500	10	798

**Table 4: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 4: Renewables: No Wind with 200 Market Purchase Flexibility**  
**(Average Megawatts)**

	Energy Efficiency	Biomass: Cogen	Biomass: Landfill Gas	Photo-voltaic	BPA Hydro	RECs	Total RECs & Resources
<b>2016</b>	13						13
<b>2017</b>	25						25
<b>2018</b>	38						38
<b>2019</b>	50						50
<b>2020</b>	63						63
<b>2021</b>	75						75
<b>2022</b>	88						88
<b>2023</b>	100						100
<b>2024</b>	113					11	124
<b>2025</b>	125					13	138
<b>2026</b>	138					12	150
<b>2027</b>	149					57	206
<b>2028</b>	158	48	8		512		726
<b>2029</b>	167	53	8		515		743
<b>2030</b>	174	53	8		515		757
<b>2031</b>	181	53	8		515	14	771
<b>2032</b>	187	53	8		515	14	777
<b>2033</b>	192	53	8		515	15	783
<b>2034</b>	197	53	8		515	32	805
<b>2035</b>	202	66	8	1	515	19	811

**Table 5: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 5: Renewables & Natural Gas**  
**(Average Megawatts)**

	Energy Efficiency	CCCT	Wind	Biomass: Cogen	Biomass: Landfill Gas	BPA Hydro	Total RECs & Resources
<b>2016</b>	13	3					16
<b>2017</b>	25	3					28
<b>2018</b>	38	34	52				124
<b>2019</b>	50	34	52				136
<b>2020</b>	63	34	52				149
<b>2021</b>	75	34	52				161
<b>2022</b>	88	34	52				174
<b>2023</b>	100	34	52				186
<b>2024</b>	113	34	52				199
<b>2025</b>	125	34	52				211
<b>2026</b>	138	34	52				224
<b>2027</b>	149	34	52				235
<b>2028</b>	158	34	141	19	8	563	926
<b>2029</b>	167	34	141	27	8	563	943
<b>2030</b>	174	34	141	27	8	563	950
<b>2031</b>	181	34	141	27	8	563	957
<b>2032</b>	187	34	141	27	8	563	963
<b>2033</b>	192	34	141	27	8	563	968
<b>2034</b>	197	34	141	27	8	563	973
<b>2035</b>	202	34	141	41	8	563	992

**Table 6: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 6: Diversity**  
**(Average Megawatts)**

	Energy Efficiency	Geo-thermal	Bio-mass: Cogen	Bio-mass: Comb. Stoker	Small Hydro	CCCT	Photo-voltaic	Bio-mass: Landfill Gas	BPA Hydro	SCCT	Solar Thermal	Total RECs & Resources
<b>2016</b>	13					3						16
<b>2017</b>	25					3						28
<b>2018</b>	38					34		8				124
<b>2019</b>	50		44			34		8				136
<b>2020</b>	63		44			34		8				149
<b>2021</b>	75		44			34		8				161
<b>2022</b>	88		44			34		8				174
<b>2023</b>	100		44			34		8				186
<b>2024</b>	113		44			34		8				199
<b>2025</b>	125		44			34		8				211
<b>2026</b>	138		44			34		8				224
<b>2027</b>	149		44			34		8				235
<b>2028</b>	158	18	66	33	3	34	8	8	563	25	10	926
<b>2029</b>	167	18	66	33	3	34	8	8	563	25	18	943
<b>2030</b>	174	18	66	33	3	34	8	8	563	25	18	950
<b>2031</b>	181	18	66	33	3	34	8	8	563	25	18	957
<b>2032</b>	187	18	66	33	3	34	8	8	563	25	18	963
<b>2033</b>	192	18	66	33	3	34	8	8	563	25	18	968
<b>2034</b>	197	18	66	33	3	34	8	8	563	25	18	973
<b>2035</b>	202	18	66	33	3	34	8	8	563	25	32	992

**Table 7: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 7: Diversity: No Gas**  
**(Average Megawatts)**

	Energy Efficiency	Biomass: Cogen	Biomass: Comb. Stoker	Wind	Photo-voltaic	Biomass: Landfill Gas	BPA Hydro	Small Hydro	Total RECs & Resources
<b>2016</b>	13			3					16
<b>2017</b>	25			3					28
<b>2018</b>	38			86					124
<b>2019</b>	50			86					136
<b>2020</b>	63			86					149
<b>2021</b>	75			86					161
<b>2022</b>	88			86					174
<b>2023</b>	100			86					186
<b>2024</b>	113			86					199
<b>2025</b>	125			86					211
<b>2026</b>	138			86					224
<b>2027</b>	149			86					235
<b>2028</b>	158	53		141		8	563	3	926
<b>2029</b>	167	61		141		8	563	3	943
<b>2030</b>	174	61		141		8	563	3	950
<b>2031</b>	181	61		141		8	563	3	957
<b>2032</b>	187	61		141		8	563	3	963
<b>2033</b>	192	61		141		8	563	3	968
<b>2034</b>	197	61		141		8	563	3	973
<b>2035</b>	202	66	1	141	8	8	563	3	992

**Table 8: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 8: BPA Extension with 200 Market Purchase Flexibility**  
**(Average Megawatts)**

	Energy Efficiency	Wind	RECs	Total RECs & Resources
<b>2016</b>	13			13
<b>2017</b>	25			25
<b>2018</b>	38			38
<b>2019</b>	50			50
<b>2020</b>	63			63
<b>2021</b>	75			75
<b>2022</b>	88			88
<b>2023</b>	100			100
<b>2024</b>	113		11	124
<b>2025</b>	125		13	138
<b>2026</b>	138		12	150
<b>2027</b>	149		57	206
<b>2028</b>	158		56	214
<b>2029</b>	167		61	228
<b>2030</b>	174		68	242
<b>2031</b>	181		75	256
<b>2032</b>	187		75	262
<b>2033</b>	192		76	268
<b>2034</b>	197		93	290
<b>2035</b>	202	2	92	296

**Table 9: Resource Portfolios Evaluated in the 2016 IRP**  
**Portfolio 9: BPA Extension & Resource Mix**  
**(Average Megawatts)**

	Energy Efficiency	Bio-mass: Cogen	Wind	CCCT	Biomass: Landfill Gas	Total RECs & Resources
<b>2016</b>	13			3		16
<b>2017</b>	25			3		28
<b>2018</b>	38		90	34		162
<b>2019</b>	50		90	34		174
<b>2020</b>	63		90	34		187
<b>2021</b>	75		90	34		199
<b>2022</b>	88		113	34		235
<b>2023</b>	100		113	34		247
<b>2024</b>	113		120	34		267
<b>2025</b>	125		120	34		279
<b>2026</b>	138		120	34		292
<b>2027</b>	149		120	34		303
<b>2028</b>	158		120	34		312
<b>2029</b>	167		123	34		324
<b>2030</b>	174		129	34		337
<b>2031</b>	181		134	34		349
<b>2032</b>	187		134	34		355
<b>2033</b>	192		139	34		365
<b>2034</b>	197	1	141	34	8	381
<b>2035</b>	202	19	141	34	8	404