TACOMA POWER 2023 DEMAND RESPONSE POTENTIAL ASSESSMENT REPORT

DECEMBER 14, 2023

Introduction

In early 2023, Tacoma Power engaged Applied Energy Group (AEG) to assess the available demand response potential in its service territory to incorporate into its 2024 integrated resource plan (IRP). Tacoma Power's previous demand response potential assessment covered the 20-year period between 2021 and 2040, while the current study covered the 20-year period beginning in 2024. This memo presents the methods, key data sources, and inputs into the analysis and summarizes the results of AEG's demand response potential assessment.

The following sections detail the key steps in the potential assessment and provide results:

- Data Collection
- Program Characterization
- Baseline Peak Demand Forecast
- Potential Estimation
- Levelized Costs

Data Collection

Table 1 presents the key data sources and data elements AEG used to perform the demand response potential assessment. Consistent with the previous study, AEG relied heavily on the Northwest Power and Conservation Council's (Council) 2021 Power Plan, which characterizes demand respond programs using regional sources. Where available, AEG incorporated data specific to Tacoma Power's service territory to develop program assumptions about participation, impacts, and costs.

Table 1 Data Sources

Source	Data Gathered
Tacoma Power Studies	• 2023 Tacoma Power Conservation Potential Assessment (CPA) • Water Heater DR Pilot • Cadmus Electrification Study
Council 2021 Power Plan	• Demand Response program characterization (e.g. Participation impacts, costs) • Program ramp rates
Other Regional Studies	• Program Characterization

Program Characterization

The program options included in the analysis are presented in Table 2. The Council's 2021 Power Plan largely dictated sector eligibility for each program option.

Table 2 Program Options Included in the Study

Program Option	Program Description	Eligible Sector(s)
Connected Thermostat Direct Load Control (DLC)	Internet-enabled control of thermostat set points	Residential and Small Commercial
Electric Vehicle (EV) Behavioral Charge Management	Encourage customers to reduce charging at times of high stress on the electric grid through behavioral messaging and limited incentives	Residential
EV Direct Charge Management	Optimize EV charging times to reduce their impact on system peak load through direct control of EV chargers or vehicle telematics	Residential
EV Fleet Direct Charge Management	Optimize EV fleet charging times to reduce their impact on system peak load through direct control of EV chargers or vehicle telematics	Commercial (Retail, School, and Warehouse Segments)
Grid Interactive Water Heater	Direct control of electric water heaters through CTA-2045 or other integrated communication port	Residential
Domestic Hot Water Heater (DHW) DLC	Direct control of electric water heaters through a traditional DLC switch installed on customer equipment	Residential
HVAC DLC	Direct control of heating and cooling load through traditional DLC switch installed on customer's HVAC equipment	Residential, Small-Medium Commercial
Time-of-Use (TOU)	Encourage customers to reduce their demand by setting a higher rate for a particular block of hours that occurs every day	Residential
Critical Peak Pricing (CPP)	Establish a significantly higher rate for a particular block of hours that occurs only on event days to encourage customers to reduce their demand during times of high stress on the grid	All Sectors
Third Party Contracts	Commercial and industrial customers with peak demand of at least 150 MW enact their customized, mandatory curtailment plan when called upon during times of high stress on the electric grid (often managed through third-party aggregators)	Medium-Large Commercial and Industrial Customers

After developing the program option list, AEG worked with Tacoma Power staff to develop key assumptions used to calculate the potential and cost estimates for each program option. The following section describes these assumptions in greater detail.

Participation Rates, Impacts, and Costs

AEG began with assumptions from the Council's 2021 Power Plan, then updated these values with information from Tacoma Power's existing programs or service territory, where available. Deviations from Council assumptions included the following.

- AEG used preliminary findings from Tacoma Power's Water Heater DR Pilot to inform impacts for electric-resistance water heaters. Impacts aligned well with the 2018 BPA CTA-2045 Water Heater Demonstration study.[1]

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[1] https://www.bpa.gov/-/media/Aep/energy-efficiency/emerging-technologies/ET-Documents/demand-response-final-report-110918.pdf

- Tacoma Power provided estimates of third-party vendor costs for monitoring electric vehicle telematics that AEG incorporated into program startup and annual administration costs for all EV charge management program options.
- AEG characterized both a bring-your-own-thermostat (BYOT) and direct install (DI) version of the Connect Thermostat DLC program option. We treated these as separate channels under a single program option such that program costs and potential could be stacked across both without double counting.
- The Council's 2021 Power Plan provides cost assumptions from a total resource cost (TRC) perspective, whereby a portion of the incentive costs are used as a proxy for customer costs to participate. To support Tacoma Power's IRP, AEG calculated costs from the Utility Cost Test (UCT) perspective and counted the full incentives costs towards the programs.
- Consistent with the Council's 2021 Power Plan, AEG did not burden the rates programs with the costs of infrastructure or software upgrades that may be required for Tacoma Power to deliver demand-focused rates to its customers.
- AEG characterized a commercial EV fleet demand response program, which the Council's 2021 Power Plan does not include. At the time of the study, limited industry data existed to inform several key assumptions. Therefore:
    - AEG used preliminary EV fleet adoption rates forecasted in the 2023 Tacoma Power electrification study, which estimated the number of EV ports used for fleet charging at retail, school, and warehouse segments of the commercial sector. AEG used these forecasts to determine the number of customers eligible for a demand response program targeting EV fleets and estimate the number of chargers (and capacity available to reduce) during system peak hours.
    - Lacking information about expected participation rates, AEG used the Council's 2021 Power Plan assumptions for commercial curtailment (5% of eligible customers at program maturity).
    - While the electrification study provided adoption rates, it did not provide a peak demand forecast in time to incorporate into the demand response potential study. Instead, AEG estimated peak impacts for an EV fleet program using the assumed nameplate capacity for DC Fast Chargers and Level 2 chargers (125kW and 11 kW, respectively). However, given the nature of (and limited information about) fleet charging habits, we assumed that only 50% of these impacts could be achieved during called peak events. This assumption attempts to control for uncertainties around fleet charging schedules and locations.
    - Similarly, the peak demand baseline against which AEG calculated demand response potential did not incorporate any increases in load due to electrification efforts. Therefore, EV fleet charging demand response potential as a percentage of baseline peak demand may be overestimated.

Enabling Equipment

Some of the demand response program options rely on enabling equipment and technology. AEG used equipment saturation forecasts estimated through Tacoma Power's energy efficiency potential assessment, including:

- AEG used the saturation of central cooling/heating systems developed through the energy efficiency study market characterization to inform the pool of customers eligible to participate in Connected Thermostat DLC (Residential and Small Commercial), and HVAC DLC (Residential and Small/Medium Commercial).
- The analysis assumed that all new water heater purchases would be grid-enabled water heaters (e.g., CTA-2045), per WAC 194-240-180 in Washington. The overall saturation of electric water heaters aligns with the energy efficiency market characterization, but the distribution of units assumed to be grid-enabled increases throughout the forecast period as existing water heaters turn over.
- Tacoma Power's 2023 Electrification study provided residential EV adoption forecasts, which AEG used to determine the eligible customer population for the EV Behavioral and Direct Charge Management programs.

Similarly, the electrification study provided estimated charger adoptions for EV fleet charging, which AEG used to define the population of retail, school, and warehouse customers eligible for this program option.

Program Option Hierarchy

Some of the program options target the same peak load. To avoid double counting demand response potential for these competing resources, AEG worked with Tacoma Power to develop the program hierarchy shown in Table 3. In general, the hierarchy prioritizes customers for existing programs first, then firm resources, and finally rate options by removing participants of programs higher in the hierarchy from the pool of customers eligible for programs lower in the hierarchy.

However, not all program options would compete for the same peak load. AEG allowed dual enrollment in program options targeting separately metered equipment (e.g., EV charge management) or distinct end uses (e.g., Connected Thermostat DLC and Water Heating DLC). Limited research exists on the interactions between rates and DLC programs, so AEG did not allow for dual enrollment in these types of program options.

Table 3 Program Hierarchy

Hierarchy Group	Residential	Commercial	Industrial
Existing/Pilot Programs	1. Grid Interactive Water Heater 2. DHW DLC		
Firm Resources	3. EV Behavioral Charge Management 4. EV Direct Charge Management 5. Connected Thermostat DLC 6. HVAC DLC	1. Third Party Contracts 2. EV Fleet Charge Management 3. Connected Thermostat DLC 4. HVAC DLC	1. Third Party Contracts
Rates	7. Time-of-Use 8. Critical Peak Pricing	5. Critical Peak Pricing	2. Critical Peak Pricing

Baseline Peak Demand Forecast

AEG developed the peak demand forecast shown in Figure 1 by:

- Using the system-level peak demand forecast estimated for the energy efficiency potential study,
- Segmenting the system-level peak demand forecast into sector and customer size using customer-level data provided by Tacoma Power and the market segmentation and characterization from the energy efficiency potential study, and
- Removing the peak demand savings potential generated through energy efficiency adoption in the achievable economic potential scenario (based on the total resource cost [TRC] test).

Demand responses potential estimates are incremental to the peak demand impacts from energy efficiency.

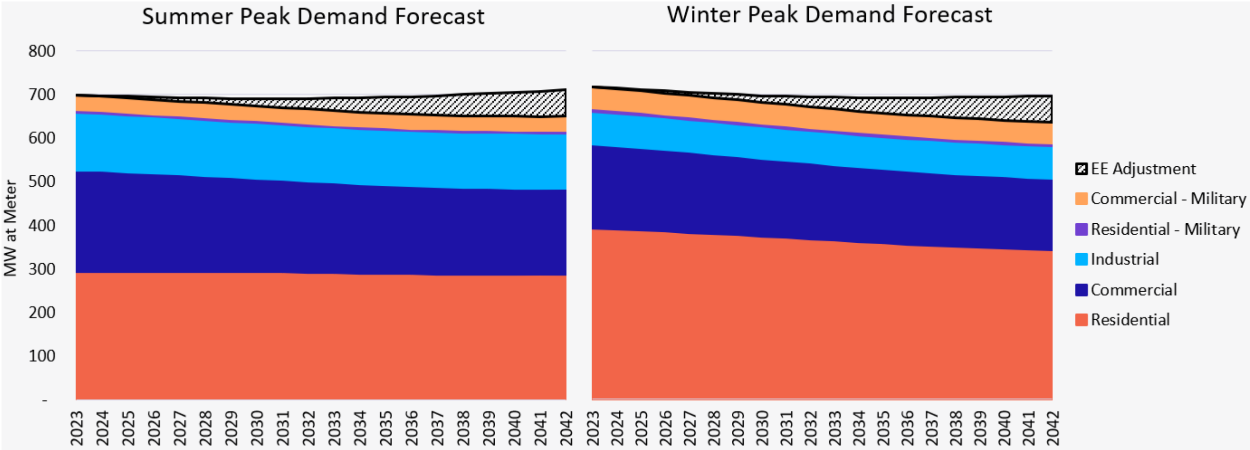
Figure 1 shows the sector contributions to the peak demand forecast for summer and Winter for each year of the study, including the total adjustment made to the baseline for efficient equipment adoption (“EE Adjustment”). This adjustment reduces the baseline peak demand by 8% in both summer and winter.[2]

As shown, Tacoma Power’s system peak demand remains relatively constant in the summer and winter. Residential customers contribute about a third more to the winter peak than to the summer peak, driven in part by the high saturation of electric water heating in the territory. Commercial and industrial customers contribute less to the winter

[2] The baseline peak demand does include any impacts of fleet vehicle electrification forecasted in Tacoma Power’s 2023 electrification study.

peak than to the summer peak, which reflects the lower saturation of electric heating equipment compared to central cooling system.

Figure 1 Summer Peak Demand Forecast



Potential Estimation

AEG calculated the demand response potential for each program by:

1. Determining the eligible customer population using enabling equipment saturations and removing the participation from programs higher in the program hierarchy,
2. Applying participation, attrition, and event non-performance rates to estimate the number of eligible customers likely to participate in the program option, and
3. Multiplying the per-customer impacts by the number of participants to estimate the total impacts (potential) for each program option in each year of the forecast period.

Figure 2 shows the estimated demand response potential. The dotted lines show the baseline peak demand (after adjusting for the efficient equipment adoption estimated in the conservation potential assessment), while the solid lines show the estimated potential forecast after demand response programs have been implemented. The difference between these lines (shown as bars on the graph) reflects the estimated potential for each year of the study.

By the end of forecast period, AEG estimates that demand programs could reduce the summer and winter peak demand by approximately 6%. Potential from demand response programs increases over the five to ten years as the programs enroll participants and reach full maturity. Most of the potential comes from the residential sector, where AEG estimated that demand response programs could reduce 10% of peak demand by the end of the forecast period. Potential for C&I sectors reduced peak demand by an estimated 3% by the end of forecast period. Note that the baseline for C&I sectors includes peak load from customers not eligible to participate in many peak demand programs, lowering the potential as a percentage of baseline peak demand.

Figure 2 Total Demand Response Potential Forecast

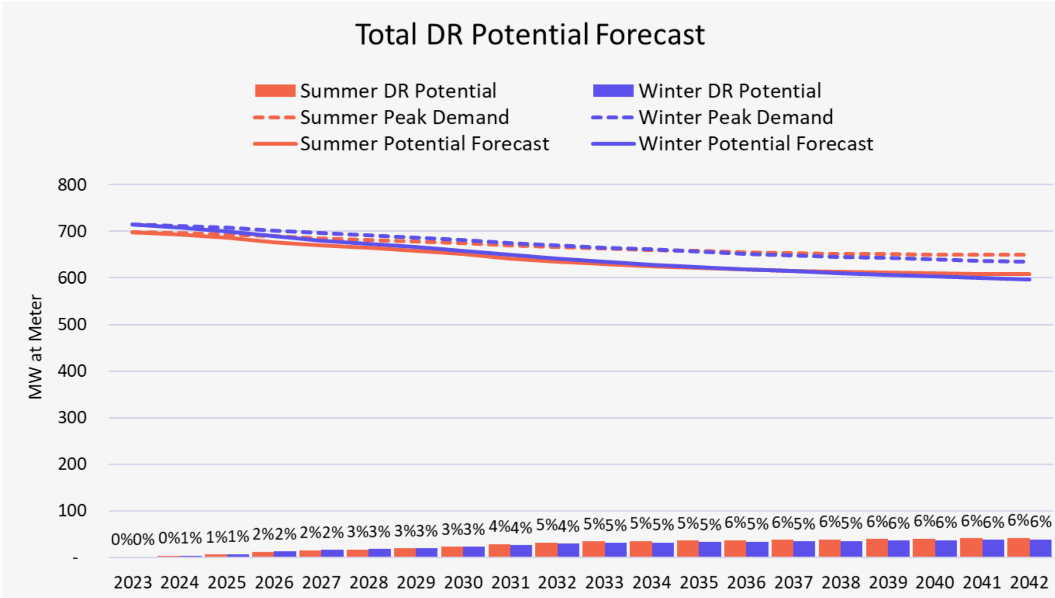


Figure 3 and Figure 4 show the potential generated by demand response programs over the select years in the forecast period for summer and winter, respectively. The early years show how the potential changes as programs mature, and the later years show what programs generate after reaching maturity. Most programs are assumed to start in 2024 or 2025, a year or two delayed from the start of the forecast period, to account for the time Tacoma Power would realistically need to launch programs. Some programs were further delayed until 2029, including the rate and EV charge management programs, given the major infrastructure changes required to Tacoma Power's billing systems to be able to offer these types of programs.

As shown, AEG estimates that Tacoma Power could generate 42 MW of demand reduction in the summer and 38 MW in the winter through demand response programs by 2042. Electric Vehicle (EV) Direct Charge Management, Critical Peak Pricing, and Grid Interactive Water Heater contribute an estimated 60% of the total demand response summer and winter potential by this year in the study. Third Party Contracts and Connected Thermostat DLC programs contribute another 24% and 21% of summer and winter potential, respectively.

Most programs contribute similarly to summer and winter potential. Some notable exceptions include Critical Peak Pricing, which assumes that more customers would be willing to respond to summer events than to winter events. Potential from Grid Interactive Water Heaters increases in the winter, when water heaters work less efficiently and the capacity to reduce peak demand is higher.

Figure 3 Summer Demand Response Program Potential for Select Years

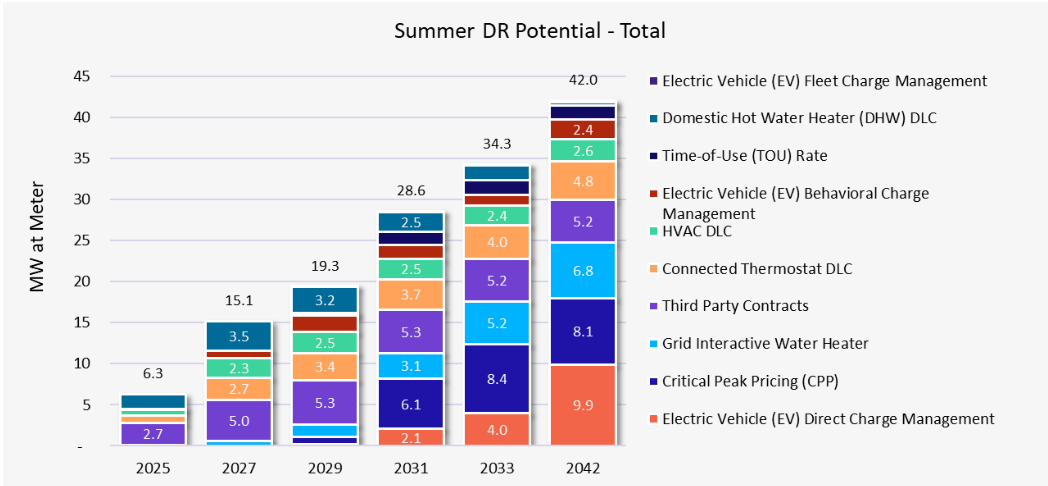
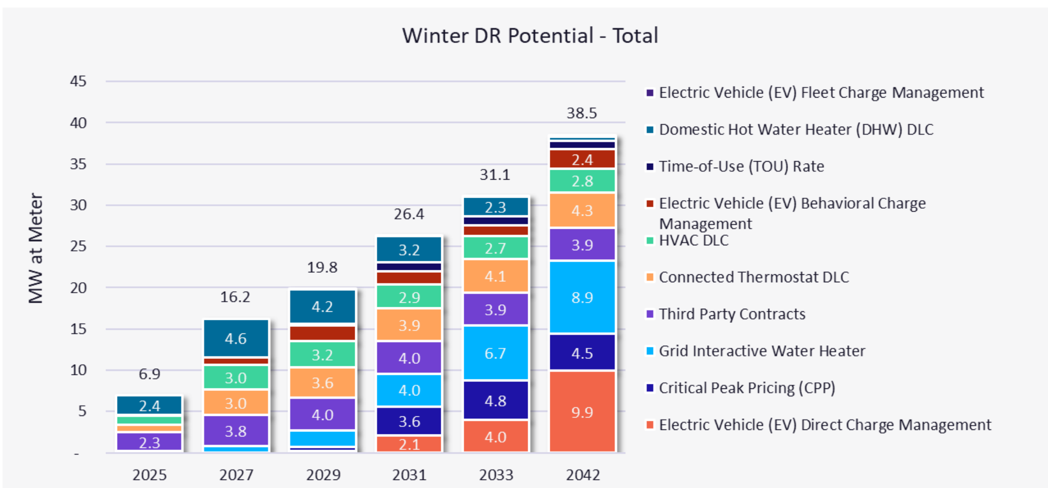


Figure 4 Winter Demand Response Program Potential by Selected Years



Levelized Costs

AEG calculated levelized costs for each program option, shown in Figure 5. Because most demand response programs take at least five years to reach maturity and will run for at least ten years, AEG used the first ten years of each program's operation to estimate levelized costs. For most programs, this includes years 2024 to 2033. For the rates and EV charge management programs, this includes years 2029 to 2038.

All of the assessed program options have the potential to generate peak demand reductions in both summer and winter, and the levelized costs shown here only apply if programs run in both seasons. Costs for single-season programs would be higher (equaling the sum of summer and winter split costs minus any season-specific incentives that are no longer applicable). AEG split costs between seasons as follows:

- Participant-dependent costs (costs for operations and maintenance [O&M], equipment, and recruitment accrued on a per-customer basis) were equally divided across seasons.
- MW-driven costs (costs for O&M, equipment, administration, and startup assumed on a per-MW basis) were allocated by summer vs. winter potential.

- Total startup and administration costs (assumed as a program/year lump sum) were also allocated based on the summer vs. winter potential.
- All incentives counted towards their respective season, as these were considered on a per-season basis.

Figure 5 shows the levelized costs estimated over the first ten years of each program's life, from a UCT perspective (i.e., including full participant incentives and additional implementation costs). Rate programs (CPP and TOU) provide the least-expensive potential, which stems from the assumption that any billing system and infrastructure upgrades needed to offer a demand-focused rate to customers is already in place. In general, internet-enabled or grid-connected program options (Connected Thermostat DLC and Grid Interactive Water Heater) offer demand response potential at lower costs than their switch-based alternatives (HVAC DLC and DHW DLC) because of the costs associated with purchasing and installing switches on customers' equipment. The three EV charge management programs were some of the more expensive program options because they carry additional costs required to access the vehicle telematics data through third-party vendors.

Figure 5 Ten-Year Levelized Costs