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JOSHUA D. DILUCIANO

REPRESENTING AVISTA CORPORATION

AEG

Distributed Energy Resources Potential Study

Final Report

Prepared For: Avista Utilities

By: Applied Energy Group, Inc.,
Cadeo Group, and Verdant Associates

cadeo

VERDANT

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AEG Key Contact: Eli Morris

This work was performed by

Applied Energy Group, Inc.
2300 Clayton Rd., Suite 1370
Concord, CA 94520

Project Director: E. Morris
Project Manager: Dr. C. Arzbaecher

AEG would also like to acknowledge the valuable contributions of

Cadeo Group
3506 N Vancouver Ave
Portland, OR 97227
Project Team: F. Schaefer

Verdant Associates
1972 Los Angeles Ave
Berkeley, CA 95618
Project Team: W. Marin
Dr. J. Shelton
C. Elliott

EXECUTIVE SUMMARY

Study Background

In late 2022, Avista Corporation (Avista) selected Applied Energy Group (AEG), Cadeo, and Verdant Associates (collectively the AEG Team) to perform a Distributed Energy Resource (DER) Potential Study. The primary objectives of this study are to develop reasonable estimates for new customer generation, battery energy storage, and electric vehicles on a localized basis within Avista's Washington electric service territory and investigate the effects of such DERs in highly impacted or vulnerable areas. The AEG Team worked closely with Avista staff to ensure the DER Potential study met these objectives while satisfying the Washington Utilities and Transportation Commission's condition 14 in approving Avista's Clean Energy Implementation Plan.[1] AEG will separately estimate localized energy efficiency (EE) and demand response (DR) to complete the DER analysis.[2]

Approach

The team used AdopDER, a Python software application, to forecast the adoption and load impacts of DERs annually in Avista's Washington service territory from 2023 through 2045. Specifically, AdopDER estimated service point-level adoption of DERs and developed hourly load impacts from those DERs by census block group will help Avista understand which areas of its distribution system will likely experience DER load growth. Table ES-1 summarizes the DER technologies included in the forecasts, which are grouped into two major categories: 1) Electric Vehicles (EVs) and Charging, and 2) New Generation and Storage.

Table ES-1. Technologies Included in DER Potential Study

Electric Vehicles and Charging	New Generation and Storage
Light-duty vehicles, battery electric vehicles (LDV BEV)	Customer Solar
Light-duty vehicles, plug-in hybrid electric vehicles (LDV PHEV)	Customer Battery Storage
Medium-duty vehicles, battery electric vehicles (MDV BEV)	Customer Wind
Heavy-duty vehicles, battery electric vehicles (HDV BEV)	
Level 1 electric vehicle supply equipment (L1 EVSE)	
Level 2 electric vehicle supply equipment (L2 EVSE)	
Direct current fast-charging electric vehicle supply equipment (DCFC EVSE)	

[1] Washington Utilities and Transportation Commission. Order 01 Approving Clean Energy Implementation Plan Subject to Conditions. Avista 2021 Clean Energy Implementation Plan List of Conditions. URL: https://apiproxy.utc.wa.gov/cases/GetDocument?docID=255&year=2021&docketNumber=210628

[2] AEG's DER and demand response (DR) potential studies for Avista are concurrent but independent. AEG strived to make the results of those studies consistent by aligning per-customer impacts and adoption counts for both EVs and Customer Battery Storage units. However, the DR forecast employs a different methodology, which assumes program participation rates and includes Avista's Idaho service territory, while the DER forecast includes only Washington. Therefore, the results across the two studies may differ.

Key Results

Table ES-2 summarizes the DER forecast results in 2045 for the reference scenario. Residential and fleet EV supply equipment (EVSE) is projected to have the most significant load impacts in Avista's Washington service territory, adding nearly 1,700 GWh of energy consumption in 2045. Because most residential customers charge their EVs in the late evening and night hours, the daily peaks of residential EVSE are not expected to coincide with Avista's planning peak hour.

Customer solar dominates new customer generation and is forecasted to reduce delivered loads by roughly 120 GWh by 2045. While the impact of customer storage load is minimal, nearly 100 MW of storage capacity will be available by 2045.

Table ES-2. 2045 Results Summary, Reference Scenario

Resource	Nameplate Capacity (MW)	Annual Load Impact (GWh)	Share of Nameplate Capacity in Named Community[3]	July Peak Load Impact[a] (MW)	December Peak Load Impact[a] (MW)
Customer Solar	105	-127	46%	-33	0
Customer Battery Storage	96	2	58%	-3	-9
Customer Wind	1	-0.3	45%	-0.1	0
Residential EVSE	1,544	853	38%	62	62
Fleet EVSE	692	841	67%	101	105
Public and Workplace EVSE	171	206	60%	33	33

a. The term "peak" refers to a planning peak beginning at 17:00 and ending at 18:00 local time.

Key Recommendations

This study represents an initial forecast of potential DER adoption in Avista's Washington electric service territory, using the best information available during the analysis. As the AEG Team developed these initial forecasts, we identified specific activities that Avista could undertake to improve the data available for future DER forecasts, including:

- **Address Fleet Data Gaps.** Finding fleet vehicle data is challenging. Secondary data likely undercount smaller light-duty vehicle (LDV) fleets. Therefore, the AEG Team recommends that Avista conduct the following activities:
    - **Continued outreach to fleet operators.** Continue surveying and collaborating with transit authorities, school districts, and parcel delivery companies in its service territory, as such outreach will help inform future DER forecasts.

[3] "Named Communities" refers to service points located in a highly impacted census tract, a vulnerable census tract, or tribal land. The team details this definition in Section 2, Project Overview, of this report.

  - **Analysis of satellite imagery.** Satellite imagery is a low-effort method to determine commercial and industrial fleet service points. Consider analyzing satellite imagery to help inform EV fleet forecasting.
  - **Acquire fleet inventory data.** The Washington Department of Ecology is currently conducting a fleet inventory. Once this data becomes available, the AEG Team recommends Avista pursue and use it.
- **Develop Commercial EV Charging Profiles.** Limited data are available to characterize EVSE charging profiles, especially for commercial fleets. The AEG Team recommends that Avista conduct load research on commercial fleet charging.
- **Develop Seasonal EV Charging Profiles.** The team did not have sufficient data to characterize seasonal differences in EV charging profiles (kW per hour) and driving patterns (vehicle miles traveled per day), so we assumed the summer and winter charging profiles are the same in Avista's service territory. However, the winter charging profile may be more significant due to vehicle cabin space heating or smaller because of less driving in the winter. Therefore, we recommend that Avista conduct load research on seasonal charging.
- **Conduct Additional Scenario Analyses.** The DER adoption forecast analyzed two scenarios: a reference scenario and a high-incentive scenario. Consider adding additional scenarios to study the impacts of climate change (e.g., weather, customer grid resiliency) and ancillary services incentives on DER forecasting.
- **Integrate the DER and Demand Response (DR) Potential Studies**. Some types of DERs, like EV charging and customer battery storage, can be leveraged in DR events. Therefore, it would benefit Avista to integrate its DER and DR potential studies to avoid overestimating or underestimating the combined potential.
- **Consider Adding Building Electrification**. Building electrification and load flexibility can affect customers' decisions regarding DER installations. Therefore, including building electrification and associated load control measures (e.g., connected thermostats, heat pump water heater switches) in future DER potential studies would provide Avista with a more comprehensive understanding of customer load growth and opportunities to shape it with programs and rates.
- **Consider Adding Emerging Technologies.** Emerging technologies, such as autonomous vehicles and vehicle-to-grid technologies, can change customer energy consumption patterns. Therefore, in future DER potential studies, Avista may want to consider emerging technologies as they become commercially available.

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1 | INTRODUCTION

This introductory section describes the study's purpose, objectives, and the AEG team's approach to forecasting and estimating the DER potential using two modeling scenarios. It also discusses the study's limitations and overall value to Avista.

Background and Objectives

Avista Utilities (Avista) contracted with AEG, with subcontractors Cadeo Group and Verdant Associates (collectively the AEG Team), to conduct a potential assessment of Distributed Energy Resources (DERs) in its Washington electric service territory.

Avista's primary objectives for completing this study include:

- Satisfy condition 14[4] from the Washington Utilities and Transportation Commission's (WUTC's) approval of Avista's Clean Energy Implementation Plan (CEIP).
- Develop reasonable estimates for new customer generation, storage, and electric vehicles localized within Avista's WA electric service territory.
- Investigate effects in highly impacted or vulnerable population areas.
- Utilize a robust forecasting model that can be updated and enhanced over time.
- Document methods, data sources, and inputs and provide results in a format that Avista can incorporate into other planning efforts.
- Engage internal and external stakeholders to get buy-in on study results.

CONDITION 14 FROM WUTC APPROVAL

- Avista will include a DER potential assessment for each distribution feeder no later than its 2025 Electric Integrated Resource Plan (IRP) and gather input from the IRP Technical Advisory Committee (TAC), Energy Efficiency Advisory Group (EEAG), and Distribution Planning Advisory Group (DPAG).
- The assessment will include a low-income DER potential assessment.
- Understand DER forecasting methodologies currently employed by other utilities.

Value to Avista

In addition to satisfying the WUTC condition, the activities and results associated with this study provide other valuable insights to Avista:

- **Informs Avista's 2025 Electric Integrated Resource Plan (IRP):** This study provides a bottom-up DER potential estimate, grounded in several reliable data sources, for the adoption and load impact from electric vehicle charging and customer solar photovoltaic (PV) for use in Avista's 2025 IRP's load forecast. Avista will need to plan its future portfolio of energy resources around these DER technologies.
- **Informs Distribution Planning Activities:** As DER adoption becomes more common, the team expects it to have disparate impacts across areas of Avista's electric distribution system. For instance, the AEG team expects electric vehicle charging to impact the industrial regions of Spokane County more heavily than other areas of the service territory, and these impacts are

[4] Avista will include a Distributed Energy Resources (DERs) potential assessment for each distribution feeder no later than its 2025 electric IRP. Avista will develop a scope of work for this project no later than the end of 2022, including input from the IRP TAC, EEAG, and DPAG. The assessment will include a low-income DER potential assessment. Avista will document its DER potential assessment work in the Company's 2023 IRP Progress Report in the form of a project plan, including project schedule, interim milestones, and explanations of how these efforts address WAC 480-100-620(3)(b)(iii) and (iv).

likely to trigger upgrades to distribution system infrastructure (i.e., service transformers and feeder lines). The DER Potential Study helps identify the areas on Avista's distribution system that will likely experience load growth from DERs over the next decade. For example, the results from the DER Potential Study will be incorporated into the data assumptions for the 2025-2026 System Assessment to help identify system deficiencies and proactively propose appropriate corrective action plans.

- **Informs Customer Engagement:** The AEG team located over 8,000 commercial fleet vehicles using various data sources to support this study. These data serve a dual purpose. In addition to identifying locations on Avista's grid likely to experience significant load growth, they also give Avista information that it can use to engage with its customers and advance transportation electrification initiatives with public and private entities. Similarly, Avista can use the results to engage customers regarding solar and storage programs.

Study Limitations

Like all potential studies, this study has limitations that can affect the interpretation of results and findings. The primary limitations include:

- **The Study Only Includes the Most Favorable Generation Technologies.** For this study, the team focused on customer solar and customer wind. Due to their unfavorable economics, the team considered but did not include other generation technologies (e.g., biomass-fired generation and combined heat and power).
- **Individual Customer Behaviors Deviate from "Average" Customer Behavior.** This study, like others, requires hundreds of assumptions concerning service territory averages and other high-level estimates. Individual customer behaviors, however, will vary from those service territory averages, and such behavioral information is unavailable for a broad study like this. For example, the AEG team assumed the average market share of BEVs in transit agency fleets would be 33% in 2030. Consider two hypothetical fleets where fleet A plans to have a 100% BEV share by 2030, while fleet B will not electrify until 2032. Because the DER Potential Study uses averages, we would assume that fleets A and B have the same proportion of BEVs (33%).

  Another example of how data gaps can affect the modeling results involves our assumption that all private MDV and HDV fleets have the same average daily charging profiles. Again, consider two hypothetical fleets: fleet A is an MDV fleet that delivers locally and charges overnight, while fleet B is an HDV fleet that makes long-haul daily charges while loading at the warehouse. This DER Potential Study assumes that fleets A and B have identical load profiles.
- **Scenario Analyses are Limited.** The analysis includes two scenarios—Reference and High-Incentive Scenarios—described in Appendix C. The solar and EV markets and the team's assumptions used to characterize them are incredibly complex. As such, this study focuses on two plausible future outcomes for DER adoption.
- **The Study is not a Comprehensive Load Forecast.** This study focuses on the load impacts of adopting DERs across Avista's distribution system. However, the project scope did not include a granular load forecast to account for other types of energy loads, such as space heating, lighting, and industrial production, and how those loads interact with DERs, energy efficiency, and demand response to get a complete view of the distribution system. As such, Avista will use the results of this study in tandem with other study results to conduct further analysis on how incremental DER adoption impacts its distribution system.

Report Organization

The remainder of this report is organized as follows:

- **Project Overview** describes the study's tasks, forecasting approach, and modeling scenarios.
- **Electric Vehicles: Modeling Scenarios and Results** presents detailed electric vehicles and charging results for the two scenarios.
- **New Customer Generation and Storage: Modeling Scenarios and Results** provides detailed forecast results for customer-sited solar PV, wind, and battery storage for the two scenarios.
- **Conclusions** summarize key findings and recommendations for Avista to consider in future DER planning activities.
- **Appendix A** contains a glossary of the acronyms used in this report.
- **Appendix B** discusses the DER forecasting methodologies of priority utilities, including PacifiCorp, Portland General Electric, Puget Sound Energy, Sacramento Municipal Utility District, Seattle City Light, and Southern California Edison.
- **Appendix C** details the DER forecasting methodology used by the AEG team to complete this study.
- **Appendix D** provides examples of Avista's engagement with DER stakeholders during the development of this study.
- **Appendix E** provides the EV charging load profiles used in this study and summary tables of the EV adoption and load impact results from the high-incentive scenario.

2 | PROJECT OVERVIEW

The AEG team performed six discrete tasks to complete this study:

Task 1: Survey Priority Utilities. The AEG team conducted a literature review and interviewed subject matter experts to characterize other electric utilities' DER forecasting methods. In collaboration with Avista, we selected six priority utilities to survey, representing Avista's regional peers and other leading West Coast utilities with advanced DER programs. The priority utilities are PacifiCorp, Portland General Electric, Puget Sound Energy, Sacramento Municipal Utility District, Seattle City Light, and Southern California Edison. The written deliverable from this task—a memorandum—is included in Appendix B of this report.

Task 2: Develop DER Forecasting Methodology. The AEG team developed a comprehensive plan for the DER forecasting approach, employing data from Avista and other secondary sources to forecast DER adoption and load impacts. The DER Forecasting Methodology document is included in Appendix C of this report.

Task 3: Forecast the Electric Vehicles and Charging Potential. For this task, the AEG team followed the methods described in the DER Forecasting Methodology document (Task 2) to model the adoption and load impact of electric vehicles and charging equipment in Avista's Washington service territory through 2045. Section 4 of this report presents the results.

Task 4: Forecast the New Generation and Storage Potential. The AEG team followed the methods described in the DER Forecasting Methodology document (Task 2) to develop a forecast of customer-sited solar PV, storage, and wind adoption and the associated load impacts in Avista's Washington service territory through 2045. Section 5 of this report presents the results.

Task 5: Present DER Forecast Results to Stakeholders. In March 2024, the AEG team presented the DER forecast results to stakeholders from Avista's IRP Technical Advisory Committee (TAC), Energy Efficiency Advisory Group (EEAG), and Distribution Planning Advisory Group (DPAG). Staff from the Washington Utilities and Transportation Commission (WUTC) and the Washington State Department of Commerce also participated in the stakeholder meeting. Appendix D contains the stakeholder presentation slides and meeting notes. It also summarizes the stakeholder questions and Avista's responses.

Task 6: Develop Final Report. This report represents the deliverable of the study's final task. In addition, the AEG team provided Avista with model input data and a summary of the results of the modeling activities.

Approach

The study is focused on the distribution system. As such, the AEG team performed the forecast analysis at a census block group level to help Avista understand at a high level of resolution which areas of its distribution system are likely to experience DER load growth.

For the modeling analysis, the team used AdopDER, a software application written in Python that was initially developed with Portland General Electric (PGE) for PGE's integrated resource planning and distribution system planning activities. AdopDER estimates service point-level adoption of DERs and creates long-term, hourly load impacts from those DERs at a granular level across a utility distribution system. Figure 2-1 illustrates how AdopDER uses a consistent framework to forecast DER adoption and DER load impacts. Appendix B details the process flow steps and describes the data sources leveraged for the analysis.[5]

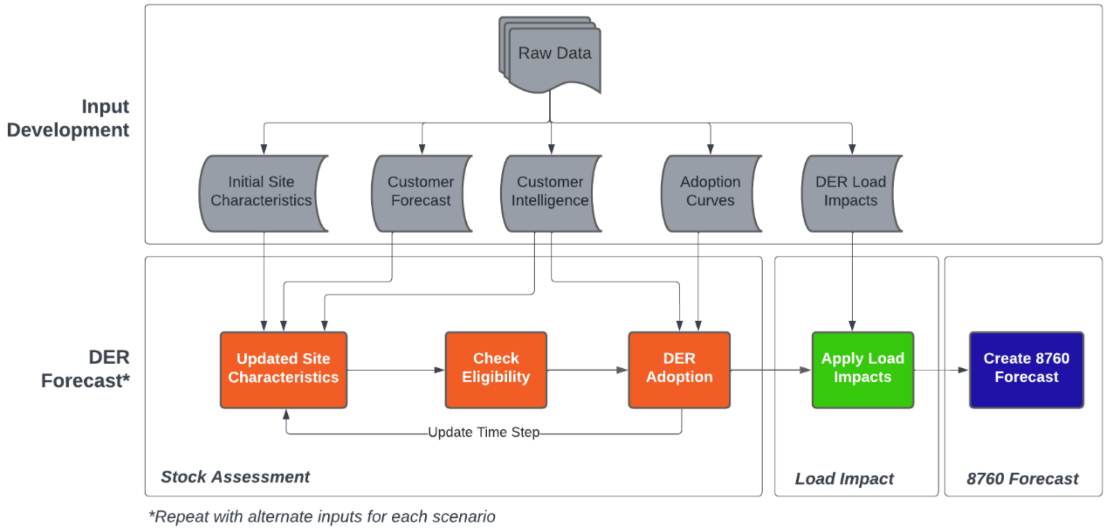


Figure 2-1. Modeling Process Diagram

Table 2-1 summarizes the DER technologies included in the forecast. For each technology, the team developed a forecast of adoption and load impact for 2023 through 2045 in Avista's Washington electric service territory.

Table 2-1. In-Scope DER Technologies

Electric Vehicles and Charging	New Generation and Storage
Light-duty vehicles, battery electric vehicles (LDV BEV)	Customer Solar
Light-duty vehicles, plug-in hybrid electric vehicles (LDV PHEV)	Customer Battery Storage
Medium-duty vehicles, battery electric vehicles (MDV BEV)	Customer Wind
Heavy-duty vehicles, battery electric vehicles (HDV BEV)	
Level 1 electric vehicle supply equipment (L1 EVSE)	
Level 1 electric vehicle supply equipment (L2 EVSE)	
Direct current fast-charging electric vehicle supply equipment (DCFC EVSE)	

[5] Appendix B contains clarifications and edits to the original document due to data availability and quality.

Named Communities

The AEG team collaborated with Avista to define a Named Community as any service point for which one or more of the following is true:

- **Highly Impacted** is in a census tract with a Washington Department of Health "EHD v2.0 Overall Rank" score of 9 or 10.
- **Vulnerable** is in a census tract with a composite score of 9 or 10 in the sensitive population or socioeconomic subcategories, as identified by the WA Department of Health's Environmental Health Disparities Map.
- **Tribal Land** is in a tribal land identified by an Avista-provided GIS shape file.

The darker-shaded regions of the map in Figure 2-2 indicate the locations of Named Communities in Avista's Washington service territory. The lighter-shaded regions are Non-Named Communities.

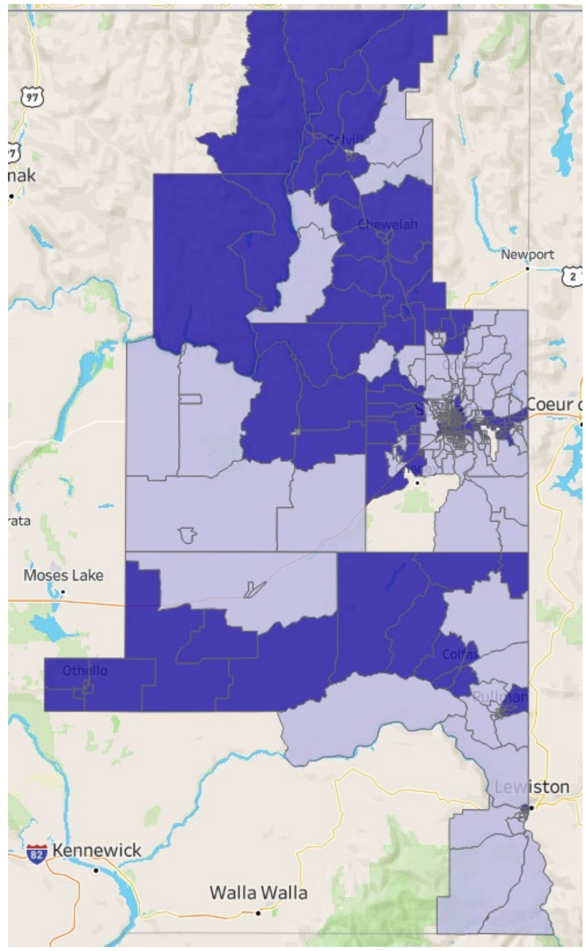


Figure 2-2. Named Communities Map

Modeling Scenarios

This study examines two scenarios: a reference and a high-incentive scenario. The two scenarios represent plausible future outcomes for DER in Avista's Washington service territory.

The reference scenario represents the "most likely" future outcome and is informed by current trends and the Washington state policy landscape. In it, we simulate adoption using knowledge of current incentive programs and typical "s-curve" changes in market share. In other words, under the reference forecast, we do not assume the existence of to-be-determined future programs, incentives, and interventions that may promote DER adoption, whether these interventions come from the utility, state, or federal level. Specifically, the reference scenario uses the following assumptions:

- Residential EV market share follows California's Advanced Clean Cars II regulation, with the Named Community market share adjusted downward.
- Non-residential EV market shares are consistent with those of regional literature review (e.g., Washington EV Council, Seattle City Light Electrification Study, Atlas Public Policy Washington Public Vehicle Electrification Assessment.
- Solar PV and storage adoption follows current market trends, with the adoption rate in Named Communities being lower than in Non-Named Communities.

The high-incentive scenario represents an alternative future where federal, state, and local policies incentivize DER adoption in Named Communities. The high-incentive scenario uses the following assumptions:

- Residential EV market share in Named Communities is the same as in Non-Named Communities.

- Residential Solar PV and storage adoption rates in Named Communities are the same as in Non-Named Communities.

3 | DETAILED RESULTS: ELECTRIC VEHICLES AND CHARGING

This section describes the detailed forecast results for electric vehicles and charging. Appendix C discusses the forecasting modeling approach, including data sources and assumptions. Appendix E provides supplemental electric vehicle data.

Vehicle Adoption

In the reference scenario, the AEG team expects there to be a total of 545,000 vehicles of any fuel type associated with residential service points in the Avista Washington service territory by 2045, as illustrated in Figure 3-1. This total includes 346,000 battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs) (64% of the total residential vehicle stock), a substantial increase over the 7,000 existing residential BEVs and PHEVs. This forecast accounts for Washington State's aggressive zero-emission vehicle (ZEV) mandate that all new, light-duty vehicles sold within the state meet ZEV Program standards by 2035.[6] However, the assumed average vehicle lifetime of 15 years somewhat tempers the EV growth. In the high-incentive scenario, where we assumed higher incentives for customers in Named Communities, we forecast an accelerated adoption of BEVs and PHEVs, with 73% of the residential vehicles becoming BEVs and PHEVs by 2045.

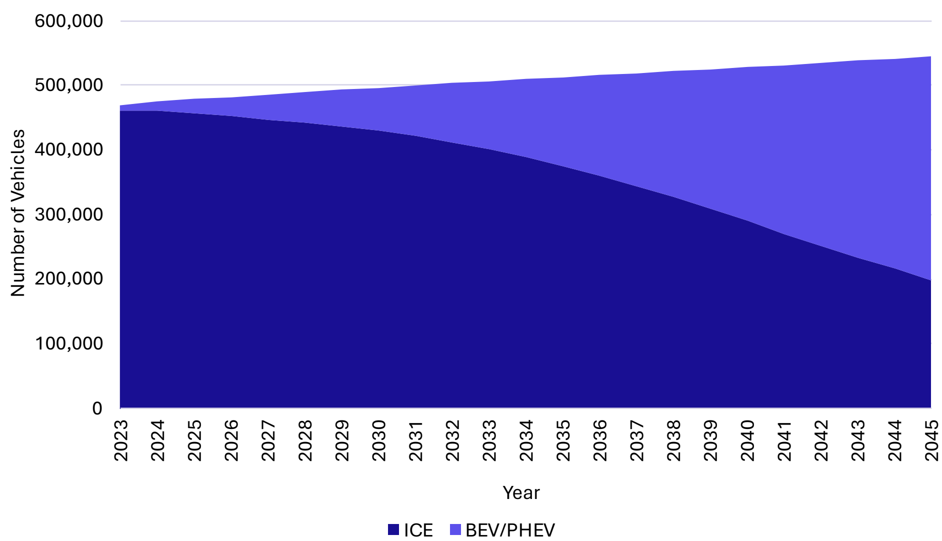


Figure 3-1. Residential Vehicles, Reference Scenario

Figure 3-2 displays the reference scenario's non-residential vehicles (fleet vehicles) by fuel type and weight class for the 2023 to 2045 timespan. Overall, we forecast 59,000 fleet vehicles by 2045, including 39,000 light-duty vehicles (LDVs), 20,000 medium-duty (MDVs), and heavy-duty vehicles (HDVs). Among MDVs and HDVs, the team expects 49% to be BEVs by 2045.[7] Within the LDV segment, we forecast 78% to be BEVs and PHEVs by 2045. In the high-incentive scenario, we assumed identical

[6] "Zero Emission Vehicles", Department of Ecology. Accessed on May 2, 2024. URL: https://ecology.wa.gov/air-climate/reducing-greenhouse-gas-emissions/zev.

[7] The team assumes that MDVs and HDVs will electrify with BEVs only. PHEVs do not have a substantive market share in these weight classes and are unlikely to achieve a significant market share in the study's time horizon.

market shares for fleet vehicles.[8] Consequently, the two scenarios have the same BEV and PHEV penetration estimates.

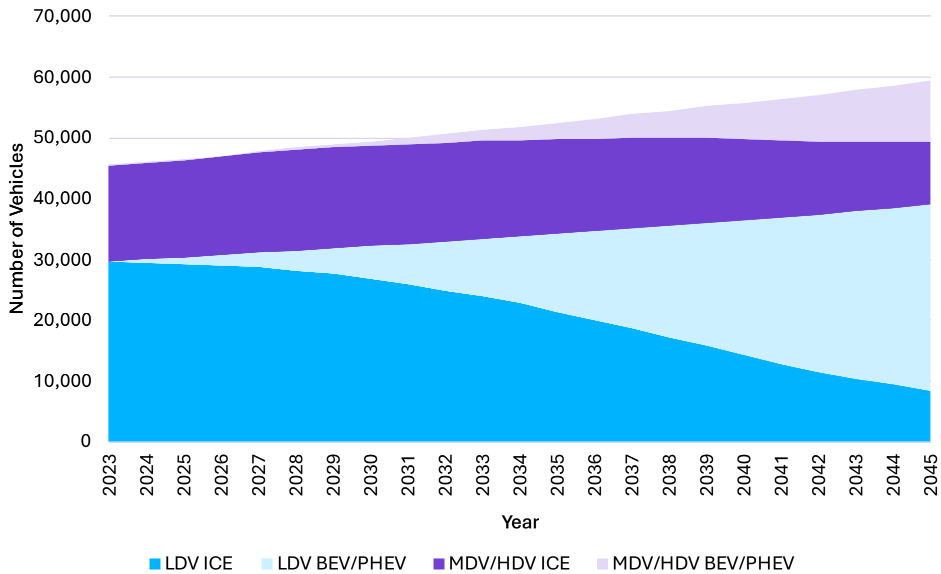


Figure 3-2. Non-Residential (Fleet) Vehicles, Reference Scenario

Charging Adoption

The BEVs and PHEVs identified in Figure 3-1 and Figure 3-2 form the basis for electric vehicle supply equipment (EVSE) in Avista's Washington service territory. We choose to display nameplate capacity rather than the number of service points because fleet and public EVSE typically have a higher rated capacity and thus can more significantly impact electric consumption than residential charging.

Figure 3-3 illustrates the forecast estimate for EVSE's nameplate capacity in megawatts (MW) by customer segment under the reference scenario. Most capacity is associated with residential customers (1,554 MW), but we expect a substantial fleet (692 MW) and public and workplace charging (171 MW) capacity, too.

[8] The team, after thorough research, determined BEV and PHEV adoption rate impacts for Named Communities relative to Non-named Communities for residential customers only. Thus, we assumed that the adoption rate of BEV and PHEV for non-residential (fleet) customers is at parity between Named Communities and Non-named Communities.

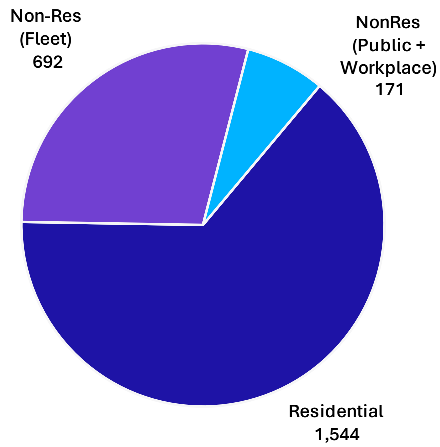


Figure 3-3. 2045 EVSE Megawatt Capacity by Customer Segment, Reference Scenario

Figure 3-4 displays the relative EVSE proportions by type (e.g., L1, L2, and DCFC) in the reference scenario. L2 will have the most charging capacity (1,923 MW of 2,407 MW total).

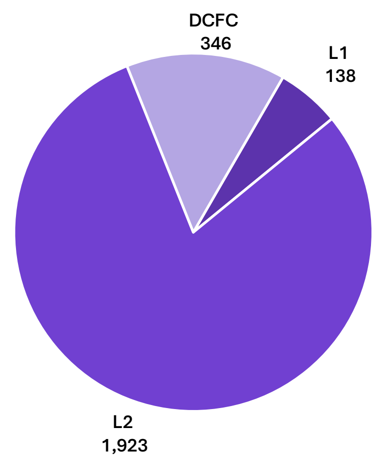


Figure 3-4. 2045 EVSE Megawatt Capacity by EVSE Type, Reference Scenario

Figure 3-5 shows how EVSE capacity varies by scenario. The high-incentive scenario has approximately 260 MW incremental EVSE capacity relative to the reference scenario (2,407 MW in the reference scenario vs. 2,665 MW in the high-incentive scenario) due to greater BEV and PHEV adoption in the residential sector. The team expects the incremental EVSE capacity in the high-incentive scenario to occur mainly in Named Communities.

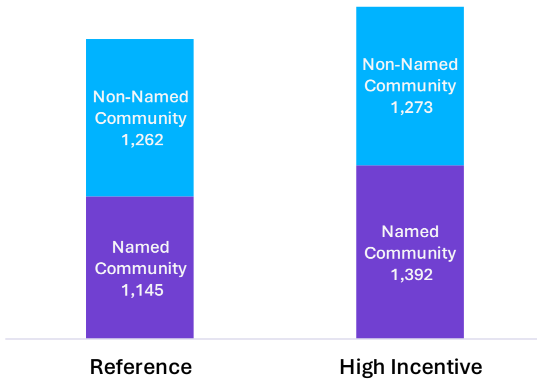


Figure 3-5. 2045 EVSE Megawatt Capacity by Named Community Status and Scenario

Load Impact

Under the reference scenario, Figure 3-6 shows the expected load impact (GWh) from vehicle electrification in Avista's Washington service territory. By 2045, the team expects BEVs and PHEVs to account for approximately 1,900 GWh of electric consumption, an increase of about 1,880 GWh relative to current electric vehicle consumption. If the load forecast that AEG created for Avista's 2023 Integrated Resource Plan[9] holds, this level of vehicle electrification would account for approximately a third of total electricity consumption[10] in the Avista Washington service territory by 2045 (i.e., 1,900 GWh divided by 5,800 GWh equals 33%).

[9] Avista Utilities. 2023 Electric Integrated Resource Plan. Appendix C – AEG Conservation Potential and Demand Response Potential Assessments. "AEG. Avista Electric Conservation Potential Assessment for 2022-2045." December 9, 2022. URL: https://www.myavista.com/-/media/myavista/content-documents/about-us/our-company/irp-documents/2023/appendix-c-cpa-and-dr-potential-assessments.pdf

[10] The team approximated Avista's 2045 load forecast of 5,800 GWh for Washington service territory in 2045 based on Tables 4-1, 4-3, and 4-5 in "Appendix C – AEG Conservation Potential and Response Potential Assessment." See footnote reference 4.

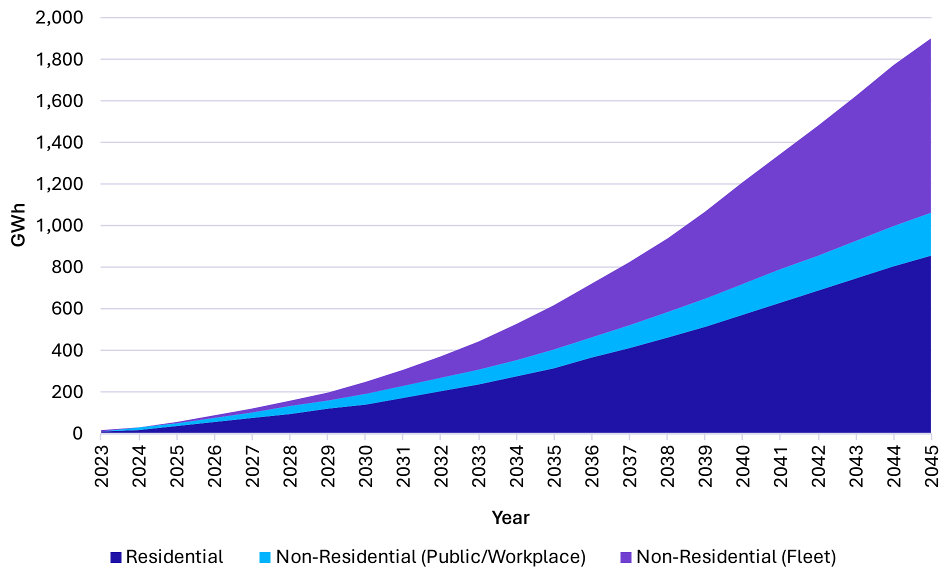


Figure 3-6. Annual Charging Load Impact (GWh), Reference Scenario

Table 3-1 shows the 2045 EVSE load impact by scenario. We expect 158 incremental GWh in 2045 in the high-incentive scenario relative to the reference scenario (2,057 GWh vs. 1,899 GWh). This increase is due to residential, public, and workplace charging. In the high-incentive scenario, we expect additional adoption of BEVs and PHEVs in Named Communities, but not every dwelling unit can accommodate EVSE. Thus, increased public and workplace charging will meet some charging demand.

Table 3-1. EVSE Load Impact in 2045, by Scenario and Customer Segment

Customer Segment	2045 Load Impact, Reference Scenario (GWh)	2045 Load Impact, High-Incentive Scenario (GWh)
Residential	853	978
Non-residential (Public and Workplace)	206	237
Non-residential (Fleet)	841	841
Total	1,899	2,057

The average daily load in megawatt-hours (MWh) associated with residential and non-residential EVSE by census block groups across Avista's Washington service territory is shown in Figure 3-7 and Figure 3-8, respectively. While the project scope does not include an analysis of how EVSE will impact the available headroom on specific distribution feeders and substations, certain areas of the distribution system will be affected more than others. For example, we anticipate that residential EVSE will typically add less than 10 MWh per day per census block group, with more significant amounts in the suburban areas surrounding the city of Spokane (Figure 3-7).

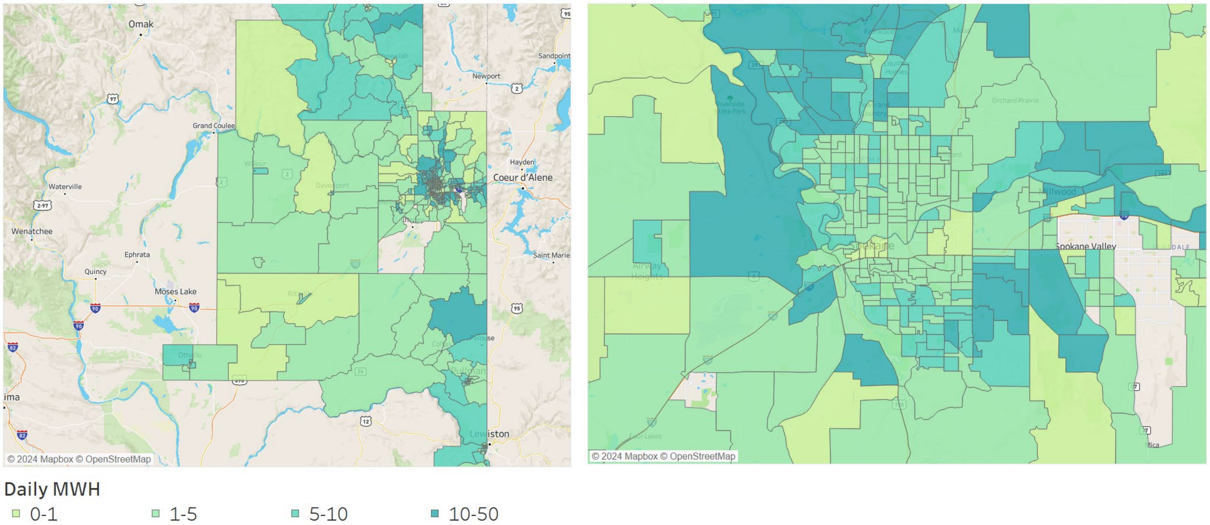


Figure 3-7. Locational Residential EVSE Load Impact in 2045. Washington Service Territory (Left) and Detailed Spokane Region (Right)

In contrast, we expect non-residential (fleet) charging to be more concentrated in some regions of the service territory. For example, the AEG team forecasts that census block groups in the industrial region bounded by Spokane River and Interstate 90 could see upwards of 100 MWh of average daily energy consumption by 2045 due to fleet and public charging under the reference scenario. (See the darkest shaded regions in Figure 3-8). Though this load growth will happen over time, our findings allow Avista to reach out to fleet customers to discuss their electrification plans. This, in turn, will enable Avista to assess when distribution system upgrades will be required and help shape how and when customers will charge EV fleets in the future.

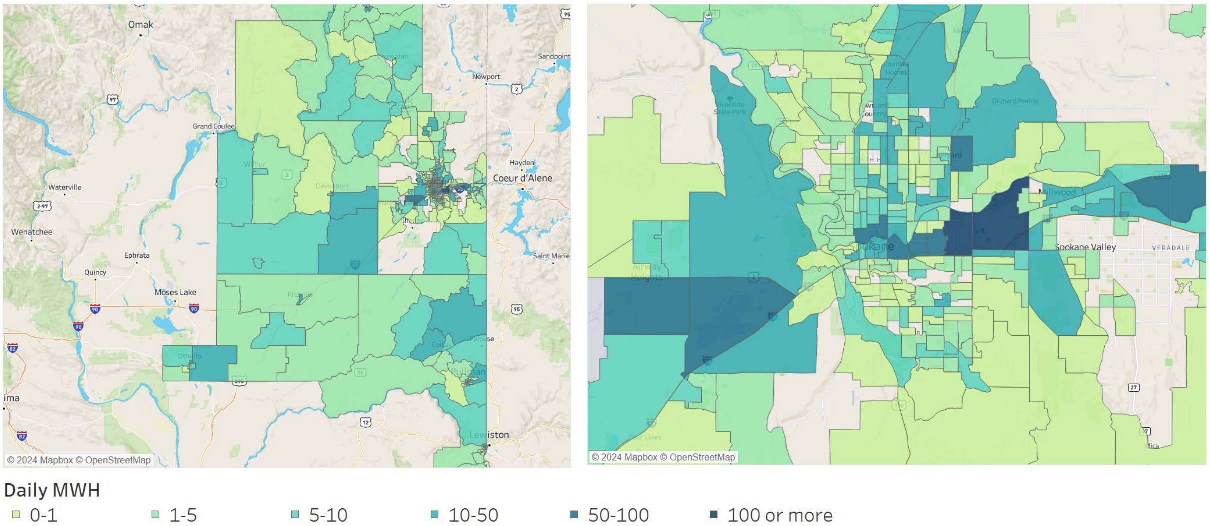


Figure 3-8. Locational Non-Residential EVSE Load Impact in 2045. Washington Service Territory (Left) and Detailed Spokane Region (Right)

Figure 3-9 illustrates the expected 2045 summer hourly charging profile for the reference scenario. We assume charging will occur mostly late into the afternoon or evening.[11] During the summer season, at Avista's planning peak for the hour beginning at 17:00 local time, we estimate 196 MW of load, ramping up to approximately 420 MW during the hour beginning at 22:00 local time, when residential customers are typically at home, and fleet customers have usually completed their daily activities. Because the team did not have sufficient data to characterize seasonal differences in EV charging load profiles (kW per hour) and driving patterns (vehicle miles traveled per day) within Avista's service territory, we assumed that the hourly charging profile does not vary over the year. Therefore, the winter and summer hourly charging profiles are nearly identical in our modeling results.

[11] The team used load profiles from Avista's 2022 Transportation Electrification report to characterize the hourly EVSE load profiles for this study. These curves indicate that Avista's customer EVSE load peaks in the evening hours.

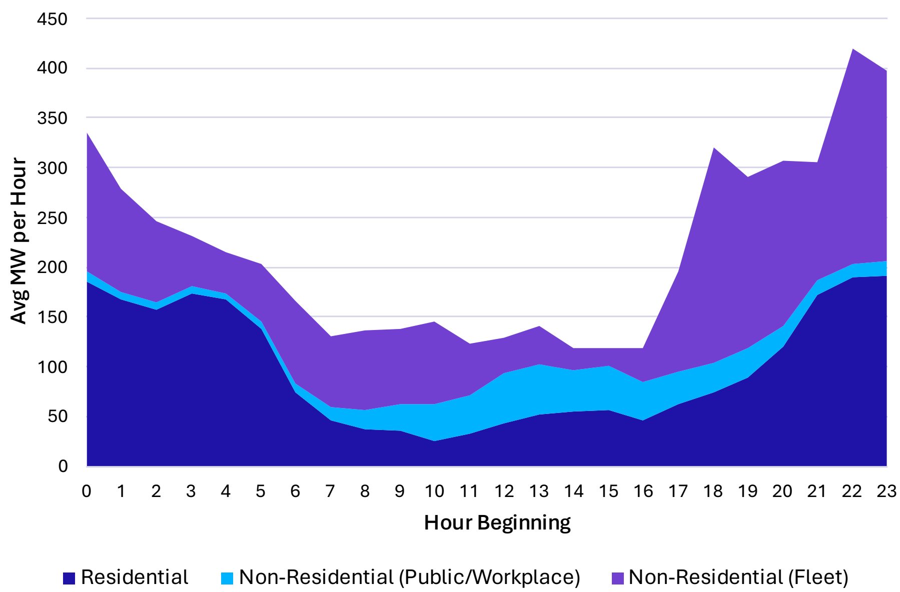


Figure 3-9. Summer Average Hourly Load Profile for EVSE in 2045, Reference Scenario

Note that Figure 3-9 represents service territory aggregates. The behavior of individual fleets and specific census block groups will vary. For example, public transit authorities may employ on-route charging rather than depot charging to manage the operational efficiency of their fleets; this is an example of a location-specific behavioral difference that would make charts like Figure 3-9 differ if viewed for each census block group.

The AEG team relied primarily on Avista's 2022 Transportation Electrification Report load profiles.[12] These load profiles do not assume explicit direct load control (DLC) measures or pricing schemes like Time-of-Use (TOU) rates, which typically influence hourly charging shapes. Because quantifying load impacts associated with DLC or TOU rates was not part of the project scope, the AEG team recommends that Avista assess DLC and TOU rates in future DER potential studies. This will become increasingly important as Avista develops its strategy for managing the growth of charging loads in its service territory.

Ancillary Services

The team assumes that the residential EVSE load is eligible for use in ancillary services because it could be controlled through a DLC program. Based on assumptions consistent with Avista's 2023 Integrated Resource Plan, we assume the following for the ancillary services potential:[13]

- 15% participation in a Residential EVSE DLC program.
- DLC reduces load impact by 75% during event hours.
- 50% of DLC load reduction is available for ancillary services.

[12] Avista Utilities. 2022 Annual Transportation Electrification Report. Submitted to the Washington Utilities and Transportation Commission. March 31, 2023. URL: https://www.myavista.com/-/media/myavista/content-documents/energy-savings/evs/avista-2022-annual-te-report.pdf

[13] Avista Utilities. 2023 Electric Integrated Resource Plan. Appendix C – AEG Conservation Potential and Demand Response Potential Assessments. "AEG. Avista Electric Conservation Potential Assessment for 2022-2045." December 9, 2022. URL: https://www.myavista.com/-/media/myavista/content-documents/about-us/our-company/irp-documents/2023/appendix-c-cpa-and-dr-potential-assessments.pdf

Applying these assumptions to the 62 MW of projected residential EVSE load during the planning peak hour, we estimate 4 MW of potential for ancillary services, as illustrated in Table 3-4. The team does not consider non-residential EVSE to have ancillary services potential, as fleet and public charging typically have less flexibility than residential charging.

Table 3-2. EVSE Load Impact in 2045, by Scenario and Customer Segment

Resource	Nameplate Capacity (MW)	Annual Load Impact (GWh)	Share of Nameplate Capacity in Named Community[14]	July Peak Load Impact[a] (MW)	December Peak Load Impact[a] (MW)	Ancillary Services Potential (MW)
Residential EVSE	1,544	853	38%	62	62	4
Fleet EVSE	692	841	67%	101	105	0
Public and Workplace EVSE	171	206	60%	33	33	0

a. The term "peak" refers to a planning peak beginning at 17:00 and ending at 18:00 local time.

[14] "Named Communities" refers to service points located in a highly impacted census tract, a vulnerable census tract, or tribal land. The team details this definition in Section 2, Project Overview, of this report.

4 | DETAILED RESULTS: NEW CUSTOMER GENERATION AND STORAGE

This section describes the detailed forecast results for new customer generation and battery energy storage; details on the forecasting modeling approach, including data sources and assumptions, are provided in Appendix C.

Customer Solar

Adoption

Figure 4-1 displays the AEG team's forecast of customer-sited solar nameplate capacity (MW) in 2045. We expect current trends to continue, with the residential customer segment dominating solar adoption. The residential segment will account for over 85% of the 104 MW new customer solar in 2045. However, our analysis indicates that some larger commercial customers will start adopting solar at more elevated rates than historically.

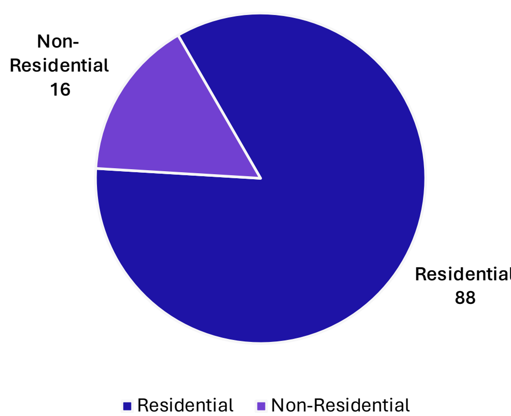


Figure 4-1. 2045 Customer Solar Nameplate Capacity (MW) by Sector, Reference Scenario

Figure 4-2 shows the expected customer solar adoption for the two scenarios. The high-incentive scenario has an incremental 15 MW of new solar capacity relative to the reference scenario (119 MW vs. 104 MW), which comes from Named Communities.

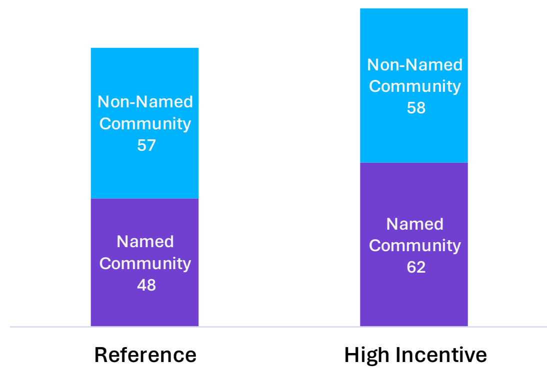


Figure 4-2. 2045 Customer Solar Nameplate Capacity (MW), by Named Community Status and Scenario

Load Impact

In the reference scenario, 104 MW of new customer solar will yield 127 GWh of load reduction by 2045. The load reduction increases rapidly in the early years of the forecast—2023 through 2030—but then levels off. This is illustrated in Figure 4-3. The leveling off is caused by Avista's net-energy metering (NEM) tariffs, which will be sunset in 2029, rendering the economics of customer solar adoption less attractive. While the team did not investigate a shift in the policy landscape in the two scenarios, we note that preserving NEM or alternative incentive mechanisms would further increase the load reduction from customer solar.

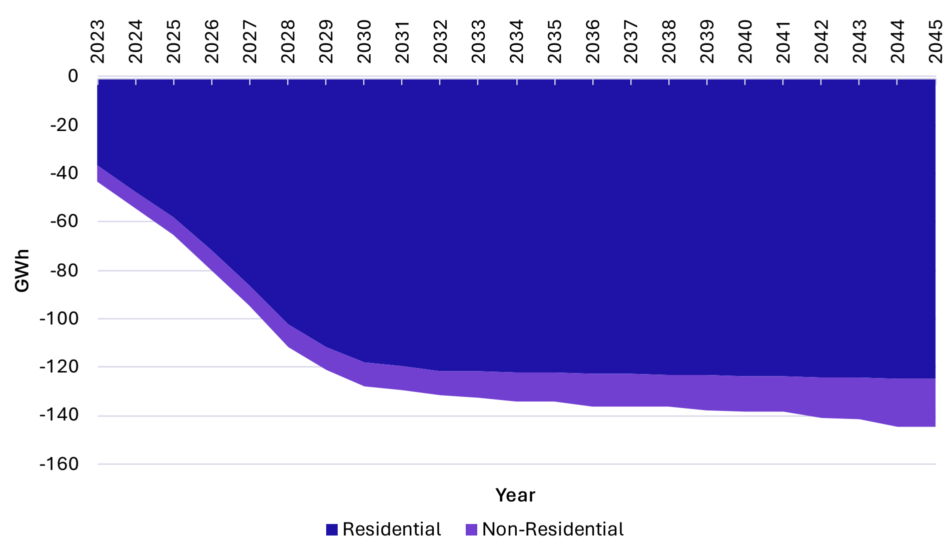


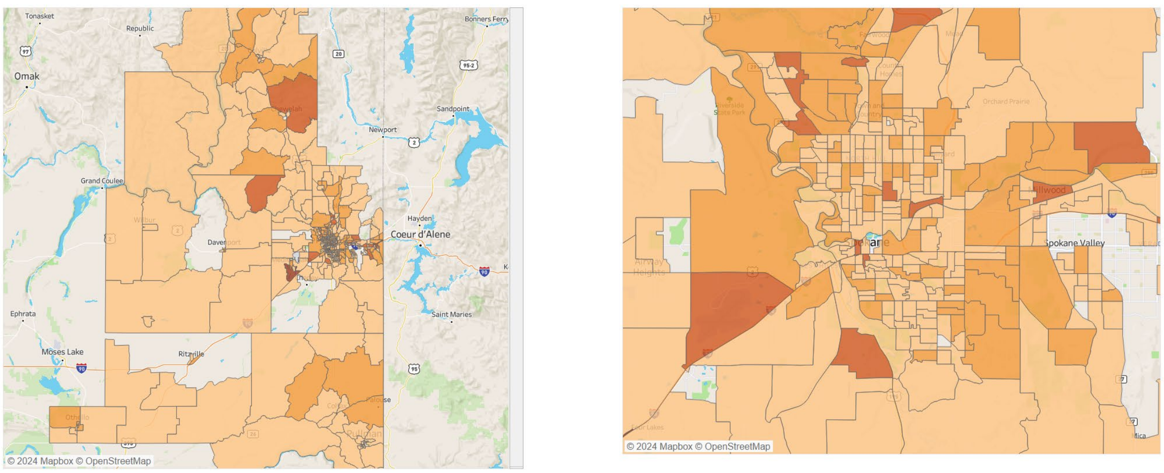
Figure 4-3. Annual Customer Solar Load Impact (GWh), Reference Scenario

Table 4-1 summarizes the customer solar load impacts by 2045 for the two scenarios. In the high-incentive scenario, we forecast an additional 18 GWh load reduction in 2045 relative to the reference scenario (145 GWh vs. 127 GWh).

Table 4-1. 2045 Customer Solar Load Impact, by Scenario and Customer Segment

Segment	2045 Load Impact, Reference Scenario (GWh)	2045 Load Impact, High-Incentive Scenario (GWh)
Residential	-107	-125
Non-Residential	-20	-20
Total	-127	-145

Figure 4-4 illustrates the average daily load reduction (in MWh) from customer solar adoption by census block group. We expect customer solar adoption to be more diffuse than EV charging, as most block groups will have less than 5 MWh of daily load reduction in 2045 under the reference scenario. The most significant solar adoption levels are expected in residential areas with a higher concentration of single-family homes.



Avg Daily MWH
▪ 0-1 ▪ 1-2 ▪ 2-5 ▪ 5 or more

Figure 4-4. Locational Customer Solar Load Impact in 2045. Washington Service Territory (Left) and Spokane Region (Right)

Figure 4-5 shows the hourly load impact shape for customer solar. As is expected, customer solar has a more considerable load reduction in summer with lower cloud cover and longer daylight hours. The AEG team forecasts a maximum of 71 MW of solar generation at an hour beginning at 14:00 local time on a typical July day by 2045. A typical December day will have a significantly reduced generation profile, with a maximum of 25 MW per hour beginning at 11:00 local time. During the summer season, at Avista's planning peak for the hour starting at 17:00 local time, we estimate 33 MW of load reduction. Our estimates are based on typical meteorological year data and thus would vary daily with actual solar irradiance patterns.

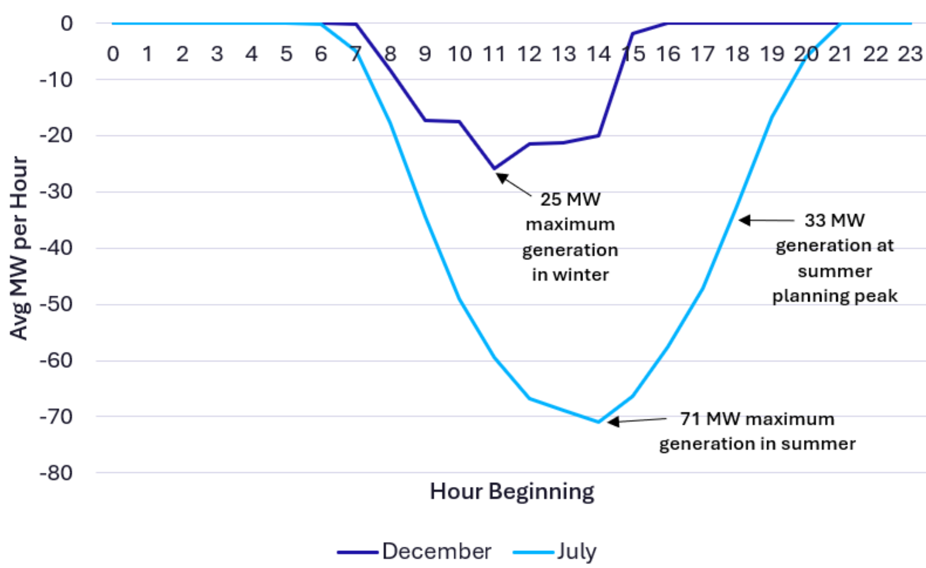


Figure 4-5 Average Hourly Load Profile for Customer Solar in 2045, Reference Scenario

Customer Wind

Adoption

Currently, customer-sited wind is being adopted minimally in Avista's Washington service territory, and we do not anticipate substantial adoption in the upcoming years. In total, we forecast a mere 0.4 MW of new customer wind capacity by 2045, and this total does not vary substantively by scenario. Figure 4-6 shows the AEG team's forecast for customer wind adoption by 2045.

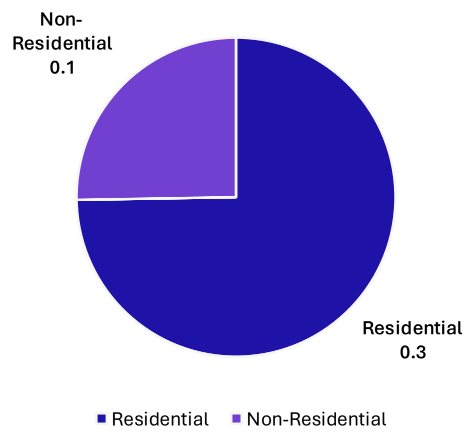


Figure 4-6. 2045 Customer Wind Nameplate Capacity (MW)

Load Impact

We estimate that customer wind will account for less than 1 MW capacity on a typical day and generate less than 1 GWh in energy annually by 2045. The team has provided Avista with these estimates but has excluded charts for annual generation (in MWh) or an hourly profile (in MW) in this report due to the minimal impact of customer wind.

Customer Battery Storage

Adoption

The current adoption of customer battery energy storage in Avista's Washington service territory is unknown but likely minimal because Avista does not have programs that cover energy storage. However, Avista recently introduced a pilot TOU tariff, which creates a tiered rate structure that incentivizes reduced energy consumption and creates arbitrage opportunities for using energy storage during peak periods. Our adoption forecast assumes this TOU rate structure is paired with current technology pricing trends. Figure 4-7. 2045 Customer Storage Nameplate Capacity (MW) by Sector, Reference Scenario illustrates the results of the customer battery storage nameplate capacity forecast by 2045. In the reference scenario, we anticipate 74 MW of storage capacity for non-residential customers and 22 MW for residential customers.

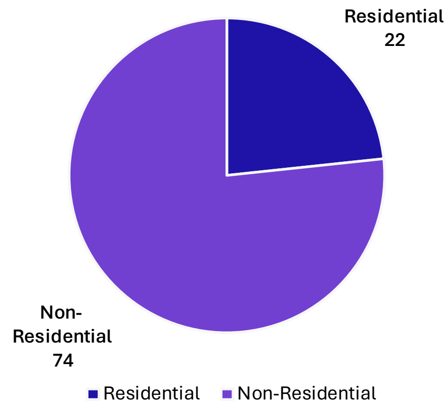


Figure 4-7. 2045 Customer Storage Nameplate Capacity (MW) by Sector, Reference Scenario

Load Impact

In the reference scenario, 96 MW of customer battery storage will yield a load addition of 2 GWh by 2045 due to round-trip efficiency losses. The hourly shapes depend on the desired state of charge, charging, and dispatch for TOU rate arbitrage. Figure 4-8 shows the average load profile for customer storage (MW) in 2045.

The project scope did not include simulating dispatch for demand response or resiliency events. From a resource planning perspective, such events would influence the typical hourly shape (MW) but have minimal impact on the annual energy load impact (MWh).

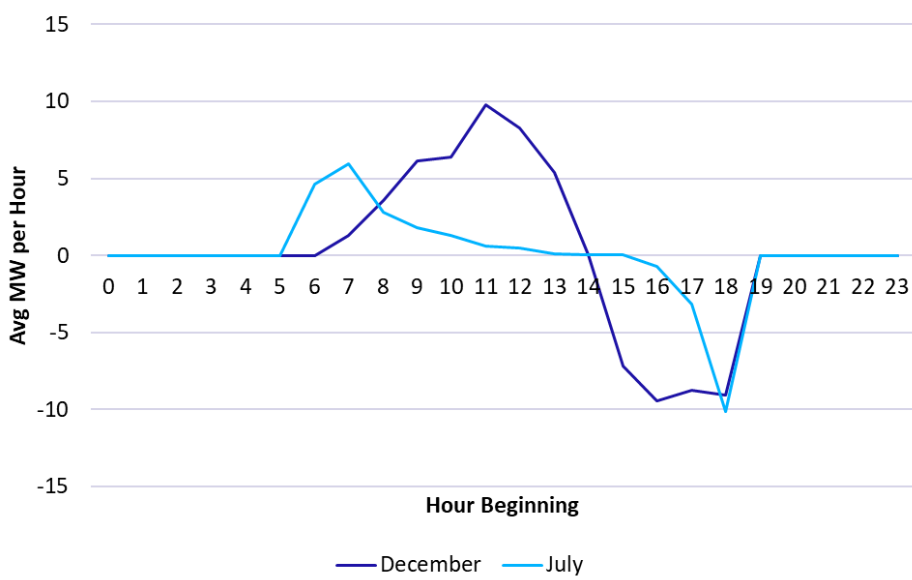


Figure 4-8. Average Hourly Load Profile for Customer Storage in 2045, Reference Scenario

Ancillary Services

The AEG team assumes that 80% of customers' battery storage capacity is eligible for use in ancillary services, which allows for some reserve capacity. Thus, the team estimates 77 MW (80% of 96 MW) of ancillary services potential for customer battery storage, with non-residential customers accounting for 59 MW and residential customers accounting for 18 MW. Customer solar and wind generation resources are intermittent due to their weather dependence, so the team assumes these resources do not offer any potential for ancillary services.

5 | CONCLUSIONS AND RECOMMENDATIONS

This section summarizes the results and findings from the DER potential forecast and provides recommendations for how Avista can update and enhance future DER potential assessments.

Summary Results

The reference scenario in Table 5-1 summarizes the 2045 DER potential results. The residential and fleet EVSE will have the most significant load impacts in the Avista Washington service territory, adding nearly 1,700 GWh of energy consumption in 2045. Customer solar will decrease energy consumption by almost 130 GWh in 2045.

Table 5-1. Summary Results for 2045, Reference Scenario

Resource	Nameplate Capacity (MW)	Annual Load Impact (GWh)	Share of Nameplate Capacity in Named Community	July Peak Load Impact[a] (MW)	December Peak Load Impact[a] (MW)
Customer Solar	105	-127	46%	-33	0
Customer Battery Storage	96	2	58%	-3	-9
Customer Wind	1	-0.3	45%	-0.1	0
Residential EVSE	1,544	853	38%	62	62
Fleet EVSE	692	841	67%	101	105
Public and Workplace EVSE	171	206	60%	33	33

b. The term “peak” refers to a planning peak beginning at 17:00 and ending at 18:00 local time.

Recommendations

As the team notes in the Utility Survey Memo (Appendix B), the current state of DER potential forecasting is bespoke and faces many of Avista's data gaps. The AEG team recommends six actions Avista can take before the next iteration of the DER potential study to increase the fidelity and depth of insights from a location-specific study like this one.

- **Address Fleet Data Gaps.** For this study, the team estimated the size and location of commercial fleets using two methods. First, Avista surveyed commercial vehicle fleets in its service territory, identifying dozens of smaller fleets. Additionally, the team used secondary data and satellite imagery to identify many larger fleets in the service territory, including school district buses and parcel delivery vehicles. While these efforts successfully obtained data from dozens of fleets, they are not comprehensive and likely undercount smaller LDV fleets. Three activities that the team recommends that Avista pursue to collect additional fleet data follow:
    - **Continued outreach to fleet operators.** Avista has begun outreach to fleet operators in its service territory to understand electrification plans and possible charging locations.

Collecting and cleansing data from these outreach activities will advance Avista's ability to inform forecasting studies.

  - **Analysis of satellite imagery.** Though an imperfect indicator of the presence of vehicle fleets, satellite imagery is a low-effort method of identifying fleets at Avista's commercial and industrial service points. Collecting and cleansing data from an analysis of satellite imagery will advance Avista's ability to inform forecasting studies like this one.
  - **Acquire fleet inventory data.** Washington Department of Ecology is currently conducting a fleet inventory[15] that requires fleets with five or more vehicles to register the vehicle types, counts, and depot locations. The team recommends that Avista pursue this data source for its service territory when it becomes available.

- **Develop Commercial EV Charging Profiles.** Limited data are available to characterize EVSE charging profiles, especially for commercial fleets. The AEG Team recommends that Avista conduct load research on commercial fleet charging.
- **Develop Seasonal EV Charging Profiles.** The team did not have sufficient data to characterize seasonal differences in EV charging profiles (kW per hour) and driving patterns (vehicle miles traveled per day), so we assumed the summer and winter charging profiles are the same in Avista's service territory. However, the winter charging profile could be more significant due to vehicle cabin space heating or smaller because of less driving in the winter. Therefore, we recommend that Avista conduct load research on seasonal EV charging.
- **Conduct Additional Scenario Analyses.** The DER adoption forecast analyzed two scenarios: a reference scenario and a high-incentive scenario. Consider adding additional scenarios to study the impacts of climate change (e.g., weather, customer grid resiliency) and ancillary services incentives on DER forecasting.
- **Integrate the DER and Demand Response (DR) Potential Studies**. Some types of DERs, like EV charging and customer battery storage, can be leveraged in DR events. Therefore, it would benefit Avista to integrate its DER and DR potential studies to avoid overestimating or underestimating the combined potential.
- **Consider Adding Building Electrification**. Building electrification and load flexibility can affect customers' decisions regarding DER installations. Therefore, including building electrification and associated load control measures (e.g., connected thermostats, heat pump water heater switches) in future DER potential studies would provide Avista with a more comprehensive understanding of customer load growth and opportunities to shape it with programs and rates.
- **Consider Adding Emerging Technologies.** Emerging technologies, such as autonomous vehicles and vehicle-to-grid technologies, can change customer energy consumption patterns. Therefore, in future DER potential studies, Avista may want to consider emerging technologies as they become commercially available.

[15] Washington Department of Ecology. Fleet Reporting Platform Guidebook for Fleet Managers. August 2023. URL: https://apps.ecology.wa.gov/publications/UIPages/documents/2302068.pdf

A | GLOSSARY

The Glossary section defines terms and acronyms used in this report.

Ancillary Services: Ancillary services help grid operators maintain a reliable electricity system by ensuring the proper flow and direction of electricity and addressing imbalances between supply and demand.

BEV: Battery electric vehicle

Customer Solar PV: Customer-sited solar photovoltaic (PV) panels installed behind the utility meter. Typically, this is rooftop solar PV.

Customer Storage: Customer-sited battery storage installed behind the utility meter.

Customer Wind: Small, customer-sited wind generation installed behind the utility meter.

DCFC: Direct current, fast charging EVSE (50 kW or more)

DLC: Direct load control

DOC: Washington Department of Commerce

EV: Electric vehicle

EVSE: Electric vehicle supply equipment; vehicle chargers

HDV: Heavy-duty vehicle (Class 7 and 8, 26,001 lbs. or more)

ICE: Internal combustion engine vehicle

L1: Level 1 EVSE (typically 1 to 3 kW)

L2: Level 2 EVSE (typically 7 to 22 kW)

LDV: Light-duty vehicle (Class 1 and 2, 0-10,000 lbs.)

MDV: Medium-duty vehicle (Class 3 through 6; 10,001-26,000 lbs.)

Peak Hour: Avista's "Planning peak" is at hour-beginning 17:00/hour-ending 18:00 on weekdays in July and December. The planning peak may differ from the actual system peak periods.

PHEV: Plug-in hybrid electric vehicle

WUTC: Washington Utilities and Transportation Commission

B | UTILITY SURVEY

The memorandum that describes the results from the utility survey (Task 1):

Avista Task 1 Utility
Survey FINAL Memo_

C | DER FORECASTING METHODOLOGY

The document that describes the DER forecasting approach (Task 2):

Task 2 DER
Forecasting Method

D | STAKEHOLDER ENGAGEMENT

During the development of the DER Potential Study, the AEG team and Avista staff engaged with DER stakeholders several times, including the customer fleet survey Avista conducted in conjunction with the development of the DER Forecasting Methodology document (Task 2) and the March 27, 2024, stakeholder meeting when the project team presented and discussed the preliminary DER results (Task 5). Evidence of DER engagement can be found below.

Avista Customer Fleet Survey:

In late 2023, Avista Utilities engaged MDC Research to survey its commercial and industrial customers about vehicle fleets and fleet electrification plans. 76 Avista customers completed the survey, with approximately 2,300 vehicles (LDV, MDV, HDV, and forklifts). The team describes its approach to using these data in Appendix C (DER Forecasting Methodology) but will keep survey results private due to the sensitive nature of the responses.

DER Potential Study slides presented at the March 27, 2024, stakeholder meeting (Task 5):

FINAL Avista DER
Potential Study Stakel

Meeting notes from the March 27, 2024, DER Potential Study stakeholder meeting, including a list of meeting attendees (Task 5):

Stakeholder meeting
notes March 27, 2024

Questions submitted by Washington Utilities and Transportation Commission (WUTC) staff following the DER Potential Study stakeholder meeting, with answers provided by Avista:

Public Engagement
Appendix D_WUTC (

Questions submitted by the Department of Commerce (DOC) staff following the DER Potential Study stakeholder meeting, with answers provided by Avista:

Public Engagement
Appendix D_DOC Qu

E | SUPPLEMENTAL ELECTRIC VEHICLE DATA

Table E-1 and Table E-2 summarize the EV adoption and load impact results from the high-incentive scenario.

Table E-3 through Table E-6 show the EV charging load profiles we used as inputs in the DER Potential Study. The hourly load profiles are unitized to 1 kW of nameplate capacity. For example, consider the Fleet HVD DFC C load profiles in Table E-3 where the utilization is 0.473 (43.7%) in the hour beginning at 0:00 on weekdays. Because we assume that Fleet DCFC has a nameplate capacity of 150 kW (see Table E-7), the assumed kW for a DCFC port in a weekday hour beginning at 0:00 is 0.437 x 150 kW = 66 kW. The 0.437 estimate is a function of nameplate kW, vehicle miles traveled, miles per kW, and vehicles per port. For a detailed explanation of the utilization estimates, see the DER Forecasting Methodology document in Appendix C.

Table E-1. Year 2030 Electric Vehicle Results Summary, High-Incentive Scenario

Vehicle Weight Class	Total Vehicles	% Electrified	EVs	Peak Load Impact (MW)	Annual Consumption (MWh)
LDV	519,499	20%	104,838	26.4	284,418
MDV	16,087	3%	436	3.0	25,913
HDV	10,348	3%	350	2.2	15,646
Total	545,934	19%	105,624	31.6	325,977

Table E-2. Year 2045 Electric Vehicle Results Summary, High-Incentive Scenario

Vehicle Weight Class	Total Vehicles	% Electrified	EVs	Peak Load Impact (MW)	Annual Consumption (MWh)
LDV	573,839	74%	426,534	97.8	1,389,054
MDV	17,855	30%	5,434	15.0	286,129
HDV	12,603	37%	4,662	19.3	381,437
Total	604,297	72%	436,630	132.1	2,056,621

Table E-3. DCFC Charging Load Profiles

Hour Beginning	DCFC, Fleet HDV		DCFC, Fleet MDV		DCFC, School		DCFC, Transit Depot		DCFC, Transit Route	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
0	0.437	0.437	0.268	0.268	0.178	0.000	0.361	0.361	0.000	0.000
1	0.328	0.328	0.201	0.201	0.134	0.000	0.181	0.181	0.000	0.000
2	0.260	0.260	0.159	0.159	0.106	0.000	0.090	0.090	0.000	0.000
3	0.164	0.164	0.100	0.100	0.067	0.000	0.054	0.054	0.000	0.000
4	0.137	0.137	0.084	0.084	0.056	0.000	0.018	0.018	0.000	0.000
5	0.191	0.191	0.117	0.117	0.078	0.000	0.005	0.005	0.000	0.000
6	0.273	0.273	0.167	0.167	0.111	0.000	0.005	0.005	0.000	0.000
7	0.232	0.232	0.142	0.142	0.095	0.000	0.006	0.006	0.000	0.000
8	0.260	0.260	0.159	0.159	0.106	0.000	0.006	0.006	0.258	0.258
9	0.246	0.246	0.151	0.151	0.100	0.000	0.005	0.005	0.258	0.258
10	0.273	0.273	0.167	0.167	0.111	0.000	0.018	0.018	0.258	0.258
11	0.164	0.164	0.100	0.100	0.067	0.000	0.045	0.045	0.258	0.258
12	0.109	0.109	0.067	0.067	0.045	0.000	0.072	0.072	0.258	0.258
13	0.123	0.123	0.075	0.075	0.050	0.000	0.090	0.090	0.258	0.258
14	0.068	0.068	0.042	0.042	0.028	0.000	0.086	0.086	0.258	0.258
15	0.055	0.055	0.033	0.033	0.022	0.000	0.077	0.077	0.258	0.258
16	0.109	0.109	0.067	0.067	0.045	0.000	0.054	0.054	0.258	0.258
17	0.328	0.328	0.201	0.201	0.134	0.000	0.027	0.027	0.258	0.258
18	0.711	0.711	0.435	0.435	0.290	0.000	0.072	0.072	0.258	0.258
19	0.547	0.547	0.334	0.334	0.223	0.000	0.316	0.316	0.258	0.258
20	0.519	0.519	0.318	0.318	0.212	0.000	0.519	0.519	0.000	0.000
21	0.355	0.355	0.217	0.217	0.145	0.000	0.596	0.596	0.000	0.000
22	0.683	0.683	0.418	0.418	0.279	0.000	0.542	0.542	0.000	0.000
23	0.601	0.601	0.368	0.368	0.245	0.000	0.474	0.474	0.000	0.000

Note: We assume schools do not charge during the summer months.

Table E-4. L1 and L2 Fleet Charging Profiles

Hour Beginning	L1, Fleet LDV		L2, Fleet HDV		L2, Fleet MDV		L2, Fleet LDV		School	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
0	0.415	0.415	0.246	0.246	0.175	0.175	0.058	0.058	0.232	0.000
1	0.311	0.311	0.184	0.184	0.131	0.131	0.044	0.044	0.174	0.000
2	0.246	0.246	0.146	0.146	0.104	0.104	0.035	0.035	0.138	0.000
3	0.156	0.156	0.092	0.092	0.066	0.066	0.022	0.022	0.087	0.000
4	0.130	0.130	0.077	0.077	0.055	0.055	0.018	0.018	0.073	0.000
5	0.182	0.182	0.107	0.107	0.077	0.077	0.026	0.026	0.102	0.000
6	0.259	0.259	0.153	0.153	0.110	0.110	0.036	0.036	0.145	0.000
7	0.220	0.220	0.130	0.130	0.093	0.093	0.031	0.031	0.123	0.000
8	0.246	0.246	0.146	0.146	0.104	0.104	0.035	0.035	0.138	0.000
9	0.233	0.233	0.138	0.138	0.099	0.099	0.033	0.033	0.131	0.000
10	0.259	0.259	0.153	0.153	0.110	0.110	0.036	0.036	0.145	0.000
11	0.156	0.156	0.092	0.092	0.066	0.066	0.022	0.022	0.087	0.000
12	0.104	0.104	0.061	0.061	0.044	0.044	0.015	0.015	0.058	0.000
13	0.117	0.117	0.069	0.069	0.049	0.049	0.016	0.016	0.065	0.000
14	0.065	0.065	0.038	0.038	0.027	0.027	0.009	0.009	0.036	0.000
15	0.052	0.052	0.031	0.031	0.022	0.022	0.007	0.007	0.029	0.000
16	0.104	0.104	0.061	0.061	0.044	0.044	0.015	0.015	0.058	0.000
17	0.311	0.311	0.184	0.184	0.131	0.131	0.044	0.044	0.174	0.000
18	0.674	0.674	0.399	0.399	0.285	0.285	0.095	0.095	0.377	0.000
19	0.519	0.519	0.307	0.307	0.219	0.219	0.073	0.073	0.290	0.000
20	0.493	0.493	0.292	0.292	0.208	0.208	0.069	0.069	0.276	0.000
21	0.337	0.337	0.199	0.199	0.142	0.142	0.047	0.047	0.189	0.000
22	0.648	0.648	0.384	0.384	0.274	0.274	0.091	0.091	0.363	0.000
23	0.570	0.570	0.338	0.338	0.241	0.241	0.080	0.080	0.319	0.000

Note: We assume schools do not charge during the summer months.

Table E-5. Residential L1 and L2 Charging Profiles

Hour Beginning	L1, Residential BEV and PHEV		L2, Residential PHEV		L2, Residential BEV	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
0	0.405	0.375	0.029	0.027	0.104	0.096
1	0.366	0.328	0.026	0.023	0.094	0.084
2	0.345	0.315	0.025	0.023	0.089	0.081
3	0.379	0.341	0.027	0.024	0.097	0.088
4	0.366	0.332	0.026	0.024	0.094	0.085
5	0.302	0.251	0.022	0.018	0.078	0.065
6	0.162	0.085	0.012	0.006	0.042	0.022
7	0.102	0.038	0.007	0.003	0.026	0.010
8	0.081	0.051	0.006	0.004	0.021	0.013
9	0.077	0.055	0.005	0.004	0.020	0.014
10	0.055	0.051	0.004	0.004	0.014	0.013
11	0.072	0.047	0.005	0.003	0.019	0.012
12	0.094	0.064	0.007	0.005	0.024	0.016
13	0.115	0.072	0.008	0.005	0.030	0.019
14	0.119	0.072	0.009	0.005	0.031	0.019
15	0.124	0.094	0.009	0.007	0.032	0.024
16	0.102	0.136	0.007	0.010	0.026	0.035
17	0.136	0.158	0.010	0.011	0.035	0.041
18	0.162	0.175	0.012	0.012	0.042	0.045
19	0.196	0.204	0.014	0.015	0.050	0.053
20	0.264	0.285	0.019	0.020	0.068	0.073
21	0.375	0.405	0.027	0.029	0.096	0.104
22	0.413	0.430	0.030	0.031	0.106	0.111
23	0.413	0.439	0.030	0.031	0.106	0.113

Table E-6. Public and Workplace Charging Profiles

Hour Beginning	L2, Workplace		L2, Public		DCQC, Public	
	Weekday	Weekend	Weekday	Weekend	Weekday	Weekend
0	0.000	0.000	0.111	0.111	0.064	0.064
1	0.000	0.000	0.086	0.086	0.049	0.049
2	0.000	0.000	0.079	0.079	0.046	0.046
3	0.000	0.000	0.079	0.079	0.045	0.045
4	0.000	0.000	0.064	0.064	0.037	0.037
5	0.001	0.000	0.066	0.066	0.038	0.038
6	0.007	0.000	0.088	0.088	0.051	0.051
7	0.024	0.000	0.130	0.130	0.075	0.075
8	0.045	0.000	0.190	0.190	0.109	0.109
9	0.046	0.000	0.277	0.277	0.159	0.159
10	0.042	0.000	0.371	0.371	0.213	0.213
11	0.036	0.000	0.398	0.398	0.229	0.229
12	0.028	0.000	0.538	0.538	0.309	0.309
13	0.031	0.000	0.514	0.514	0.296	0.296
14	0.035	0.000	0.432	0.432	0.248	0.248
15	0.037	0.000	0.452	0.452	0.260	0.260
16	0.028	0.000	0.392	0.392	0.225	0.225
17	0.011	0.000	0.345	0.345	0.198	0.198
18	0.004	0.000	0.314	0.314	0.180	0.180
19	0.001	0.000	0.317	0.317	0.182	0.182
20	0.001	0.000	0.209	0.209	0.120	0.120
21	0.001	0.000	0.169	0.169	0.097	0.097
22	0.000	0.000	0.149	0.149	0.086	0.086
23	0.000	0.000	0.150	0.150	0.086	0.086

Table E-7. Charging Nameplate kW Assumptions

Charging Use Case	Nameplate kW
L1, Residential BEV and PHEV	1.5
L1, Fleet LDV	1.5
L2, Residential BEV	7.0
L2, Residential PHEV	7.0
L2, Fleet HDV	19.2
L2, Fleet LDV	19.2
L2, Fleet MDV	19.2
L2, School	19.2
DCFC, Fleet HDV	150.0
DCFC, Fleet MDV	150.0
DCFC, School	50.0
DCFC, Transit Depot	150.0
DCFC, Transit Route	450.0
Public L2	11.5
Public DCFC	150.0
Workplace L2	11.5

Final Section Note

DO NOT ADD ANY CONTENT AFTER THE FOLLOWING EVEN PAGE BREAK

Applied Energy Group, Inc.
2300 Clayton Rd., Suite 1370
Concord, CA 9450