2021 DEMAND RESPONSE POTENTIAL ASSESSMENT

Clark Public Utilities

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Prepared by:

LIGHTHOUSE ENERGY CONSULTING

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Introduction

This report summarizes the 2021 Demand Response Potential Assessment (DRPA) conducted by Lighthouse Energy Consulting (Lighthouse) for Clark Public Utilities (CPU). The assessment generally followed the methodology used by the Northwest Power and Conservation Council (Council) for the draft 2021 Power Plan (2021 Plan) and included many of the same demand response (DR) products. The DR products included are applicable to the residential, commercial, and industrial sectors, impacting both the summer and winter seasons, and utilize a range of strategies including direct load control, customer-initiated demand curtailment, and time-varying prices to effect reductions in peak demand. This assessment updates a similar assessment developed in 2020.

DR has not been widely used in the Northwest but has received increased interest in recent years. DR is defined in the Council's Seventh Power Plan (Seventh Plan) as "voluntary reductions in customer electricity use during periods of high demand and limited resource availability."[1] Growing capacity constraints associated with the closure of regional coal-fired power plants, increases in policies requiring the use of carbon-neutral or renewable energy, and operational limitations placed on the region's hydropower system are all driving a need for cost-effective generation capacity. DR offers a solution to reduce peak demands, help integrate renewable resources, and reduce congestion on transmission and distribution systems.

In addition, the State of Washington recently passed the Clean Energy Transformation Act (CETA), which requires utilities to assess the amount of DR resource potential that is cost-effective, reliable, and feasible, and use that assessment to identify a target for DR in each Clean Energy Implementation Plan (CEIP). The first CEIP is due January 1, 2022, and every subsequent four years.

CPU has a provided conservation programs for its customers since 2015 and achieved over 30 average megawatts from 2014-2018, which is approximately a 5% reduction in energy consumption. Like many utilities in the Northwest, does not currently have an active demand response program, as the need for demand response resources has only recently started to emerge. Regional utilities have been conducting pilots of different demand response program types in an effort to learn what types of programs would work well in the Northwest, and CPU has been an active participant in those programs. In 2017 and 2018, CPU participated in a regional pilot focused on using electric water heaters as a flexible resource to help integrate renewable energy resources. CPU also participated in a commercial demand response pilot program in 2015 and 2016 by facilitating conversations with its large commercial customers and providing metering data. In total, the program included nearly 1.5 MW of load and was successful in providing reduced energy demands when given a 20-minute notice.

[1] Northwest Power and Conservation Council, 'Seventh Northwest Conservation and Electric Power Plan', 2016, https://www.nwcouncil.org/sites/default/files/7thplanfinal_allchapters_1.pdf.

Methodology

This assessment began by identifying the DR products to be included and then quantified CPU's customer base that could adopt them. With these inputs developed, Lighthouse quantified the DR potential.

Like a conservation potential assessment, the DR potential calculation process began with the quantification of technical potential, which is the maximum amount of DR possible without regard to cost or market barriers. The assessment then considered market barriers, program participation rates, and other factors to quantify the achievable potential. Finally, the economic potential is quantified by applying an economic screen to the achievable potential. The methodology used to calculate technical and achievable potential is discussed in further detail below.

Demand Response Products

To determine the products that would be included in this DRPA, Lighthouse reviewed the DR products developed for the 2021 Plan and discussed their applicability to CPU with staff. Based on these discussions, Lighthouse included products targeting both the summer and winter seasons while excluding the agricultural sector as CPU has limited customer load in this area. Lighthouse also excluded demand voltage reduction (DVR), as CPU prefers to implement conservation voltage reduction across its service territory.

DR products that rely on pricing strategies to influence customer behavior typically require advanced metering infrastructure (AMI) to record the time-based impacts. CPU currently has no plans to deploy AMI across its service territory. This assessment presents the results both with and without these products, as the demand response potential associated with these products would not be available until CPU implements AMI. The results that do include these products are intended to show what might be possible, in terms of both potential and cost, over a long-term basis if CPU were to implement AMI. The cost of these products does not include the AMI necessary for implementation.

The high-level categories of DR products included in this assessment are summarized in Table 1 below, which organizes the products by sector and implementation strategy.

Direct load control (DLC) products are those in which the utility has direct control of the operation of applicable equipment. This category includes switches installed on equipment or other equipment with integrated controls such as smart thermostats or grid-enabled hot water heaters. DLC products typically achieve high event participation rates as the participation is only limited by the success of the controlled equipment receiving and implementing any instructions to change its operation. Demand curtailment is like DLC but requires the intervention of customers to implement reductions in load. These products usually involve contracts between the customer and utility that detail the amount, duration, and frequency of load reductions. Time-varying price products rely on a variety of strategies to encourage customers to respond to higher energy or demand prices.

Table 1: Demand Response Products

	Residential	Commercial	Industrial
Direct Load Control	EV Charging Grid-Enabled Water Heater Water Heater Switch Space Heating Switch Smart Thermostat	Space Heating Switch Space Cooling Switch Smart Thermostat	
Demand Curtailment		Demand Curtailment	Demand Curtailment
Time-Varying Prices	Time of Use Pricing Critical Peak Pricing	Critical Peak Pricing	Critical Peak Pricing Real Time Pricing

A complete list of the products used in this assessment is included in the Appendix of this report.

Customer and Sales Forecasts

With the products identified, Lighthouse then quantified the customer base over which the products could be installed. Lighthouse used data provided by CPU and other publicly available data to develop forecasts of sales and customer counts for each sector. These forecasts are shown in Figure 1 and Figure 2. The majority of CPU's customers and sales are in the residential sector.

Figure 1: Sales Forecast by Sector

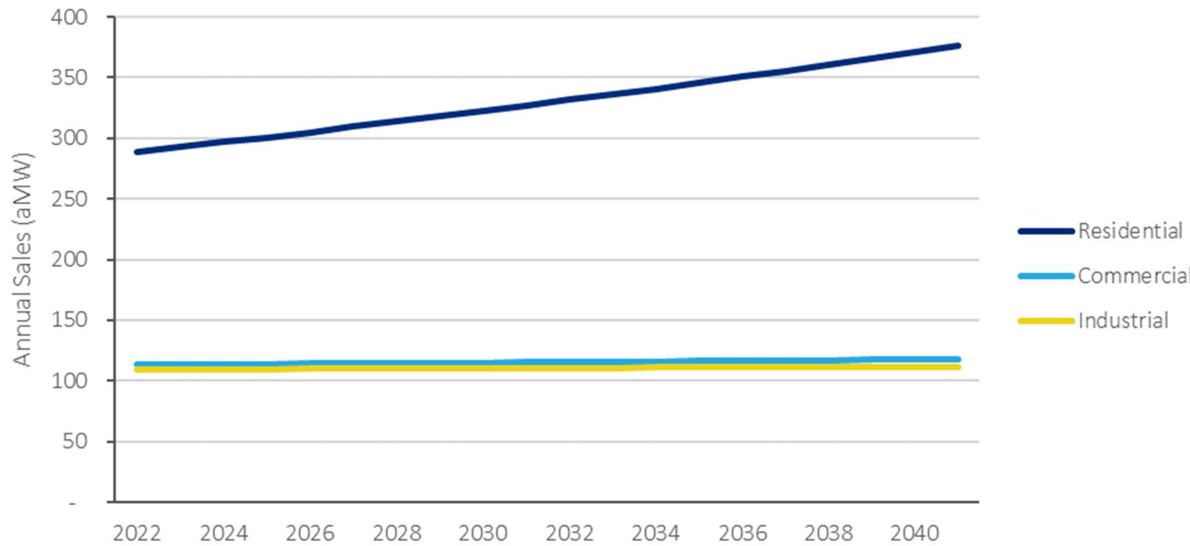
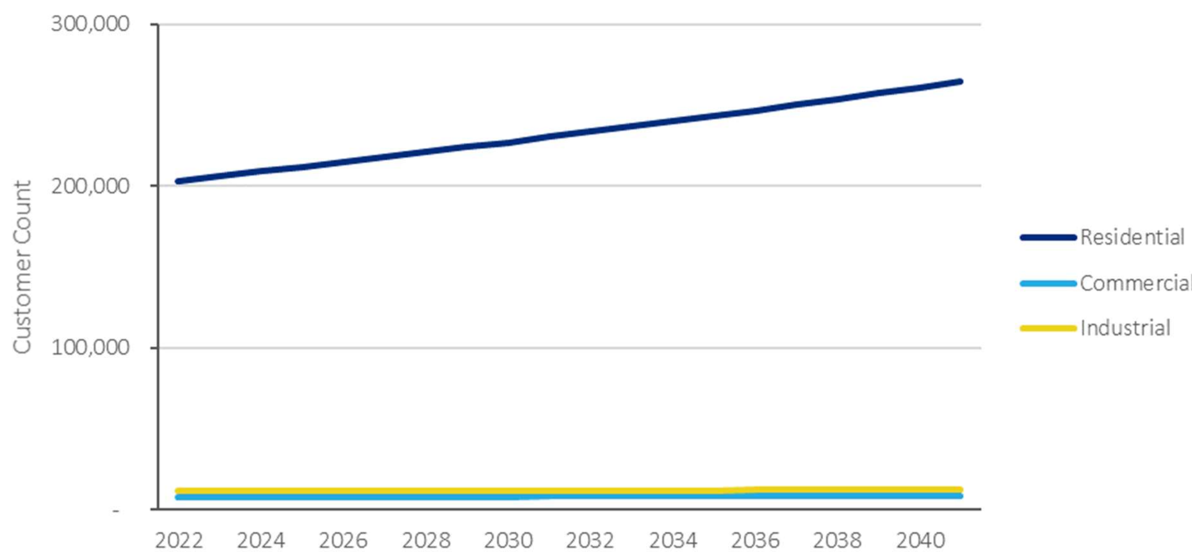


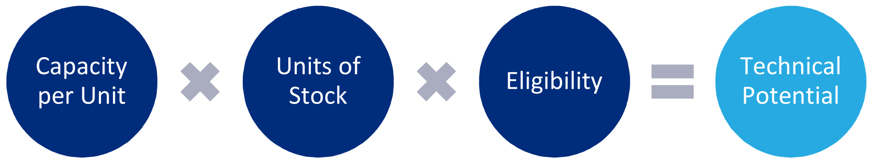
Figure 2: Customer Count Forecast by Sector



Technical Potential

The technical DR potential was quantified by a combination of bottom-up and top-down methodologies. In the bottom-up method, illustrated in Figure 3, the per-unit DR capacity reduction of each product was multiplied by the number of technically possible opportunities. The number of opportunities was determined by multiplying the units of stock, such as the number of homes, by an eligibility factor. This factor quantifies the share of units that are eligible to install the DR product or participate in a program. For example, in quantifying the potential associated with electric resistance water heaters, the eligibility factor would be the share of homes with electric resistance water heaters in CPU's service territory.

Figure 3: Bottom-Up Technical Potential Calculation



This analysis used the capacity values determined by Council staff in the development of the 2021 Plan. Stock unit counts were developed from data provided by CPU and additional public data. Finally, the eligibility factors were determined by a combination of data from CPU's 2021 CPA and the 2021 Plan. Specifically, Lighthouse used projections of future adoption of smart thermostats and heat pump water heaters to inform the future potential identified this DRPA. This was dynamic effect was not included in CPU's 2020 DRPA and is one of the primary drivers for any differences in this assessment.

In the top-down method, the technical potential was determined by multiplying an assumption of the DR product's impact on load by an applicable load basis. The impact is expressed as a percentage, and the load basis is measured in units of demand. The load basis was determined by multiplying the load of a given customer segment by the share of load within the impacted end use. For example, with products controlling HVAC equipment, the customer segment's load used for HVAC was the starting point and was determined by multiplying an annual energy consumption value by an assumption of what percent of the load is consumed by HVAC equipment. Finally, a peak demand factor converted annual energy consumption values into an average peak demand, based on the expected number and duration of DR events. This calculation is shown in Figure 4.

Figure 4: Top-Down Technical Potential Calculation

In this equation, the load impact assumptions and end use shares were taken from the 2021 Plan. The segment loads within each sector were developed from updated sector-level forecasts developed as part of CPU's 2021 Conservation Potential Assessment (CPA). Peak demand factors were calculated by Lighthouse based on 2021 Plan load shapes.

Achievable Potential

The achievable potential was quantified by incorporating additional considerations for program and event participation rates as well as program ramp up periods to the technical potential. Program participation is the proportion of eligible customers who participate in a DR program while event participation quantifies the share of program participants that participate in any given event. For DR products enabled through DLC, the event participation rate is based on the success of the controlled equipment responding to the control signal and reducing demand while for other types of programs this factor considers the likelihood of human intervention.

The annual acquisition of DR programs was determined by ramp rates. Ramp rates consider whether a program is starting from scratch or already has traction in the market and how long it will take to reach its maximum participation levels. This assessment used the ramp rates used in the draft 2021 Plan, where most products were given a ramp rate that reflects a 5- or 10-year ramp up period.

The calculation of achievable potential is the same for both bottom-up and top-down methods and is shown in Figure 5.

Figure 5: Achievable Potential Calculation

Economic Potential

The economic potential was determined by applying a cost-effectiveness screening to the achievable potential described above. To perform this screening, Lighthouse estimated the costs of capacity avoided through demand response for CPU. As part of the CPA, Lighthouse identified the following avoided costs related to reductions in peak demand:

- Avoided capital costs related to the deferral or avoidance of capacity expansions on the transmission and distribution systems that deliver power to CPU's customers
- Avoided generation capacity costs associated with reductions in peak demand

As discussed in the CPA, CPU's avoided generation capacity costs are currently best reflected in the monthly demand charges paid to BPA. Lighthouse used these charges as well as estimates of the months in which each DR product could be used to estimate the avoided generation capacity costs for each DR product. These avoided generation capacity costs were combined with the avoided transmission and distribution system costs and compared with the costs of each product.

Results

This section documents the results of the DRPA. It begins with the winter and summer achievable potential available to CPU and then discusses the costs and results of the economic screening used to identify the cost-effective potential.

Winter Achievable Potential

The estimated achievable winter DR potential is summarized by sector and year in Figure 6. The total winter potential is 58 MW, which is approximately 5.6% of CPU's estimated 2041 winter peak demand. The potential reaches a high point in 2032 but then declines slightly afterwards due to the forecasted adoption of heat pump water heaters, which provide less load reduction for demand response. Additional potential is added at the very end due to the continued adoption of smart thermostats.

Most of the potential is in the residential sector, which totals 53 MW in the last year of the study period. The remaining potential is primarily in the commercial and industrial sectors. Together, the potential in these two sectors totals approximately 5 MW.

Figure 6: Annual Achievable Winter DR Potential by Sector

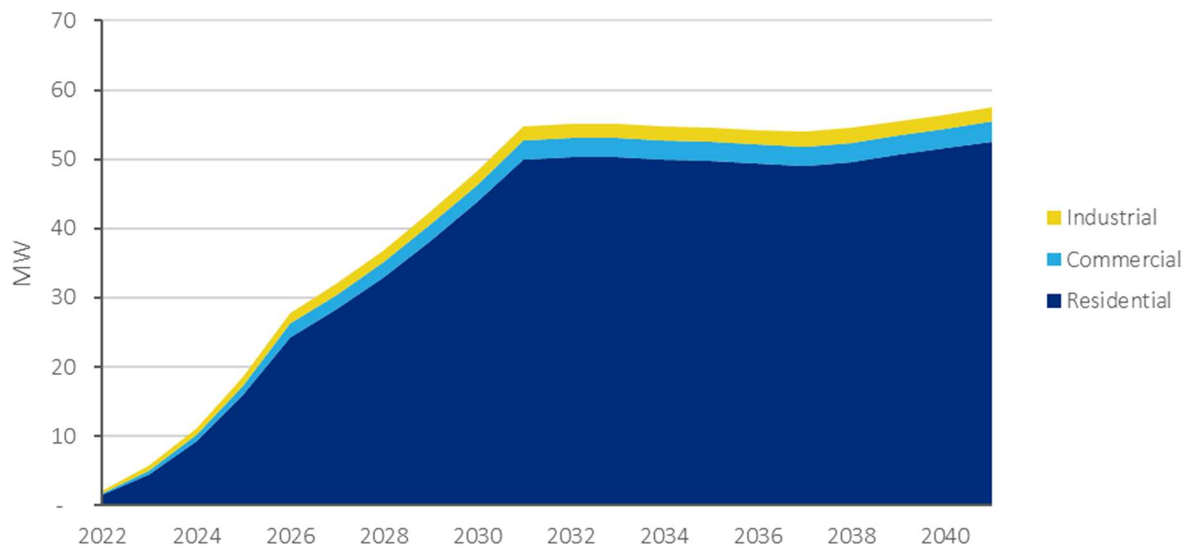


Figure 7 Figure 7shows how this potential breaks down by end use. Most of the winter potential is spread across the categories of space heating and water heating, with pricing and curtailment and EV charging contributing smaller amounts. The pricing and curtailment categories are assumed to impact all customer end uses.

Figure 7: Annual Achievable Winter DR Potential by End Use

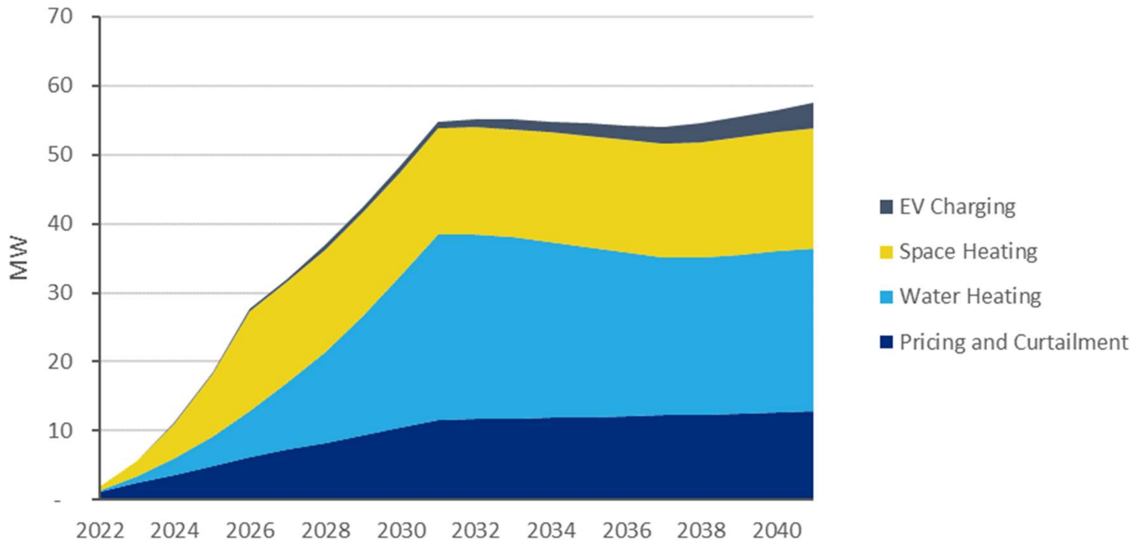
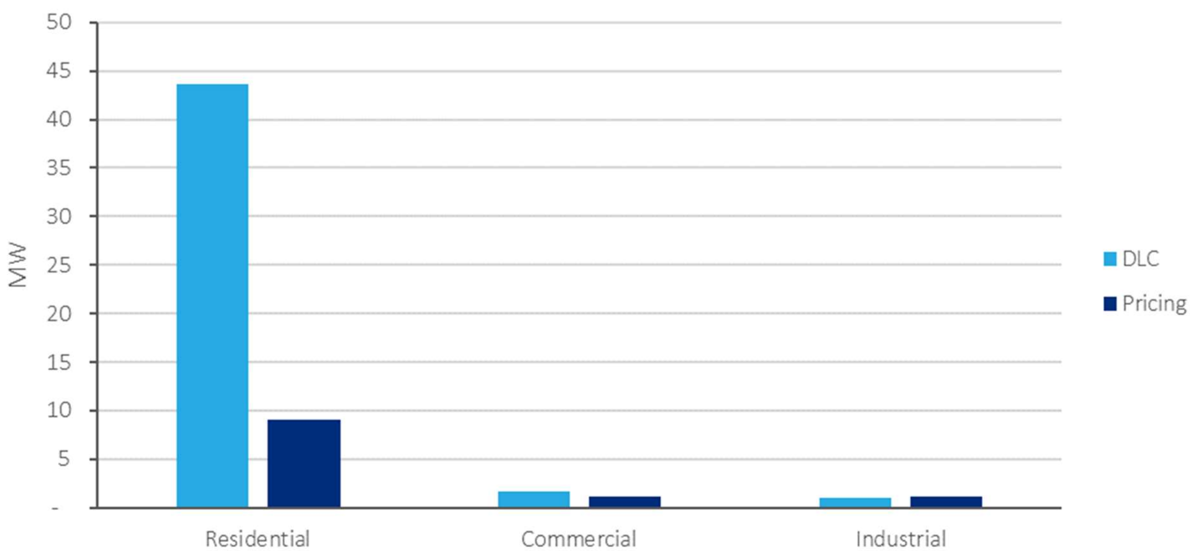


Figure 8 shows how this potential breaks down across the various product types within each sector. In this figure, the commercial and industrial curtailment products are classified as DLC products. Most of the potential is from DLC products, with smaller amounts coming from the pricing strategies that require AMI.

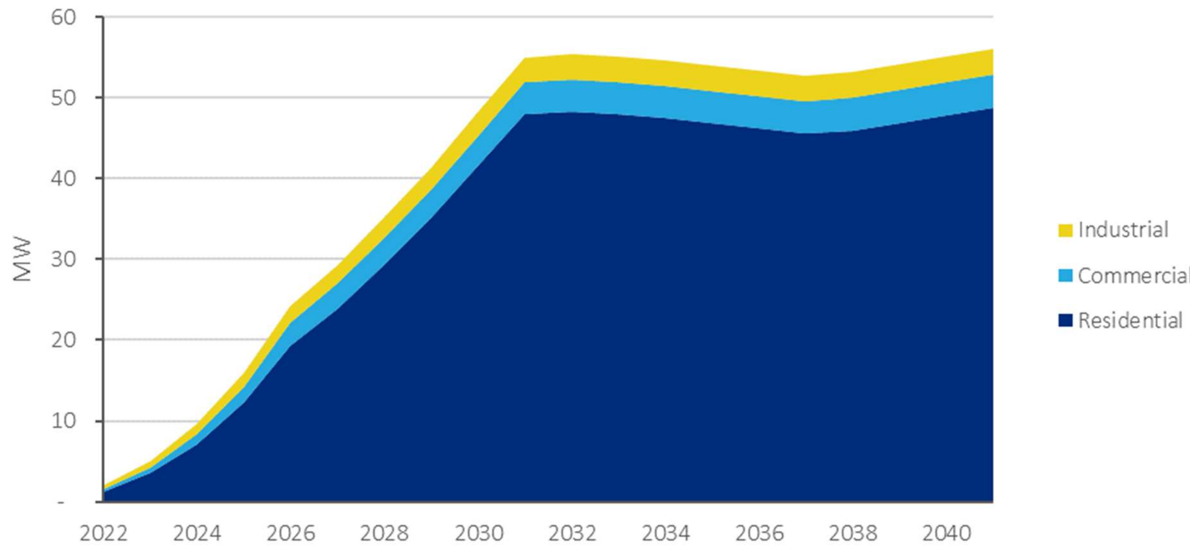
Figure 8: Achievable Winter DR Potential by Sector and Type



Summer Achievable Potential

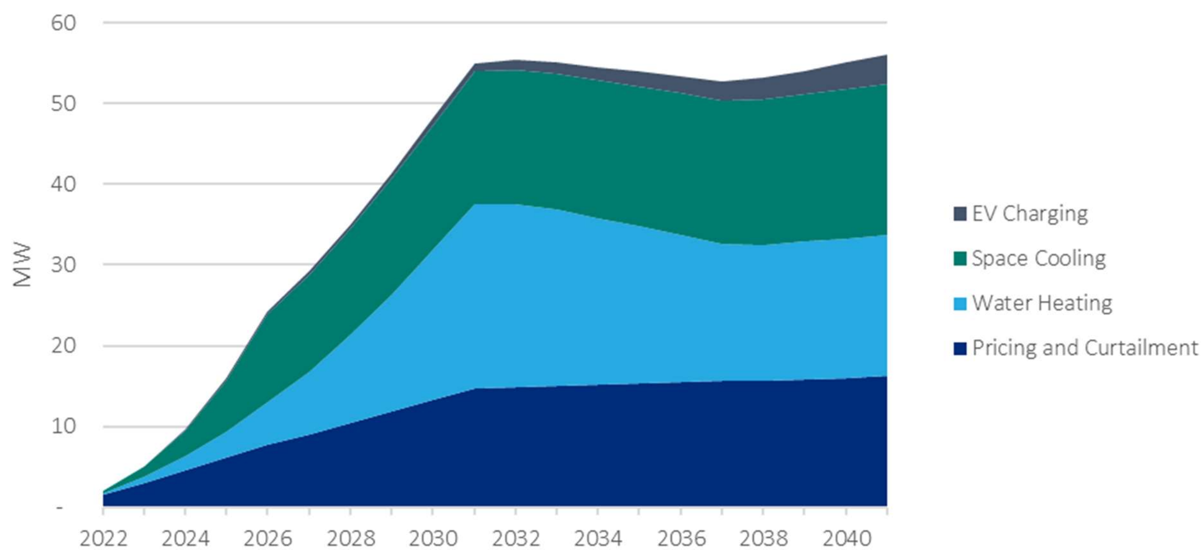
In the summer, CPU has approximately 56 MW of achievable demand response available. Figure 9, below, shows the annual achievable summer potential by sector. The distribution of summer potential across sectors is similar to the winter potential, with slightly more potential available in the commercial sector due to higher air conditioning loads.

Figure 9: Annual Achievable Summer DR Potential by Sector



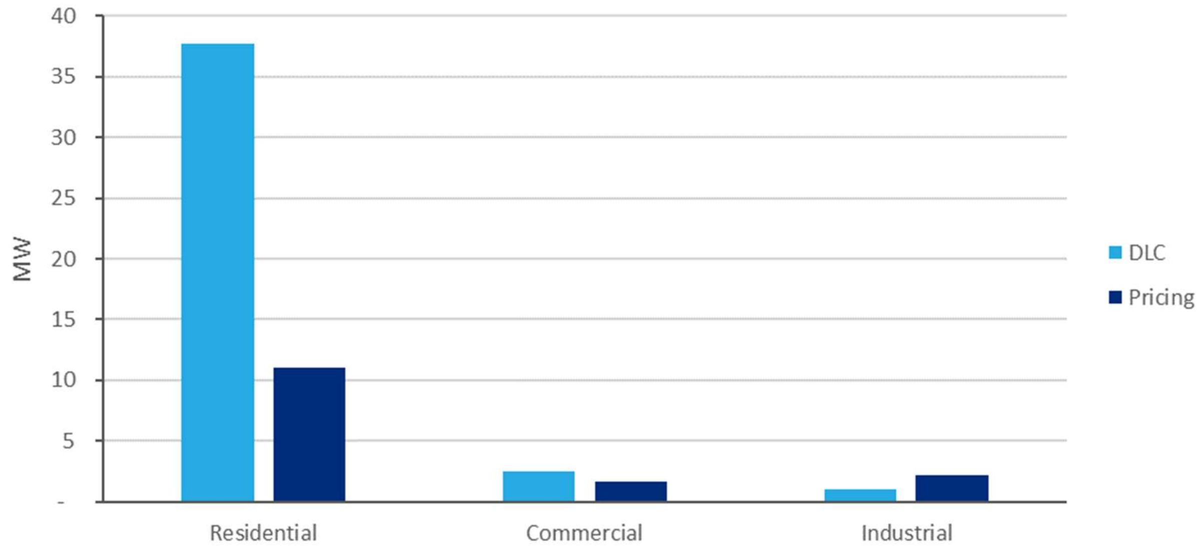
As shown in Figure 10, space cooling is the end use with the largest summer potential, followed by the water heating and pricing and curtailment end uses.

Figure 10: Annual Achievable Summer DR Potential by End Use



The breakdown of the 20-year potential by sector and product type is shown in Figure 11. Similar to the winter season, most of the summer potential is in residential DLC products.

Figure 11: Achievable Summer DR Potential by Sector and Type

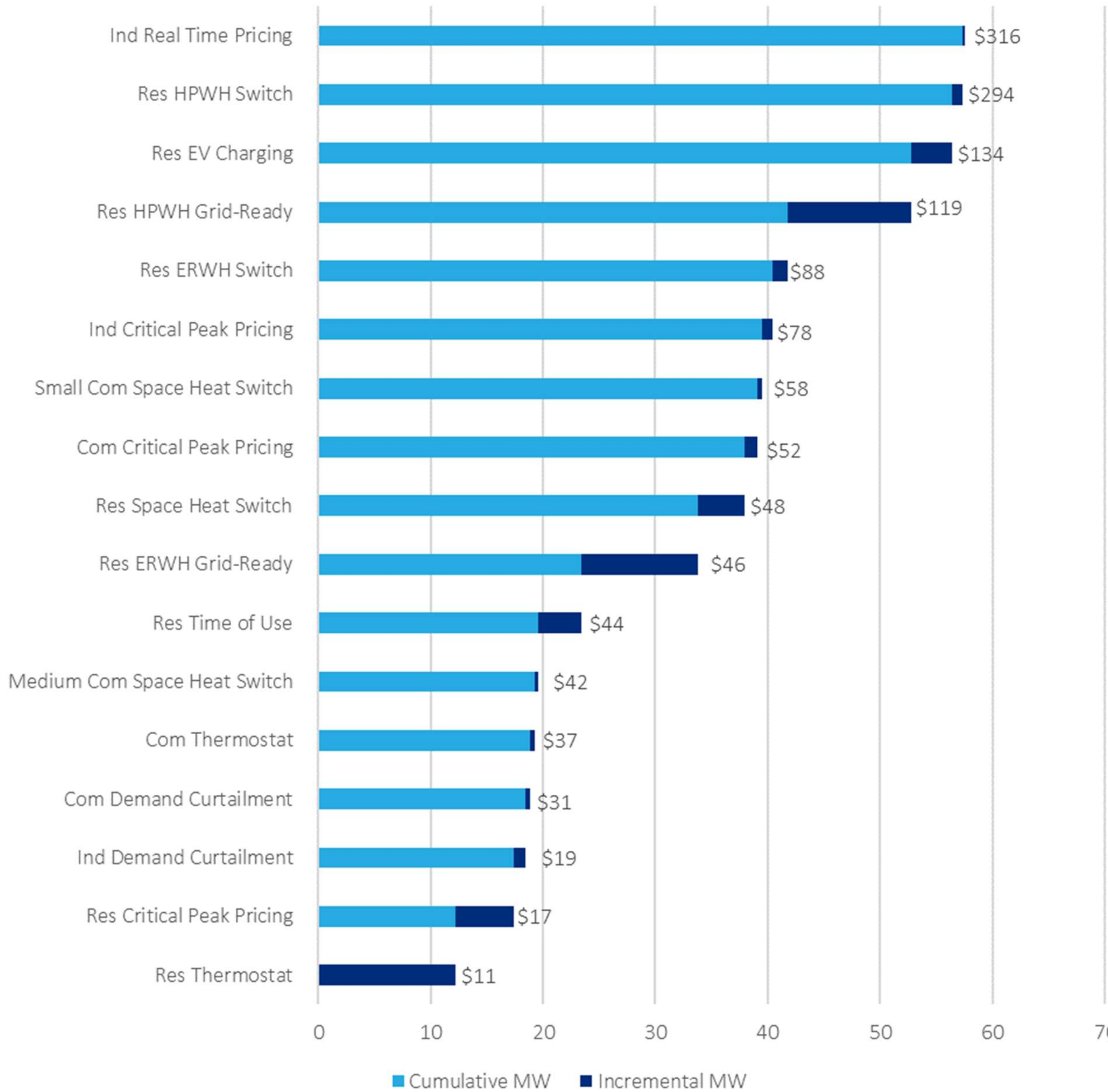


Costs

A supply curve detailing the quantity of capacity and cost for each winter DR product is shown in Figure 12. The products are ranked by levelized cost in $/kW-year, with the lowest cost product at the bottom. As you move up the supply curve, the incremental DR potential for each product is shown in dark blue, with the cumulative potential from all previous products shown in light blue. The horizontal axis reflects the DR capacity available and the value at the end of each bar is the levelized cost of each product. The levelized cost calculations include the credits for deferred distribution and transmission system capacity costs. These credits are the same credits that were used in CPU's 2021 CPA. Figure 12 includes all DR product types. The supply curve without products requiring AMI is shown in subsequently, in Figure 14.

Figure 12 shows that the individual products with the lowest costs include smart thermostats and industrial demand curtailment. Products with the highest amount of potential includes DR from smart thermostats and grid-ready water heaters, including both electric resistance (ERWH) and heat pump (HPWH), although the water heating products have higher costs. The cost of the HPWH product is especially high at $119/kW-year as any program costs are spread over fewer megawatts since heat pump water heaters are more efficient and offer less in terms of available load reductions.

Figure 12: Winter DR Supply Curve - All Product Types (MW and $/kW-year)



In Figure 13, only DLC products are shown as these can be implemented without AMI. Approximately 45 MW of winter DR potential is available from these products.

Figure 13: Winter DR Supply Curve - Excluding AMI Products (MW and $/kW-year)

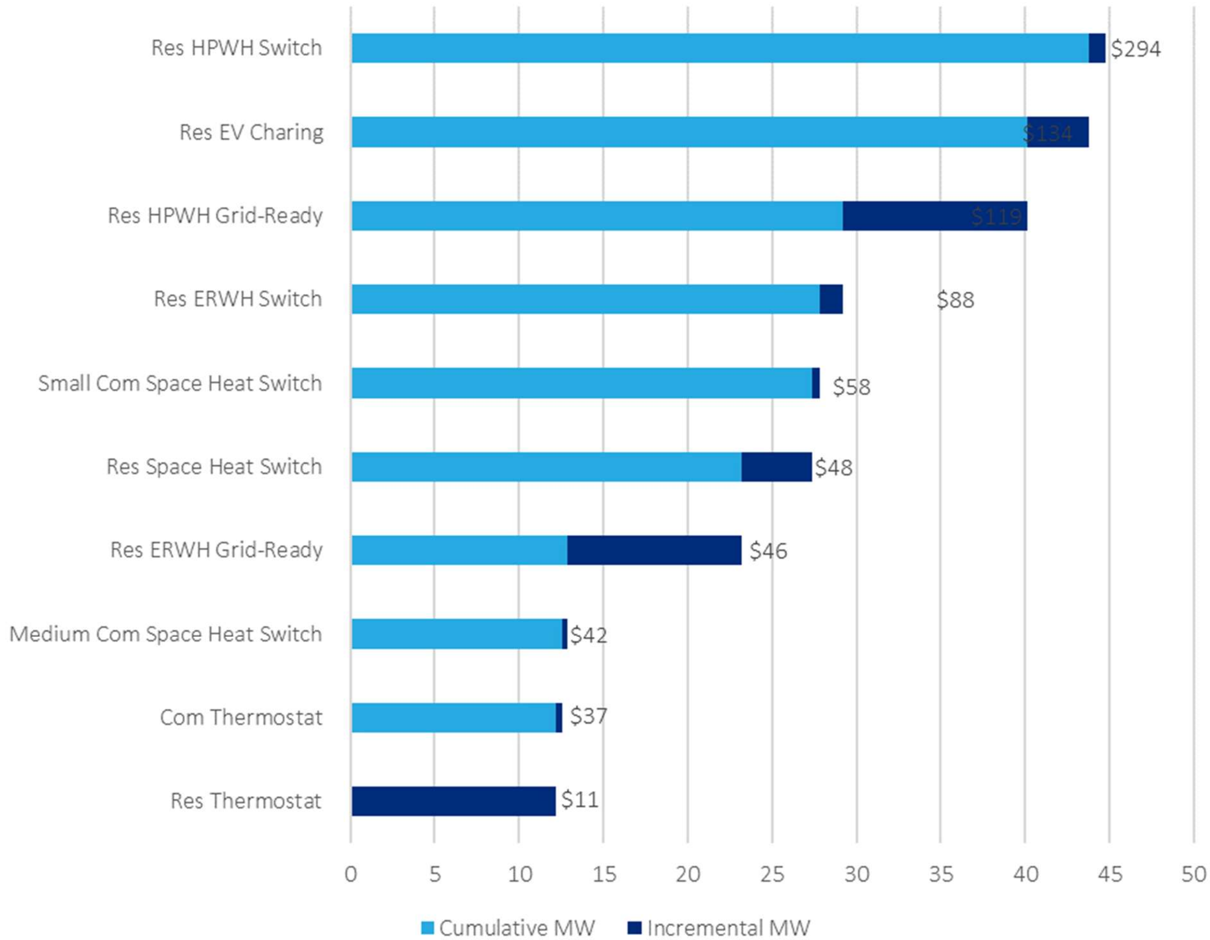


Figure 14 shows a similar supply curve for the summer DR products. The overall characteristics of the summer supply curve are similar to the winter supply curve discussed above. Smart thermostats offer significant amounts of potential at low costs while water heating offers additional potential at higher costs.

Figure 14: Summer DR Supply Curve – All Products (MW and $/kW-year)

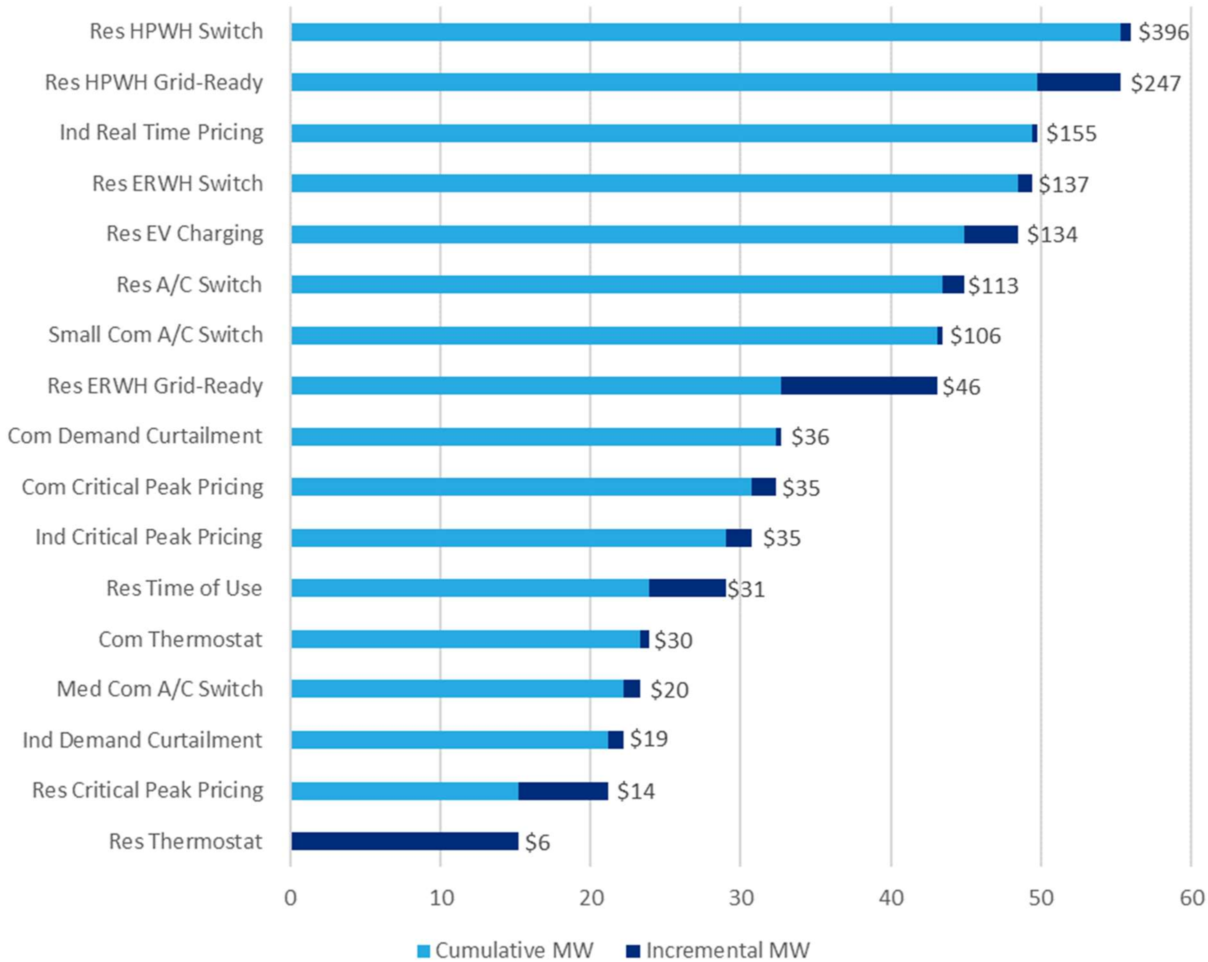
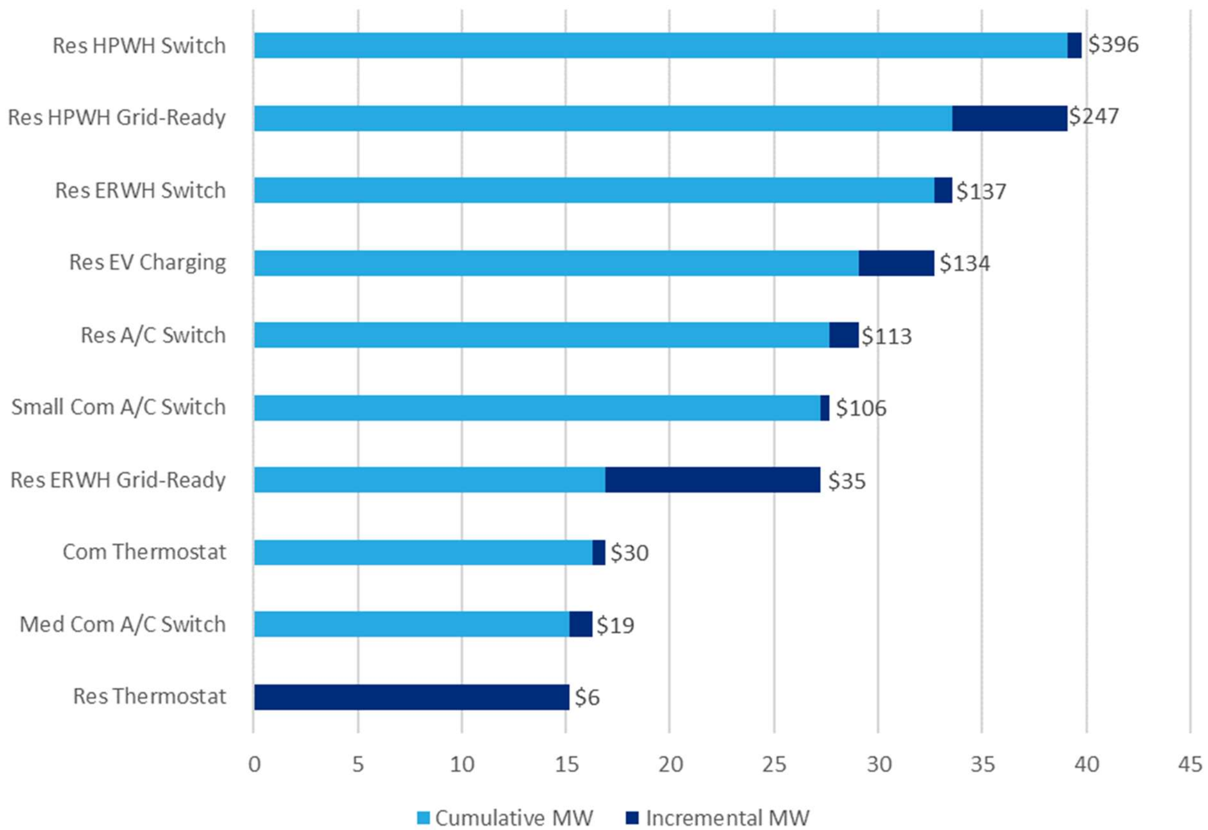


Figure 15 shows the supply curve for DLC products that do not require AMI. Based on this figure, approximately 40 MW of summer DR potential is available.

Figure 15 Summer DR Supply Curve – DLC Products (MW and $/kW-year)



Cost Effectiveness

Table 2 shows the result of the cost-effectiveness screening for each winter DR product. Products are ranked in descending order by benefit-cost ratio. The 20-year DR potential for each product is also shown. Residential smart thermostats were the only winter product identified as cost effective, with several other products falling just below the cost-effectiveness threshold of 1.0.

Table 2: Winter Benefit-Cost Ratio Results by Product

Product	Benefit-Cost Ratio	MW
Res Thermostat	1.1	12.2
Res Time of Use	0.9	3.8
Res ERWH Grid-Ready	0.8	10.4
Res Critical Peak Pricing	0.8	5.2
Ind Demand Curtailment	0.8	1.0
Com Demand Curtailment	0.5	0.5
Res ERWH Switch	0.5	1.4
Com Thermostat	0.5	0.4
Medium Com Space Heat Switch	0.4	0.3
Res Space Heat Switch	0.4	4.2
Res HPWH Grid-Ready	0.4	11.0
Com Critical Peak Pricing	0.4	1.2
Small Com Space Heat Switch	0.3	0.4
Ind Critical Peak Pricing	0.2	0.9
Res HPWH Switch	0.2	1.0
Res EV Charging	0.2	3.6
Ind Real Time Pricing	0.1	0.2

In the summer season, smart thermostats were again identified as cost effective, as shown in Table 3 below.

Table 3: Summer Benefit-Cost Ratio Results by Product

Product	Benefit-Cost Ratio	MW
Res Thermostat	1.4	15.2
Res Critical Peak Pricing	0.9	6.0
Res Time of Use	0.8	5.1
Ind Demand Curtailment	0.8	1.0
Med Com A/C Switch	0.7	1.1
Res ERWH Grid-Ready	0.6	10.4
Com Thermostat	0.5	0.6
Ind Critical Peak Pricing	0.5	1.8
Com Critical Peak Pricing	0.5	1.6
Com Demand Curtailment	0.5	0.3
Res ERWH Switch	0.2	0.9
Small Com A/C Switch	0.2	0.4
Res A/C Switch	0.2	1.4
Res EV Charging	0.2	3.6
Ind Real Time Pricing	0.1	0.4
Res HPWH Grid-Ready	0.1	5.5
Res HPWH Switch	0.1	0.7

Summary

This assessment summarizes the results of the 2021 DRPA conducted for CPU. The products included and the methodology used were based on those used by the Council in the 2021 Plan, customized to CPU's service territory, and aligned with the projections of CPU's 2021 CPA. It included products applicable to the winter and summer seasons across the residential, commercial, and industrial sectors using a variety of DLC, demand curtailment, and price-based strategies and targeting a variety of end uses.

Overall, the assessment quantified 58 MW of achievable winter DR potential and 56 MW in the summer. Most of the DR potential identified is in the residential sector, which is consistent with the makeup of CPU's customer base. Smart thermostats used to control residential space heating and cooling equipment was the product with the highest potential across both seasons and was also the only cost-effective DR product identified in this assessment, although it was only marginally cost-effective in the winter. Lighthouse recommends that CPU evaluate this product further to refine the regional assumptions on program participation, cost, and impacts to see if a DR program using this technology across both seasons could be a cost-effective capacity resource. This could include surveying customers to validate the assumptions used in this assessment, researching program implementation costs, and implementing a pilot program if further research confirms the findings of this assessment.

Appendix: DR Product List

Sector	End Use	Product	Type	Methodology
Residential	EV Charging	Res EV Charging - Winter	DLC	Bottom Up
Residential	EV Charging	Res EV Charging - Summer	DLC	Bottom Up
Residential	Water Heating	Res ERWH Switch - Winter	DLC	Bottom Up
Residential	Water Heating	Res ERWH Switch - Summer	DLC	Bottom Up
Residential	Water Heating	Res ERWH Grid-Ready - Winter	DLC	Bottom Up
Residential	Water Heating	Res ERWH Grid-Ready - Summer	DLC	Bottom Up
Residential	Water Heating	Res HPWH Switch - Winter	DLC	Bottom Up
Residential	Water Heating	Res HPWH Switch - Summer	DLC	Bottom Up
Residential	Water Heating	Res HPWH Grid-Ready - Winter	DLC	Bottom Up
Residential	Water Heating	Res HPWH Grid-Ready - Summer	DLC	Bottom Up
Residential	Space Heating	Res Space Heat Switch - West	DLC	Bottom Up
Residential	Space Cooling	Res Space Cooling Switch - West	DLC	Bottom Up
Residential	Space Heating	Res Space Heat Thermostat - West	DLC	Bottom Up
Residential	Space Cooling	Res Space Cooling Thermostat - West	DLC	Bottom Up
Commercial	Space Heating	Com Space Heating Switch - Small/West	DLC	Bottom Up
Commercial	Space Cooling	Com Space Cooling Switch - Small/West	DLC	Bottom Up
Commercial	Space Heating	Com Space Heating Thermostat - West	DLC	Bottom Up
Commercial	Space Cooling	Com Space Cooling Thermostat - West	DLC	Bottom Up
Commercial	Space Heating	Com Space Heating Switch - Medium/West	DLC	Bottom Up
Commercial	Space Cooling	Com Space Cooling Switch - Medium/West	DLC	Bottom Up
Commercial	All	Com Demand Curtailment - Winter	DLC	Top Down
Commercial	All	Com Demand Curtailment - Summer	DLC	Top Down
Industrial	All	Ind Demand Curtailment - Winter	DLC	Top Down
Industrial	All	Ind Demand Curtailment - Summer	DLC	Top Down
Residential	All	Res TOU Pricing - Winter	Pricing	Top Down
Residential	All	Res TOU Pricing - Summer	Pricing	Top Down
Residential	All	Res Critical Peak Pricing - Winter	Pricing	Top Down
Residential	All	Res Critical Peak Pricing - Summer	Pricing	Top Down
Commercial	All	Com Critical Peak Pricing - Winter	Pricing	Top Down
Commercial	All	Com Critical Peak Pricing - Summer	Pricing	Top Down
Industrial	All	Ind Critical Peak Pricing - Winter	Pricing	Top Down
Industrial	All	Ind Critical Peak Pricing - Summer	Pricing	Top Down
Industrial	All	Ind Real Time Pricing - Winter	Pricing	Top Down
Industrial	All	Ind Real Time Pricing - Summer	Pricing	Top Down