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ENERGY

# Assessing DR Program Potential for the Seventh Power Plan

*Prepared for the Northwest Power and Conservation Council*

*February 25, 2015*

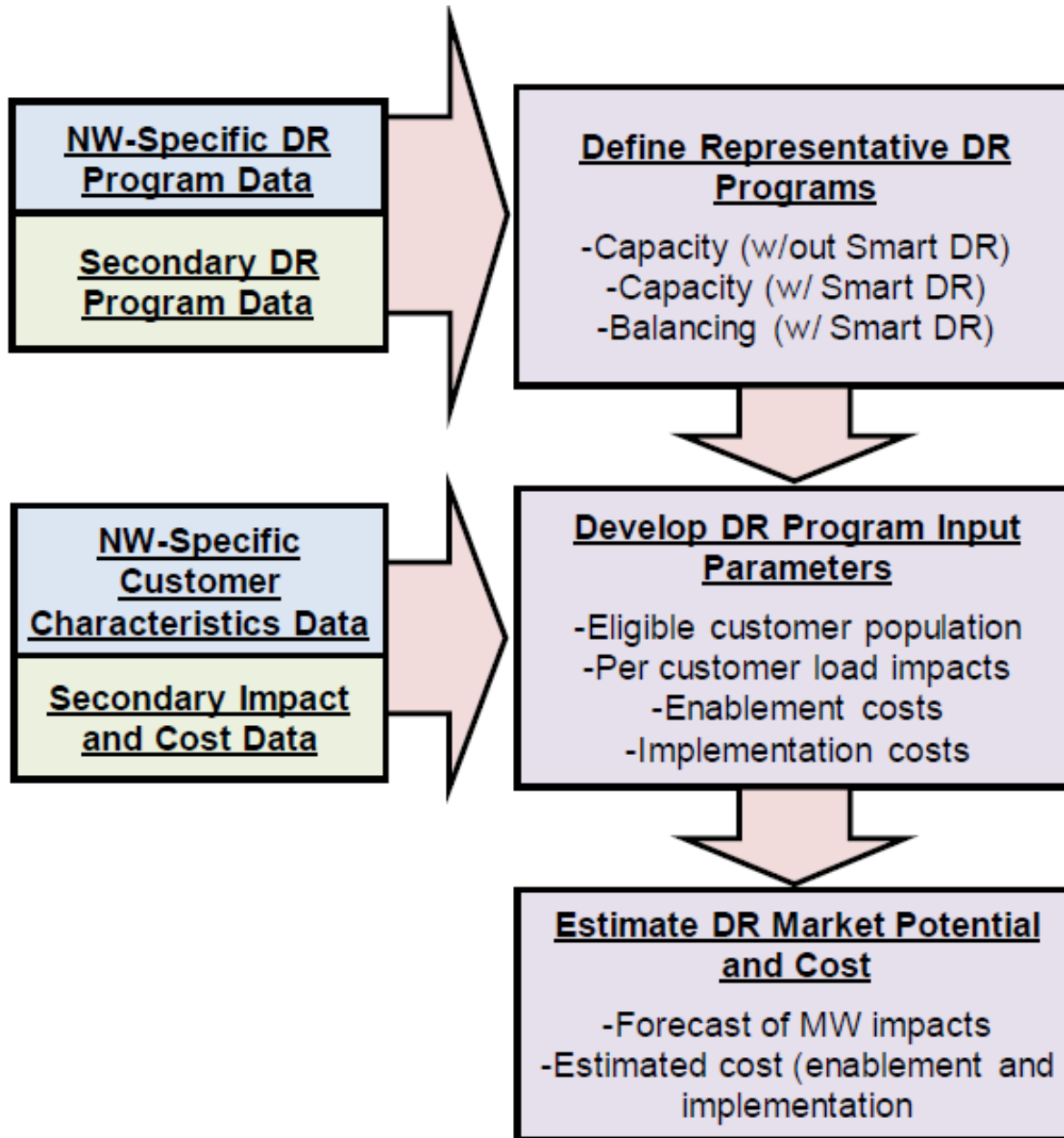
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# Agenda:

1	Introduction	11:00 – 11:05
2	Methodology	11:05 – 11:15
3	Results and Observations	11:10 – 11:30
4	Q&A	11:30 – 12:00

- This DR market potential assessment was intended to establish a framework by which DR market potentials could be considered as NPCC develops modeling inputs to support DR-related forecasts for the Seventh Power Plan.
- Data sources used:
  - Northwest-specific data sources, including DR program plans and assessments from the regulated utilities.
  - Information about DR programs and data gaps prepared by Navigant for BPA.
  - Existing information about DR programs from non-Northwest sources, including Navigant-compiled DR program data from other utilities outside of the region.



- DR program type
- DR technology type
- Enablement costs (\$/customer)
  - Technology costs
  - Installation costs
  - Incentives
- Implementation costs (\$/kW-yr)
- Load impacts (kW/customer)
- Saturation rate (%)
- Participation rate (%)
- Load impact seasonality (% load impact)

- DR programs tailored to unique conditions in the Northwest:
  - Residential Space Cooling
  - Residential Space Heating
  - Residential Water Heating
  - Small Commercial Space Cooling
  - Medium Commercial Space Cooling
  - Commercial Lighting Controls
  - Agricultural Irrigation Pumping
  - Industrial Curtailable / Interruptible
  - Industrial Load Aggregator
  - Industrial Refrigerated Warehouses

- Capacity DR programs with basic and advanced (“*smart*”) technologies.
- Balancing services DR programs with advanced (“*smart*”) technologies.

DR Program Type	Capacity		Balancing Services
	With Basic Technology	With Advanced Technology	
1. Residential DR	X	X	X
2. Commercial DR	X	X	X
3. Industrial/Agricultural DR	X	X	X

# DR Program Technologies

Capacity					
DR Program Type	Basic Technology	Advanced Technology			
	DLC Switch	PCT	AutoDR	Water Heater Controls	Refrigerated Warehouse Controls
Residential DR	X	X		X	
Commercial DR	X	X	X		
Industrial/Agricultural DR	X		X		X

Balancing Services					
DR Program Type	Basic Technology	Advanced Technology			
	DLC Switch	PCT	AutoDR	Water Heater Controls	Refrigerated Warehouse Controls
Residential DR				X	
Commercial DR			X		
Industrial/Agricultural DR			X		X



# Summary of Results

Capacity (Base + Smart DR ) Programs								
	2015		2020		2025		2030	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
<b>Total Load Impact (MW)</b>	141	130	3,039	2,837	3,242	3,026	3,436	3,208
<b>Total Load Impact (%)</b>	0.42%	0.42%	8.38%	8.41%	8.48%	8.35%	8.51%	8.18%
<b>Total Program Cost (\$)</b>	\$ 35,615,367		\$ 210,786,970		\$ 94,628,668		\$ 98,834,454	

Balancing Programs								
	2015		2020		2025		2030	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
<b>Total Load Impact (MW)</b>	1	1	242	278	258	297	274	315
<b>Total Load Impact (%)</b>	0.00%	0.00%	0.67%	0.72%	0.68%	0.71%	0.68%	0.70%
<b>Total Program Cost (\$)</b>	\$ 72,438		\$ 16,636,820		\$ 10,852,975		\$ 11,465,038	

- DR programs assumed to ramp up over a 5-year period from 2015 to 2020, reaching a steady state of modest growth through 2030.
- Total program cost includes enablement costs (technology and installation) and program implementation costs.

# Summary of Results

Capacity (Base + Smart DR ) Programs								
	2015		2020		2025		2030	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
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<b>Total Program Cost (\$)</b>	\$ 72,438		\$ 16,636,820		\$ 10,852,975		\$ 11,465,038	

- Estimated cumulative DR market potential for capacity programs represents just over 8.5% of winter peak load by 2030.
- Balancing programs likely yield lower load impacts and program costs due to limited data on program experience. Additional future program experience will allow for more comprehensive analyses.

# DR Market Potential for Northwest Capacity Programs with Basic Technology

	Capacity - Base							
	2015		2020		2025		2030	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
<b>Load Impact (MW)</b>								
<b>Residential</b>								
a. Space Cooling - CAC Switch	0.00	7.71	0.00	99.60	0.00	106.33	0.00	112.66
b. Space Cooling - RAC Switch	0.00	0.35	0.00	4.48	0.00	4.78	0.00	5.07
c. Space Heating - Switch	21.09	0.00	272.35	0.00	290.72	0.00	308.03	0.00
d. Water Heating - Switch	21.86	21.86	470.42	470.42	502.16	502.16	532.06	532.06
<b>Total</b>	<b>42.96</b>	<b>29.92</b>	<b>742.77</b>	<b>574.51</b>	<b>792.89</b>	<b>613.27</b>	<b>840.09</b>	<b>649.79</b>
<b>Commercial</b>								
a. Space Cooling, Small - Switch	0.25	1.27	3.25	16.26	3.47	17.33	3.68	18.38
b. Space Cooling, Medium - Switch	0.68	3.39	8.71	43.54	9.28	46.42	9.85	49.23
<b>Total</b>	<b>0.93</b>	<b>4.65</b>	<b>11.96</b>	<b>59.80</b>	<b>12.75</b>	<b>63.76</b>	<b>13.52</b>	<b>67.61</b>
<b>Agricultural / Industrial</b>								
a. Irrigation Pumping - Switch	0.00	0.43	0.00	9.11	0.00	9.71	0.00	10.30
b. Curtailable/Interruptible Tariff	24.10	24.10	516.03	516.03	550.19	550.19	583.47	583.47
<b>Total</b>	<b>24.10</b>	<b>24.52</b>	<b>516.03</b>	<b>525.14</b>	<b>550.19</b>	<b>559.90</b>	<b>583.47</b>	<b>593.76</b>
<b>GRAND TOTAL</b>	<b>67.98</b>	<b>59.10</b>	<b>1,270.76</b>	<b>1,159.44</b>	<b>1,355.83</b>	<b>1,236.93</b>	<b>1,437.09</b>	<b>1,311.16</b>

- 1,437 MW winter impact and 1,311 MW summer impact by 2030.

- Bulk of savings from residential space heating, residential water heating, and curtailable/interruptible programs.

# DR Program Cost for Northwest Capacity Programs with Basic Technology

	Capacity - Base			
	2015	2020	2025	2030
<b>Estimated Program Cost (\$)</b>				
<b>Residential</b>				
Enablement Costs	\$ 8,308,593	\$ 23,243,572	\$ 1,912,496	\$ 1,771,710
Implementation Costs	\$ 1,020,344	\$ 16,937,063	\$ 18,079,924	\$ 19,156,419
<b>Total Program Cost</b>	<b>\$ 9,328,937</b>	<b>\$ 40,180,636</b>	<b>\$ 19,992,420</b>	<b>\$ 20,928,130</b>
<b>Commercial</b>				
Enablement Costs	\$ 365,245	\$ 752,013	\$ 63,065	\$ 58,009
Implementation Costs	\$ 46,535	\$ 597,969	\$ 637,554	\$ 676,111
<b>Total Program Cost</b>	<b>\$ 411,781</b>	<b>\$ 1,349,982</b>	<b>\$ 700,618</b>	<b>\$ 734,120</b>
<b>Agricultural / Industrial</b>				
Enablement Costs	\$ 19,694	\$ 421,774	\$ 449,694	\$ 476,890
Implementation Costs	\$ 245,206	\$ 5,251,401	\$ 5,599,035	\$ 5,937,646
<b>Total Program Cost</b>	<b>\$ 264,900</b>	<b>\$ 5,673,174</b>	<b>\$ 6,048,729</b>	<b>\$ 6,414,537</b>
<b>GRAND TOTAL</b>	<b>\$ 10,005,618</b>	<b>\$ 47,203,792</b>	<b>\$ 26,741,767</b>	<b>\$ 28,076,787</b>

- \$28.1 million by 2030 yields an estimated 1,437 MW of peak load reduction in the winter.
- Largest contributor to total cost comes from residential DR programs.

# DR Market Potential for Northwest Capacity Programs with *Smart* Technology

	Capacity - <i>Smart</i>							
	2015		2020		2025		2030	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
<b>Load Impact (MW)</b>								
<b>Residential</b>								
a. Space Cooling - CAC PCT	0.00	7.71	0.00	232.41	0.00	248.09	0.00	262.86
b. Space Cooling - RAC PCT	0.00	3.47	0.00	104.58	0.00	111.64	0.00	118.29
c. Space Heating - PCT	21.09	0.00	635.48	0.00	678.36	0.00	718.75	0.00
d. Water Heating - WH Controls	2.43	2.43	52.27	52.27	55.80	55.80	59.12	59.12
<b>Total</b>	<b>23.52</b>	<b>13.62</b>	<b>687.75</b>	<b>389.26</b>	<b>734.15</b>	<b>415.53</b>	<b>777.87</b>	<b>440.27</b>
<b>Commercial</b>								
a. Space Cooling, Small - PCT	0.13	0.63	3.79	18.96	4.04	20.22	4.29	21.44
b. Space Cooling, Medium - AutoDR	1.36	6.78	40.64	203.19	43.33	216.64	45.95	229.75
c. Lighting Controls - AutoDR	7.40	7.40	158.48	158.48	168.98	168.98	179.19	179.19
<b>Total</b>	<b>8.88</b>	<b>14.81</b>	<b>202.92</b>	<b>380.64</b>	<b>216.35</b>	<b>405.84</b>	<b>229.43</b>	<b>430.38</b>
<b>Agricultural / Industrial</b>								
a. Irrigation Pumping - AutoDR	0.00	0.21	0.00	4.55	0.00	4.85	0.00	5.15
b. Curtailable/Interruptible - AutoDR	24.10	24.10	516.03	516.03	550.19	550.19	583.47	583.47
c. Load Aggregator - AutoDR	6.02	6.02	129.01	129.01	137.55	137.55	145.87	145.87
d. Refrigerated Warehouses - Controls	10.84	12.05	232.22	258.02	247.59	275.10	262.56	291.73
<b>Total</b>	<b>40.96</b>	<b>42.38</b>	<b>877.26</b>	<b>907.61</b>	<b>935.33</b>	<b>967.69</b>	<b>991.90</b>	<b>1,026.22</b>
<b>GRAND TOTAL</b>	<b>73.37</b>	<b>70.80</b>	<b>1,767.92</b>	<b>1,677.52</b>	<b>1,885.83</b>	<b>1,789.07</b>	<b>1,999.19</b>	<b>1,896.87</b>

- 1,999 MW winter impact and 1,897 MW summer impact by 2030.
- Bulk of savings from residential space heating programs using PCT technologies and curtailable/interruptible programs that deploy AutoDR technologies.

# DR Program Cost for Northwest Capacity Programs with *Smart* DR Technology

	Capacity - <i>Smart</i>			
	2015	2020	2025	2030
<b>Estimated Program Cost (\$)</b>				
<b>Residential</b>				
Enablement Costs	\$ 18,812,526	\$ 89,895,260	\$ 7,396,638	\$ 6,852,147
Implementation Costs	\$ 867,736	\$ 25,618,560	\$ 27,347,221	\$ 28,975,499
<b>Total Program Cost</b>	<b>\$ 19,680,263</b>	<b>\$ 115,513,820</b>	<b>\$ 34,743,859</b>	<b>\$ 35,827,646</b>
<b>Commercial</b>				
Enablement Costs	\$ 3,744,040	\$ 15,479,650	\$ 1,298,138	\$ 1,194,082
Implementation Costs	\$ 296,194	\$ 7,612,845	\$ 8,116,803	\$ 8,607,681
<b>Total Program Cost</b>	<b>\$ 4,040,234</b>	<b>\$ 23,092,495</b>	<b>\$ 9,414,941</b>	<b>\$ 9,801,764</b>
<b>Agricultural / Industrial</b>				
Enablement Costs	\$ 860,945	\$ 2,954,372	\$ 247,756	\$ 227,897
Implementation Costs	\$ 1,028,307	\$ 22,022,492	\$ 23,480,345	\$ 24,900,361
<b>Total Program Cost</b>	<b>\$ 1,889,252</b>	<b>\$ 24,976,863</b>	<b>\$ 23,728,101</b>	<b>\$ 25,128,258</b>
<b>GRAND TOTAL</b>	<b>\$ 25,609,749</b>	<b>\$ 163,583,179</b>	<b>\$ 67,886,901</b>	<b>\$ 70,757,667</b>

- \$70.8 million by 2030 yields an estimated 1,999 MW of peak load reduction in the winter.
- Largest contributor to total cost comes from enablement technologies associated with residential DR programs.

# DR Market Potential for Northwest Balancing Programs

	Balancing							
	2015		2020		2025		2030	
	Winter	Summer	Winter	Summer	Winter	Summer	Winter	Summer
<b>Load Impact (MW)</b>								
<b>Residential</b>								
a. Water Heating - WH Controls	0.03	0.03	12.94	12.94	13.81	13.81	14.63	14.63
<b>Total</b>	<b>0.03</b>	<b>0.03</b>	<b>12.94</b>	<b>12.94</b>	<b>13.81</b>	<b>13.81</b>	<b>14.63</b>	<b>14.63</b>
<b>Commercial</b>								
a. Space Cooling, Medium - AutoDR	0.01	0.05	0.00	30.17	0.00	32.17	0.00	34.12
b. Lighting Controls - AutoDR	0.05	0.05	23.53	23.53	25.09	25.09	26.61	26.61
<b>Total</b>	<b>0.07</b>	<b>0.11</b>	<b>23.53</b>	<b>53.71</b>	<b>25.09</b>	<b>57.26</b>	<b>26.61</b>	<b>60.73</b>
<b>Agricultural / Industrial</b>								
a. Irrigation Pumping - AutoDR	0.00	0.00	0.00	0.90	0.00	0.96	0.00	1.02
b. Curtailable/Interruptible - AutoDR	0.30	0.30	127.72	127.72	136.17	136.17	144.41	144.41
c. Load Aggregator - AutoDR	0.07	0.07	31.93	31.93	34.04	34.04	36.10	36.10
d. Refrigerated Warehouses - Controls	0.11	0.12	45.98	51.09	49.02	54.47	51.99	57.76
<b>Total</b>	<b>0.48</b>	<b>0.49</b>	<b>205.63</b>	<b>211.64</b>	<b>219.24</b>	<b>225.65</b>	<b>232.50</b>	<b>239.29</b>
<b>GRAND TOTAL</b>	<b>0.58</b>	<b>0.63</b>	<b>242.10</b>	<b>278.28</b>	<b>258.14</b>	<b>296.72</b>	<b>273.74</b>	<b>314.65</b>

- 274 MW winter impact and 315 MW summer impact by 2030.
- Bulk of savings from curtailable/interruptible and refrigerated warehouses programs.
- DR potential and cost estimates are likely low, due to limited data on program experience.

# DR Program Cost for Northwest Balancing Programs

	Balancing			
	2015	2020	2025	2030
<b>Estimated Program Cost (\$)</b>				
<b>Residential</b>				
Enablement Costs	\$ 16,292	\$ 2,016,363	\$ 93,376	\$ 86,503
Implementation Costs	\$ 1,127	\$ 485,119	\$ 517,854	\$ 548,687
<b>Total Program Cost</b>	<b>\$ 17,419</b>	<b>\$ 2,501,482</b>	<b>\$ 611,230</b>	<b>\$ 635,190</b>
<b>Commercial</b>				
Enablement Costs	\$ 25,984	\$ 3,794,296	\$ 178,145	\$ 163,865
Implementation Costs	\$ 3,158	\$ 1,611,273	\$ 1,717,937	\$ 1,821,832
<b>Total Program Cost</b>	<b>\$ 29,142</b>	<b>\$ 5,405,569</b>	<b>\$ 1,896,082</b>	<b>\$ 1,985,698</b>
<b>Agricultural / Industrial</b>				
Enablement Costs	\$ 7,699	\$ 943,835	\$ 44,314	\$ 40,762
Implementation Costs	\$ 18,178	\$ 7,785,934	\$ 8,301,350	\$ 8,803,389
<b>Total Program Cost</b>	<b>\$ 25,877</b>	<b>\$ 8,729,769</b>	<b>\$ 8,345,664</b>	<b>\$ 8,844,150</b>
<b>GRAND TOTAL</b>	<b>\$ 72,438</b>	<b>\$ 16,636,820</b>	<b>\$ 10,852,975</b>	<b>\$ 11,465,038</b>

- \$11.5 million by 2030 yields an estimated 274 MW of peak load reduction in the winter.
- Largest contributor to total cost comes from implementation-related activities associated with agricultural/industrial DR programs.



# Questions?

# Key CONTACTS



Thank you.

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## Backup Slides

# DR Market Potential for Northwest Capacity Programs with Basic Technology

	Capacity - Base							
	2015		2020		2025		2030	
	Winter	Summmer	Winter	Summmer	Winter	Summmer	Winter	Summmer
<b>Load Impact (MW)</b>								
<b>Residential</b>								
<b>Total</b>	<b>42.96</b>	<b>29.92</b>	<b>742.77</b>	<b>574.51</b>	<b>792.89</b>	<b>613.27</b>	<b>840.09</b>	<b>649.79</b>
<b>Commercial</b>								
<b>Total</b>	<b>0.93</b>	<b>4.65</b>	<b>11.96</b>	<b>59.80</b>	<b>12.75</b>	<b>63.76</b>	<b>13.52</b>	<b>67.61</b>
<b>Agricultural / Industrial</b>								
<b>Total</b>	<b>24.10</b>	<b>24.52</b>	<b>516.03</b>	<b>525.14</b>	<b>550.19</b>	<b>559.90</b>	<b>583.47</b>	<b>593.76</b>
<b>GRAND TOTAL</b>	<b>67.98</b>	<b>59.10</b>	<b>1,270.76</b>	<b>1,159.44</b>	<b>1,355.83</b>	<b>1,236.93</b>	<b>1,437.09</b>	<b>1,311.16</b>

	Capacity - Base							
	2015		2020		2025		2030	
	Winter	Summmer	Winter	Summmer	Winter	Summmer	Winter	Summmer
<b>Load Impact (% of Peak Load)</b>								
<b>Residential</b>								
Residential DR Programs	0.21%	0.32%	3.47%	5.73%	3.52%	5.47%	3.53%	5.18%
<b>Commercial</b>								
Commercial DR Programs	0.01%	0.04%	0.14%	0.42%	0.14%	0.43%	0.15%	0.43%
<b>Agricultural / Industrial</b>								
Agricultural / Industrial DR Programs	0.39%	0.27%	8.00%	5.50%	8.03%	5.50%	8.01%	5.42%
<b>GRAND TOTAL</b>	<b>0.20%</b>	<b>0.19%</b>	<b>3.50%</b>	<b>3.44%</b>	<b>3.55%</b>	<b>3.42%</b>	<b>3.56%</b>	<b>3.34%</b>

# DR Market Potential for Northwest Capacity Programs with *Smart* Technology

	Capacity - <i>Smart</i>							
	2015		2020		2025		2030	
	Winter	Summmer	Winter	Summmer	Winter	Summmer	Winter	Summmer
Load Impact (MW)								
Residential								
Total	23.52	13.62	687.75	389.26	734.15	415.53	777.87	440.27
Commercial								
Total	8.88	14.81	202.92	380.64	216.35	405.84	229.43	430.38
Agricultural / Industrial								
Total	40.96	42.38	877.26	907.61	935.33	967.69	991.90	1,026.22
<b>GRAND TOTAL</b>	<b>73.37</b>	<b>70.80</b>	<b>1,767.92</b>	<b>1,677.52</b>	<b>1,885.83</b>	<b>1,789.07</b>	<b>1,999.19</b>	<b>1,896.87</b>

	Capacity - <i>Smart</i>							
	2015		2020		2025		2030	
	Winter	Summmer	Winter	Summmer	Winter	Summmer	Winter	Summmer
Load Impact (% of Peak Load)								
Residential								
Residential DR Programs	0.12%	0.15%	3.21%	3.88%	3.26%	3.71%	3.27%	3.51%
Commercial								
Commercial DR Programs	0.12%	0.12%	2.41%	2.69%	2.45%	2.74%	2.46%	2.74%
Agricultural / Industrial								
Agricultural / Industrial DR Programs	0.66%	0.46%	13.61%	9.51%	13.65%	9.50%	13.61%	9.36%
<b>GRAND TOTAL</b>	<b>0.22%</b>	<b>0.23%</b>	<b>4.87%</b>	<b>4.97%</b>	<b>4.93%</b>	<b>4.94%</b>	<b>4.95%</b>	<b>4.84%</b>

# DR Market Potential for Northwest Balancing Programs

Balancing								
	2015		2020		2025		2030	
	Winter	Summmer	Winter	Summmer	Winter	Summmer	Winter	Summmer
Load Impact (MW)								
Residential								
Total	0.03	0.03	12.94	12.94	13.81	13.81	14.63	14.63
Commercial								
Total	0.07	0.11	23.53	53.71	25.09	57.26	26.61	60.73
Agricultural / Industrial								
Total	0.48	0.49	205.63	211.64	219.24	225.65	232.50	239.29
<b>GRAND TOTAL</b>	<b>0.58</b>	<b>0.63</b>	<b>242.10</b>	<b>278.28</b>	<b>258.14</b>	<b>296.72</b>	<b>273.74</b>	<b>314.65</b>

Balancing								
	2015		2020		2025		2030	
	Winter	Summmer	Winter	Summmer	Winter	Summmer	Winter	Summmer
Load Impact (% of Peak Load)								
Residential								
Residential DR Programs	0.00%	0.00%	0.06%	0.13%	0.06%	0.12%	0.06%	0.12%
Commercial								
Commercial DR Programs	0.00%	0.00%	0.28%	0.17%	0.28%	0.17%	0.29%	0.17%
Agricultural / Industrial								
Agricultural / Industrial DR Programs	0.01%	0.01%	3.19%	2.16%	3.20%	2.15%	3.19%	2.12%
<b>GRAND TOTAL</b>	<b>0.00%</b>	<b>0.00%</b>	<b>0.67%</b>	<b>0.72%</b>	<b>0.68%</b>	<b>0.71%</b>	<b>0.68%</b>	<b>0.70%</b>

# Key Assumptions for Capacity Programs – Model Inputs

DR Type		DR Component	Capacity - Base							Load Impact Seasonality		
			DR Technology	Enablement Costs (\$/customer)			Implementation Cost (\$/kW-yr)	Load Impact (kW/customer)	Saturation (%)	Participation (%)	(% load impact)	
				Technology Cost	Installation Cost	Incentive					Winter	Summer
1	Residential DR	Space Heating - DLC	Switch	\$ 60.00	\$ 139	\$ -	\$ 20.00	1.74	33%	25%	100%	0%
		Water Heating - DLC	Switch	\$ 60.00	\$ 46	\$ -	\$ 20.00	0.58	57%	25%	100%	100%
		Space Cooling - CAC DLC	Switch	\$ 60.00	\$ 48	\$ -	\$ 20.00	0.6	35%	25%	0%	100%
		Space Cooling - RAC DLC	Switch	\$ 40.00	\$ 22	\$ -	\$ 20.00	0.27	18%	25%	0%	100%
2	Commercial DR	Space Cooling, Small - CAC DLC	Switch	\$ 100.00	\$ 168	\$ -	\$ 10.00	2.8	35%	15%	20%	100%
		Space Cooling, Medium - CAC DLC	Switch	\$ 100.00	\$ 900	\$ -	\$ 10.00	15	17%	15%	20%	100%
		Lighting Controls	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100%	100%
3	Agricultural / Industrial DR	Irrigation Pumping - DLC	Switch	\$ 100.00	\$ 1,000	\$ -	\$ 10.00	25	70%	20%	0%	100%
		Curtable/Interruptible Tariffs	-	\$ -	\$ -	\$ -	\$ 10.00	500	70%	25%	100%	100%
		Load Aggregator	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	100%	100%
		Refrigerated Warehouses	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	90%	100%

DR Type		DR Component	Capacity - Smart							Load Impact Seasonality		
			DR Technology	Enablement Costs (\$/customer)			Implementation Cost (\$/kW-yr)	Load Impact (kW/customer)	Saturation (%)	Participation (%)	(% load impact)	
				Technology Cost	Installation Cost	Incentive					Winter	Summer
1	Residential DR	Space Heating - DLC	PCT	\$ 696.00	\$ 199.93	\$ -	\$ 25.00	1.74	33%	25%	100%	0%
		Water Heating - DLC	Water Heater Controls	\$ 232.00	\$ 66.64	\$ -	\$ 25.00	0.58	57%	25%	100%	100%
		Space Cooling - CAC DLC	PCT	\$ 240.00	\$ 68.94	\$ -	\$ 25.00	0.6	35%	25%	0%	100%
		Space Cooling - RAC DLC	PCT	\$ 108.00	\$ 31.02	\$ -	\$ 25.00	0.27	18%	25%	0%	100%
2	Commercial DR	Space Cooling, Small - CAC DLC	PCT	\$ 798.48	\$ 229.80	\$ -	\$ 20.00	2.8	35%	15%	20%	100%
		Space Cooling, Medium - CAC DLC	AutoDR	\$ 2,077.50	\$ 1,440.00	\$ -	\$ 20.00	15	17%	15%	20%	100%
		Lighting Controls	AutoDR	\$ 7,894.50	\$ 5,472.00	\$ -	\$ 20.00	57	25%	15%	100%	100%
3	Agricultural / Industrial DR	Irrigation Pumping - DLC	AutoDR	\$ 3,462.50	\$ 2,400.00	\$ -	\$ 20.00	25	35%	20%	0%	100%
		Curtable/Interruptible Tariffs	AutoDR	\$ 2,500.00	\$ 1,250.00	\$ -	\$ 20.00	500	18%	25%	100%	100%
		Load Aggregator	AutoDR	\$ 2,500.00	\$ 1,250.00	\$ -	\$ 50.00	100	18%	25%	100%	100%
		Refrigerated Warehouses	Refrigerated Warehouse Controls	\$ 5,000.00	\$ 2,500	\$ -	\$ 20.00	250	18%	20%	90%	100%

# Key Assumptions for Balancing Services– Model Inputs

DR Type		DR Component	Balancing								Load Impact Seasonality	
			DR Technology	Enablement Costs (\$/customer)			Implementation Cost (\$/kW-yr)	Load Impact (kW/customer)	Saturation (%)	Participation (%)	(% load impact)	
				Technology Cost	Installation Cost	Incentive					Winter	Summer
1	Residential DR	Space Heating - DLC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A
		Water Heating - DLC	Water Heater Controls	\$ 232.00	\$ 66.64	\$ -	\$ 37.50	\$ 0.58	100%	25%	100%	100%
		Space Cooling - CAC DLC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	100%
		Space Cooling - RAC DLC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	0%	100%
2	Commercial DR	Space Cooling, Small - CAC DLC	N/A	N/A	N/A	N/A	N/A	N/A	N/A	N/A	20%	100%
		Space Cooling, Medium - CAC DLC	AutoDR	\$ 2,077.50	\$ 1,440.00	\$ -	\$ 30.00	\$ 15.00	100%	15%	20%	100%
		Lighting Controls	AutoDR	\$ 7,894.50	\$ 5,472.00	\$ -	\$ 30.00	\$ 57.00	100%	15%	100%	100%
3	Agricultural/Industrial DR	Irrigation Pumping - DLC	AutoDR	\$ 3,462.50	\$ 2,400.00	\$ -	\$ 30.00	\$ 25.00	100%	20%	0%	100%
		Curtable/Interruptible Tariffs	AutoDR	\$ 2,500.00	\$ 1,250.00	\$ -	\$ 30.00	\$ 500.00	100%	25%	100%	100%
		Load Aggregator	AutoDR	\$ 2,500.00	\$ 1,250.00	\$ -	\$ 75.00	\$ 100.00	100%	25%	100%	100%
		Refrigerated Warehouses	Refrigerated Warehouse Controls	\$ 5,000.00	\$ 2,500.00	\$ -	\$ 30.00	\$ 250.00	100%	20%	90%	100%