BPA Demand Response Potential Study Results

Lee Hall

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Agenda

1. Overview and purpose
2. Basis for estimates
3. Estimate of DR Potential
4. Barriers Assessment

1. Overview and Purpose

- This is the supply side (amount, cost) of DR over a 20 year horizon with an expected seven year ramp
- This is not the needs or requirements side of the equation
- This is not a study of 2018 DR Potential or 2018 DR Costs

Overview and Purpose Continued

- This study was intended to fulfill the request for a DR Potential Assessment in the 7th Power Plan
- Be a useful tool for BPA Resource Planning
- And it was expanded to include BPA Non-wires potential 2017 locational considerations

Demand Response Potential Study

Background:
In the 7th Plan's Action Plan, **the Council** recommended that the BPA conduct a study of DR potential and an assessment of barriers. The 2018 **BPA Power Resource Program** will model DR as an input.

The study helps answer these questions for BPA:

- ✓ **How cost competitive** *is DR as an alternative for power (e.g. future peaks) and for transmission (e.g. build deferrals)?*
- ✓ **How much (MWs)** *DR is there in BPA service territory and what will it take to get it?*

BPA contracted and selected the Cadmus Group LLC (Cadmus) to perform this work. In addition to the Potential Assessment and Barriers Assessment, Cadmus performed a companion Elasticity Study .

DR Study Parameters

Geography (Primary):
- BPA public power portion of the region.
- I-5 Corridor/West of Cascades and East of Cascades.
- Six geographical areas, as defined by transmission planning.

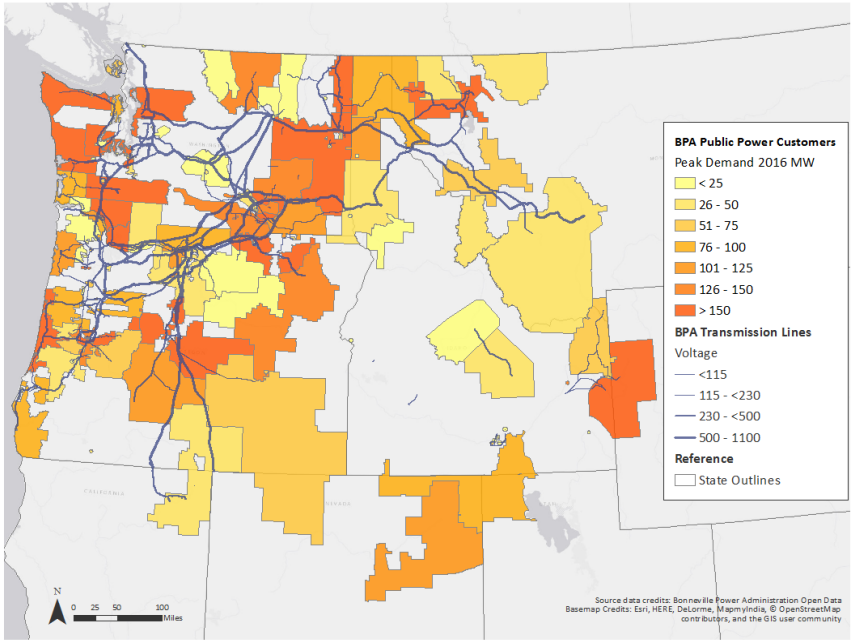
Scope:
- All BPA preference customers.

Timing:
- 20-year potential estimates.
- Aligns with Resource Program and CPA.

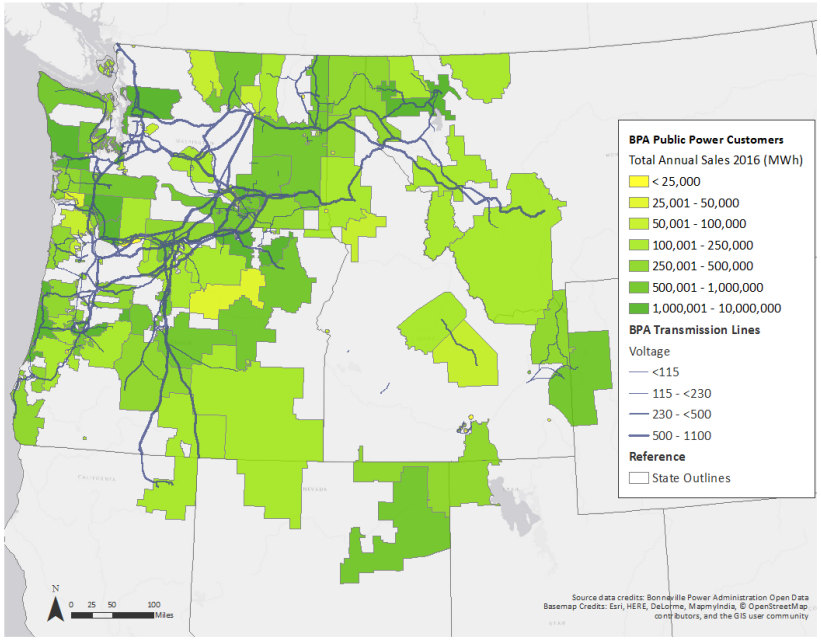
Inputs:
- Interviews w/ 162 stakeholders (incl. 52 BPA power customers) and 454 surveys.
- National and regional cost benchmarking.

Scope of DR Analysis

BPA Preference Customer Peak Demand (2016)



BPA Preference Customer Energy Sales (2016)

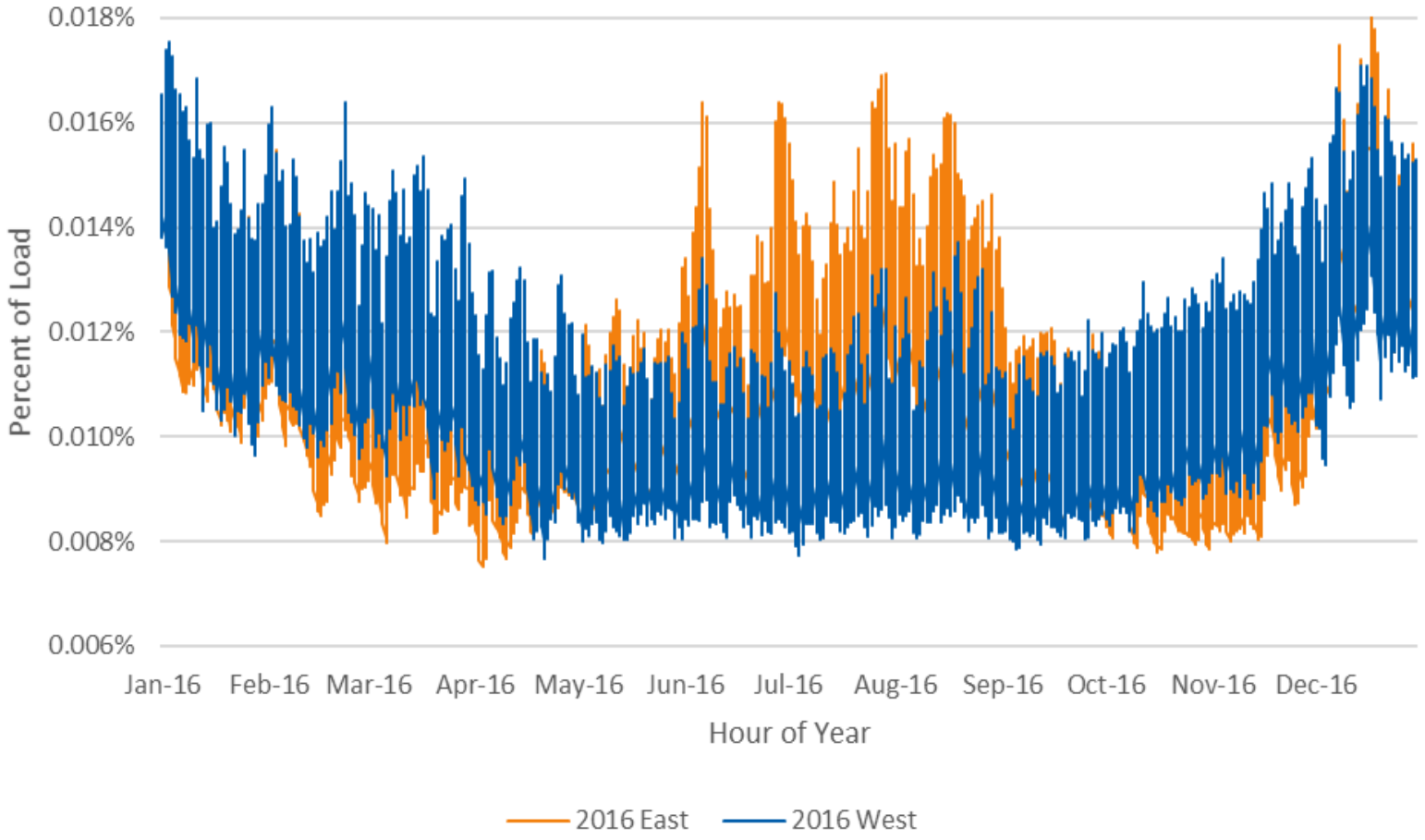


The analysis included all BPA Power preference customers, including federal agencies, direct-service industrial customers, tribal utilities, federal irrigation districts, and one port district. Figures above did not display 10 customers because their map boundaries were not available in BPA-sourced maps.

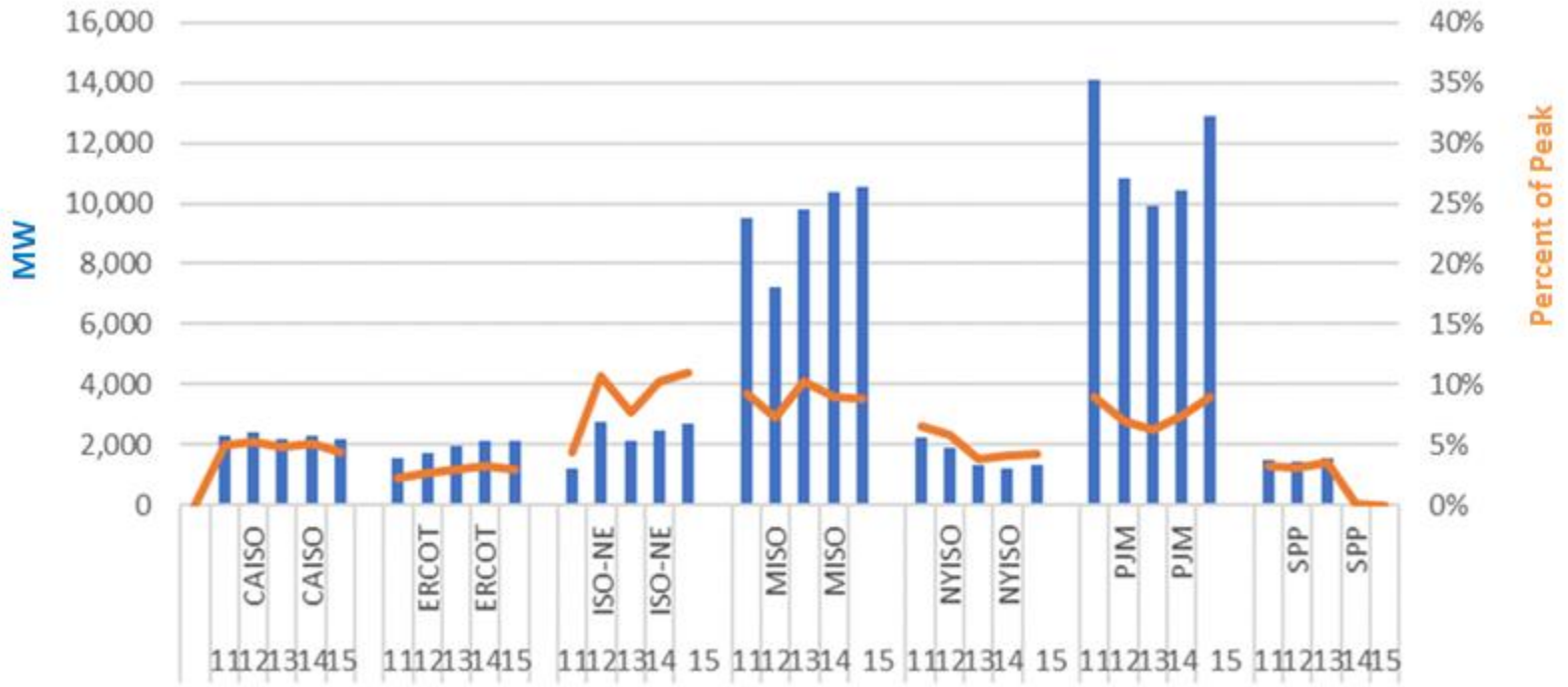
2. Basis for Estimates

- Considered East vs. West in Pacific Northwest
- Comparison of DR across USA and in Pacific Northwest
- DR costs are based on similar programs and achievable rates of adoption

BPA Firm Power Customer Hourly Load Duration, East vs. West (2016)

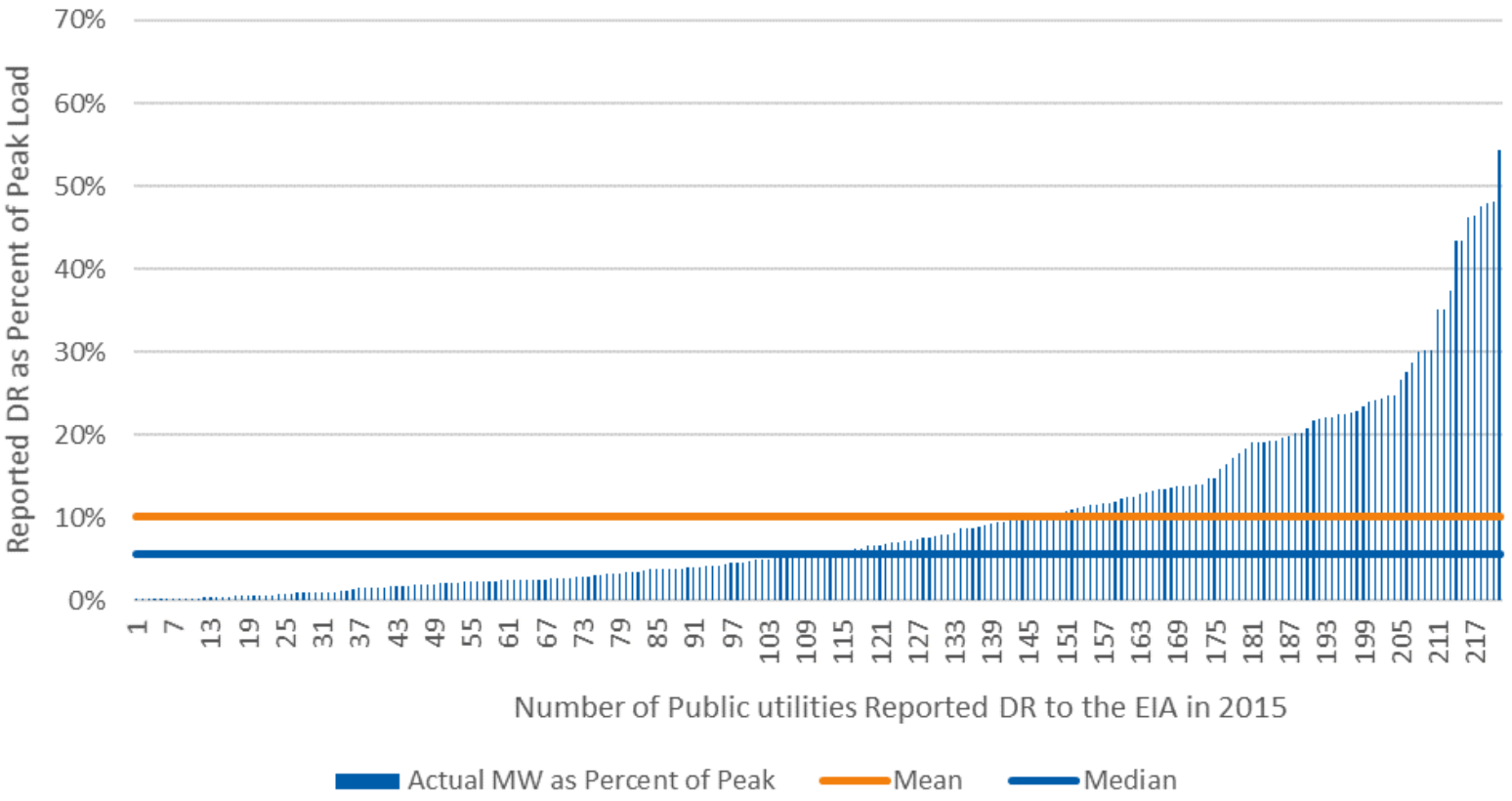


DR Resources in Wholesale Markets of RTOs/ISOs and Peak Load Reduction



Note: None of these markets for DR are unconstrained; DR targets are pre-determined which limits the total amount of DR resources. Values are typical average within each area.

DR Capability as Percent of Peak Load – Public Utilities (2015)

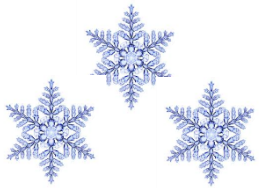


Note: Few utilities reporting DR to EIA are unconstrained. Almost all of the DR reported is target-driven; reports indicate what utilities choose to do, not what is possible to accomplish.

3. Estimate of DR Potential

- **Multiple DR products modeled using current technologies (and costs)**
- **Uses Ramp of 7 years, then overall 20 year levelized cost estimates***
- **Sectors – Residential, Commercial, Industrial, Utility, Agricultural (DR products have different costs)**

Base Case Achievable Potential



Area	Winter Achievable Potential (MW)	Percent of Area System Peak—Winter	Summer Achievable Potential (MW)	Percent of Area System Peak—Summer
West	1,061	9.9%	807	10.8%
East	490	9.6%	795	13.5%
Total	**1,551**	**9.8%**	**1,602**	**12.0%**

The base case was developed by benchmarking research participation rates of common programs. These participation rates are generally a median value and are intended to depict participation in a healthy, established DR program. Most of the products reach a **full ramp within 7 years**, and after that grow with anticipated load rate changes.

The base case values represent the **mean of a range**.

DR Products Modeled

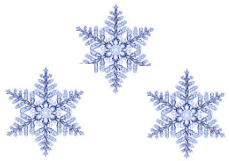
Sector	DR Product	Deployment Mechanism	Seasonality
Residential	**DLC—Water Heating**	DLC	Summer and winter
	DLC—Space Heating	DLC	Winter only
	DLC—Central Air Conditioning (CAC)	DLC	Summer only
	DLC—Smart Thermostats	DLC	Summer and winter
	Critical Peak Pricing (CPP)*	Tariff-Based	Summer and winter
	Behavioral DR	Direct Communication (e.g., event notifications)	Summer and winter
Commercial**	**DLC—CAC**	DLC	Summer only
	Lighting Controls	Automated Response	Summer and winter
	Thermal Storage	Cooling Storage	Summer only
Industrial***	**Real Time Pricing (RTP)***	Tariff-Based	Summer and winter
Commercial and Industrial	**Demand Curtailment and DLC**	Contract (Automated or Manual Response)	Summer and winter
	Interruptible Tariff	Tariff-Based	Summer and winter
Agricultural	**Irrigation DLC**	DLC	Summer
Utility System	**Demand Voltage Reduction (DVR)**	SCADA	Summer and winter

*Cadmus assumed that Time of Use (TOU) rates were already in place.

**In this assessment, Cadmus included public buildings in the commercial sector.

***In this assessment, Cadmus included public process loads such as municipal water treatment plants in the industrial sector.

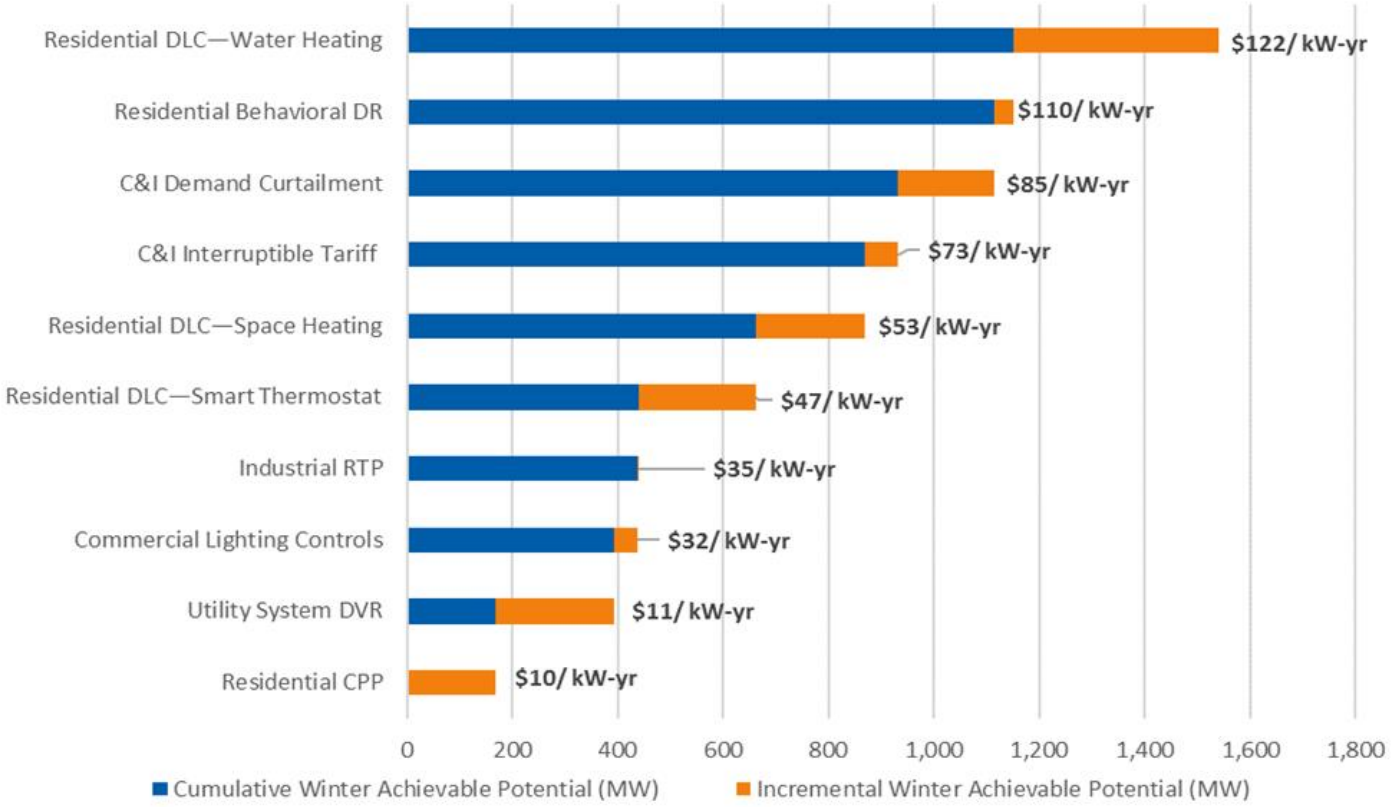
Base Achievable DR – Product View



Product	Winter Achievable Potential (MW)	Percent of Area System Peak - Winter	Levelized Cost ($/kW-year)	Summer Achievable Potential (MW)	Percent of Area System Peak - Summer	Levelized Cost ($/kW-year)
Residential DLC—Space Heating	206	1.3%	$53	0	0.0%	n/a
Residential DLC—Water Heating	389	2.5%	$122	285	2.1%	$167
Residential DLC—CAC	0	0.0%	n/a	113	0.8%	$74
Residential DLC—Smart Thermostat	222	1.4%	$47	120	0.9%	$88
Residential CPP	168	1.1%	$10	57	0.4%	$12
Residential Behavioral DR	37	0.2%	$110	13	0.1%	$111
Commercial DLC—CAC	0	0.0%	n/a	110	0.8%	$29
Commercial Lighting Controls	44	0.3%	$32	55	0.4%	$32
Commercial Thermal Storage	0	0.0%	n/a	9	0.1%	$51
C&I Demand Curtailment	184	1.2%	$85	205	1.5%	$85
C&I Interruptible Tariff	62	0.4%	$73	69	0.5%	$73
Industrial RTP	5	0.0%	$35	5	0.0%	$34
Agricultural Irrigation DLC	0	0.0%	n/a	420	3.1%	$44
Utility System DVR	225	1.4%	$11	133	1.0%	$12
Total	**1,541**	**9.8%**		**1,592**	**11.9%**	

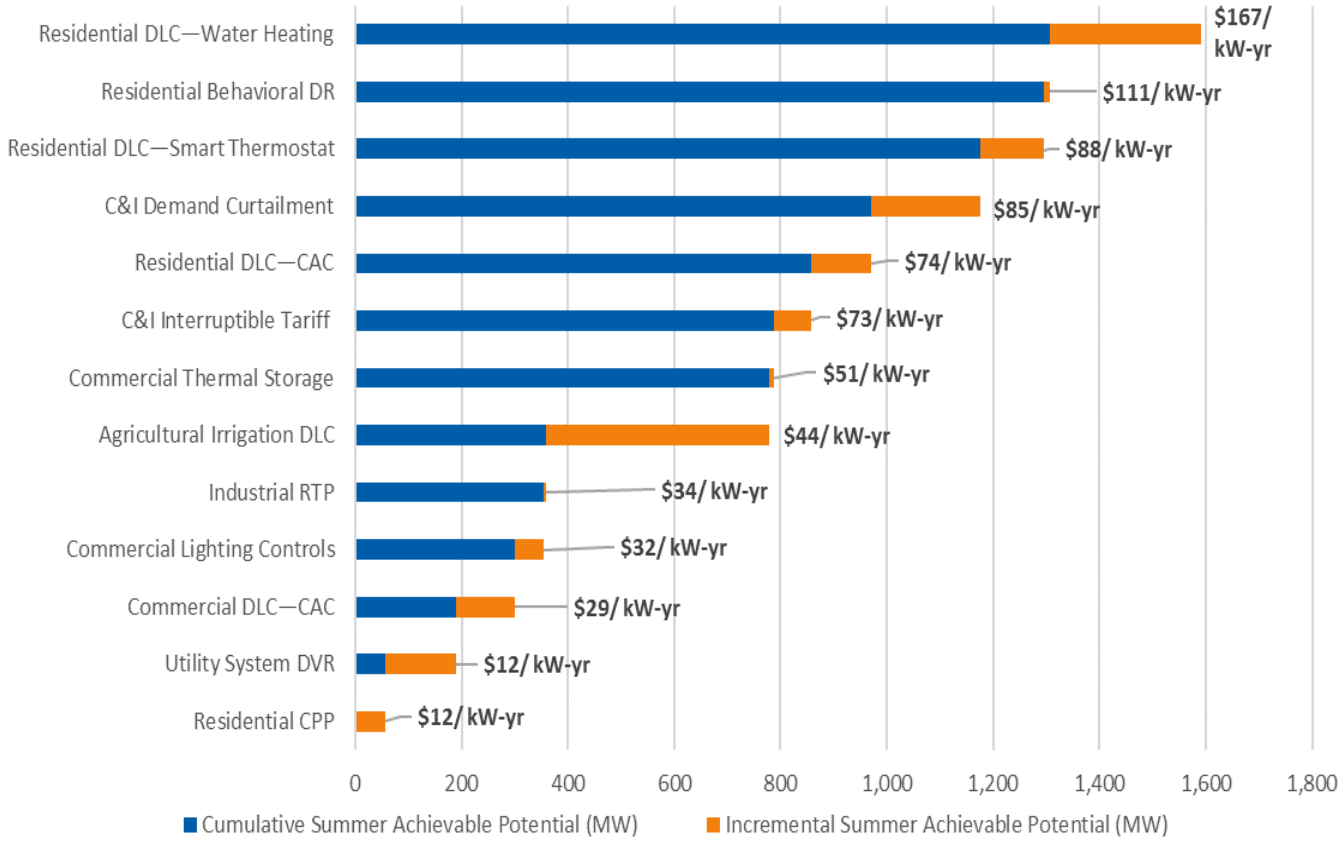
* The total achievable potential values in this detailed potential by product table do not match those in the previous slide because estimated achievable potential for DSI customer was estimated independently.

Winter Base Achievable Potential



Note: Displayed costs are the sum of annual costs, levelized over the 20-year study planning horizon, from the total resource cost perspective.

Summer Base Achievable Potential



Note: Displayed costs are the sum of annual costs, levelized over the 20-year study planning horizon, from the total resource cost perspective.

4. DR Barriers Assessment

- **While the DR Potential study provides a supply curve (amount, cost), the Barrier Study considers barriers to adoption and mitigation strategies**
- **These two are Complementary Studies**
- **Barriers Study briefed earlier (key slide provided)**
- **Both based on strong research methods**

Barriers to DR Development

Findings from 2017 Cadmus Barriers Assessment

Barrier	Demand Response				Distributed Generation				Energy Storage			
	SME n=17	STK n=12	PC n=25	DSP n=7	SME n=16	STK n=12	PC n=25	DSP	SME n=16	STK n=12	PC n=24	DSP n=4
Economic/Market												
Lack of power customer business case	65%	75%	73%	86%	56%	83%	72%		81%	83%	76%	75%
Lack of clearly defined need/value to BPA	59%	42%	64%	100%	56%	42%	56%		50%	50%	58%	75%
Low power costs	56%	46%	70%	71%	59%	92%	85%		65%	58%	69%	25%
Absence of organized market for DERs	61%	54%	59%	57%	13%	23%	24%		35%	46%	55%	50%
Cost of development/ deployment	50%	46%	68%	29%	59%	77%	67%		88%	85%	89%	50%
Lack of well-defined M&V framework	46%	18%	35%	14%	33%	27%	14%		50%	27%	41%	25%
Organizational/Operational												
Competition for human/financial resources	63%	46%	58%	17%	43%	46%	39%		43%	36%	36%	25%
Lack of staff knowledge and capability	44%	50%	30%	43%	47%	50%	19%		47%	58%	23%	0%
Lack of standardized technical specs/agreements	35%	39%	48%	40%	20%	15%	29%		33%	25%	38%	0%
Insufficient intra-organizational coordination/ communication	27%	50%	17%	29%	15%	40%	25%		23%	33%	22%	67%
Infrastructure/Technology												
Data issues (e.g. lack of AMI, poor "big data" tools)	54%	39%	38%	60%	30%	25%	17%		50%	25%	30%	67%
Back office systems	50%	60%	52%	0%	46%	30%	39%		46%	70%	38%	25%
Communication protocols not standard; interoperability issues	36%	50%	48%	0%	18%	18%	17%		27%	46%	30%	25%
Difficulty integrating DERs with current infrastructure	24%	23%	54%	20%	33%	31%	19%		47%	23%	36%	0%
Concerns about cybersecurity	15%	20%	48%	14%	8%	20%	32%		8%	10%	33%	0%
Lack of test facilities & infrastructure for communications to distributed devices	23%	27%	30%	0%	23%	18%	22%		31%	55%	18%	0%
Ability to control/ manage EV charging and discharging	25%	33%	30%	20%	13%	11%	16%		14%	40%	30%	0%
Unstable vendor supply chain	39%	25%	29%	20%	18%	17%	21%		46%	36%	39%	0%
Legal/Regulatory												
Lack of established tariffs & contracts for DER	33%	63%	50%	60%	21%	44%	32%		39%	75%	35%	75%
Concerns about data privacy	31%	27%	54%	14%	8%	9%	24%		8%	10%	29%	0%
Environmental regulation/compliance and permitting/siting issues					0%	0%	24%		33%	42%	18%	0%

Source: Cadmus DER barriers rating survey
Percent of respondents rating the barrier as a 4 or 5 on a 1 to 5 significance rating scale
SME=BPA subject matter expert; STK=external stakeholder; PC= BPA power customer; DSP=DER service provider
Note: Sample sizes identified are maximum sample size for each interview group and DER category. Due to small sample sizes, results should be interpreted as directional

Questions

Lee Hall 503-230-5189
ljhall@bpa.gov