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September 9, 2021

Jan Noriyuki, Secretary
Idaho Public Utilities Commission
11331 W. Chinden Blvd. Bldg. 8, Ste. 201-A
Boise, Idaho 83714

RE: Case No. AVU-E-21-__

Dear Ms. Noriyuki:

Attached for filing with the Commission is Avista Corporation's, doing business as Avista Utilities', application requesting that the Commission authorize the Company to implement pilot electric transportation programs as outlined in the attached Application.

Please direct any questions regarding this filing to Linda Gervais at 509-495-4975 (linda.gervais-falkner@avistacorp.com) or me at 509.495.8620 (Patrick.ehrbar@avistacorp.com).

Sincerely,

/s/ Patrick Ehrbar

Patrick Ehrbar
Director of Regulatory Affairs

Enclosure

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BEFORE THE IDAHO PUBLIC UTILITIES COMMISSION

IN THE MATTER OF THE APPLICATION OF AVISTA CORPORATION FOR AN ORDER AUTHORIZING PILOT PROGRAMS FOR THE RESEARCH AND DEVELOPMENT OF ELECTRIC TRANSPORTATION	)	CASE NO. AVU-E-21-__ APPLICATION OF AVISTA CORPORATION

I. INTRODUCTION

In accordance with IDAPA 31.01.01 (Rules of Procedure, or RP), RP 052 and RP 201, et seq., Avista Corporation, doing business as Avista Utilities (hereinafter Avista or Company), hereby respectfully makes application to the Idaho Public Utilities Commission (IPUC or the Commission) for an order authorizing the Company to implement pilot electric transportation programs. The Company proposes to offer these programs under its electric tariff Schedule 90, “Electric Energy Efficiency Programs”, specifically under the Market Transformation Program and associated Research and Development (R&D), and fund the programs under its electric tariff Schedule 91, “Energy Efficiency Rider Adjustment”, effective November 1, 2021.

The Company requests that this filing be processed under the Commission’s Modified Procedure rules through the use of written comments.

Communications in reference to this Application should be addressed to:

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The Company has included the following attachments in support of this filing, which are also referenced below:

a) Exhibit No. 1 – Avista Electric Vehicle Supply Equipment Pilot Final Report
b) Exhibit No. 2 – Avista Transportation Electrification Plan

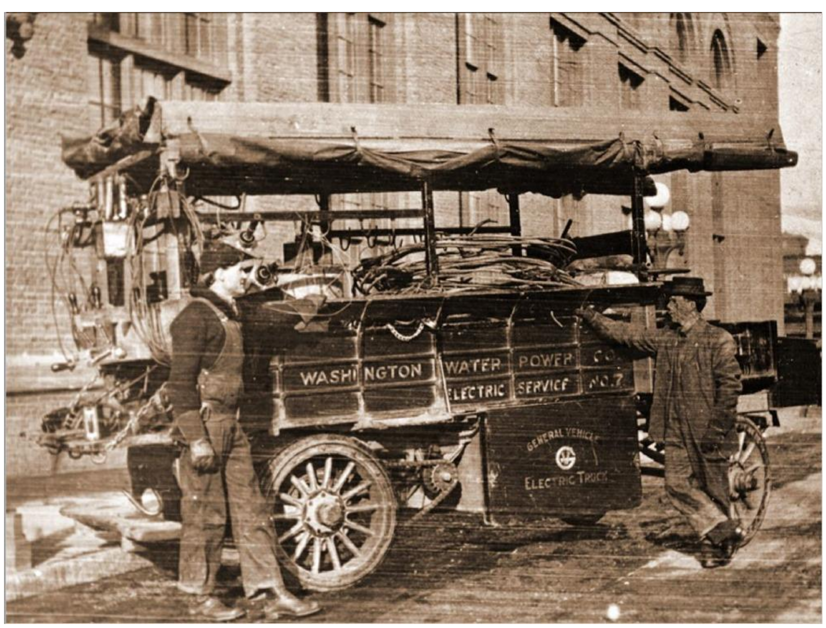
II. BACKGROUND

In November 2020, NARUC President Paul Kjellander announced the theme for his term, "Connecting the Dots: Innovative/Disruptive Technology and Regulation." This theme seeks to explore the many different emerging technologies and innovations that will impact electricity, natural gas, telecommunications, and water utilities. This theme highlights how the utility sector faces unprecedented pressure created by energy policy shifts, growing consumer expectations, and rapidly evolving technological advancements that could fundamentally alter the utility landscape. Concerns about deep decarbonization, electrification, grid modernization, the need for more renewable energy resources, cybersecurity, and the surge of distributed energy resource development are among the many drivers that will alter this landscape. There remains uncertainty as to which emerging technologies and innovations will carry the industry forward and what impact those changes will have on the current regulatory regime. As utilities confront the changes that could significantly alter the value proposition of their services, what role should regulators play in the integration of these potentially disruptive technologies and innovations?

Avista recognizes that innovation often happens through a series of incremental, smaller steps, rather than in a great leap forward. In this spirit, the Company proposes a relatively small set of electric transportation programs in Idaho, which could lead to larger scale innovations and benefits in the long run. The programs also align with the need to "connect the dots" in transportation electrification, now poised to make dramatic impacts on the energy industry and society as a whole over the next several decades.

This isn't the Company's first venture in electric transportation. Back in the early 1900s, Avista (then Washington Water Power) briefly partnered with the General Vehicle Company to market and sell electric vehicles, including cars and trucks. It also invested in public electric transportation in the form of electric trolleys to help expand early growth in the Inland Northwest.

Illustration No. 1

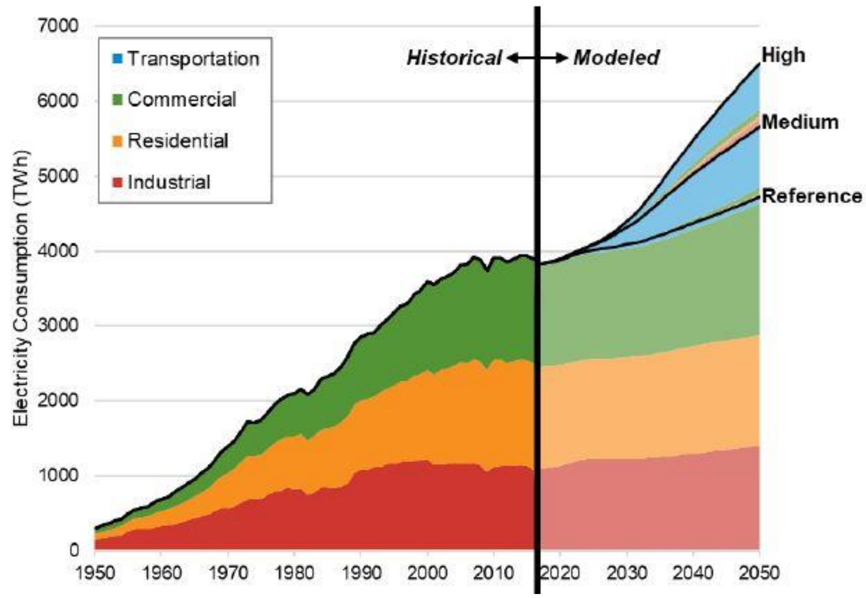


Over a century has passed since the internal-combustion engine achieved dominance in the transportation sector. However, modern advances in battery technology and costs, and the global imperative to reduce greenhouse gas emissions and air pollution, positions electric transportation to transform both the transportation and energy sectors – not just in the light-duty passenger vehicle market, but also in medium- and heavy-duty segments, including freight and material transport of all kinds – on the road, by rail, and even over air and water in some cases.

Today, driving a light-duty electric vehicle (EV) fueled by Avista's electricity costs less than an equivalent $1 per gallon of gasoline at a stable price, saves $300 per year in maintenance expenses, and results in zero tailpipe emissions, for a total CO_2 emissions reduction of 80%.[1] If all light-duty vehicles were electric, this would result in regional savings of over $1 billion per year – creating a powerful ripple effect for the economy – and avoided annual emissions of 2.5 million tons of CO_2, using local and relatively clean energy sources.[2] Other electrified transportation beyond light-duty passenger vehicles could result in even greater reduced emissions and operational savings. In addition, electric transportation provides grid benefits for all utility customers, in the form of net revenue that helps pay for fixed utility infrastructure costs. By 2050, electric transportation may represent 20% or more of overall utility electric load, as modeled by the National Renewable Energy Laboratory. This is illustrated below:

[1] Estimates assume Avista's current mix of electric generation sources, 3.3 miles/kWh and $0.11/kWh for EVs, and $3/gallon, 26 mpg for conventional vehicles.
[2] Avista Transportation Electrification Plan (2020), p. 4 and 40-43.

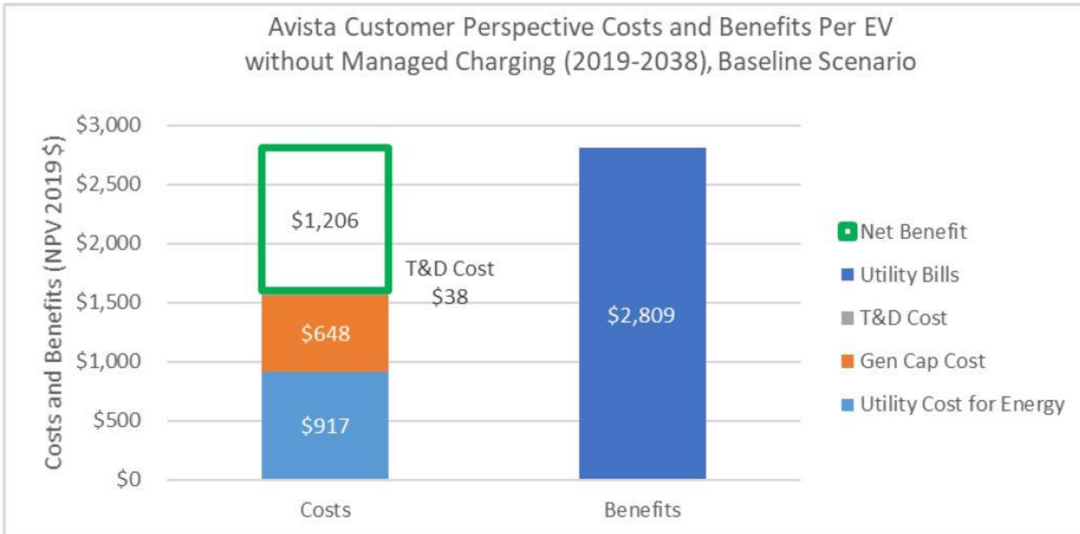
Illustration No. 2 – U.S Historical and Projected Annual Electricity Consumption[3]



Fortunately, transportation loads are very flexible, in that a large portion of charging may occur when equipment is idled, such as while a personal EV is parked at work during the day or at home overnight. In the future, the greatest benefits may be realized by capitalizing on this flexibility, charging EVs when grid resources are less constrained, and/or when renewable energy resources such as solar and wind are abundant. In other words, electric transportation can benefit all customers and society as a whole – not just those using EVs and other forms of electrified transportation equipment – by using a cheaper and cleaner fuel, more efficiently utilizing grid infrastructure, and integrating renewable energy resources that energize a more efficient and sustainable economy. Initial modeling indicates positive net benefits both from a regional and a customer rate-impact perspective, which may be further amplified when charging off-peak:

[3] Electrification Futures Study: Scenarios of Electric Technology Adoption and Power Consumption for the United States, p. xiv. National Renewable Energy Laboratory, 2018.

Figure No. 1 – Net Benefits from Light-Duty EVs[4]



The electric utility is in a unique position to support electric transportation for the benefit of all customers, mainly through charging infrastructure investments, education and outreach, and grid optimization through load management. The industry and markets continue to rapidly evolve, making constant monitoring and learning a necessity.

In 2019, Avista completed a three-year EV pilot in the State of Washington.[5] The Company had significant learnings from the pilot regarding utility support of light-duty vehicle electrification – costs and benefits, grid impacts, and customer experience for example. The utility does play an important role in supporting beneficial electrification, primarily in areas of charging infrastructure, load management, and education and outreach. It is clear that the transition to electric transportation will result in significant economic and environmental benefits for the region and customers over the long term, e.g. driving an EV costs less than $1/gallon equivalent, results in an 80% reduction of CO_2 emissions. Avista believes it is now well positioned to propose initial

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[4] Avista Transportation Electrification Plan (2020), p. 37.
[5] https://www.utc.wa.gov/casedocket/2016/160082

comprehensive pilot strategies and activities for Idaho customers that build upon this experience, being responsive and flexible to evolving conditions in a variety of market segments and technologies.

III. STRATEGY FOR IDAHO

In order to be successful, the strategy for Idaho must incorporate a regional approach as summarized in further detail in the Company's Exhibit No. 2 to this Application – "Avista Transportation Electrification Plan." The intent of these programs is meant to be scalable. Given the multiple technology and program options, these programs as proposed will assist with determining future efforts. These proposed programs will provide experience in Idaho and the ability to examine cost-effectiveness and customer acceptance, thereby better defining system and infrastructure requirements, and assessing costs/benefits.

Avista proposes electric transportation programs in two areas of focus:

1. Integrated Charging, On-site Renewables, and Battery Storage Research

   The Company has received an increasing number of questions from commercial customers, interested in the possibility of installing charging infrastructure integrated with on-site renewable power generation and battery storage, either connected or isolated from the grid. In addition, with improved technology and costs, such an integrated system could prove essential to cost-effectively deploy fast-charging in more remote areas where three-phase, medium-voltage utility power is not practically available. This includes many rest-stops along major travel corridors (I-90 from Post Falls to the Montana Border, and Highway 95 from the Canadian Border to the southern tip of our service territory) and a variety of other public and commercial locations in both urban and rural locations where charging infrastructure is strategically important. Finally, a distribution of charging stations less reliant on the grid could prove especially beneficial in terms of community resiliency in the wake of power outages, particularly in the future when a high percentage of transportation is electrified.

The Company proposes the following: (1) to develop and implement a research project and report summarizing the current state of integrated stations, (2) develop a parametric model used to identify variable cost factors and resulting charging outputs on an ongoing basis, and (3) a construction project design and implementation plan with estimated costs and benefits, which may be executed in the future provided funding from grant and other contributing funds, or at such time that economic thresholds are met. The Company intends to collaborate and solicit assistance from local research institutions and industry experts, developing knowledge and contributing to the general body of knowledge in the industry, with $50,000 proposed annually for the research project.

2. Workplace, Fleet, and Rural Access Charging Infrastructure

This program makes it easy and less costly for commercial customers to install workplace and/or fleet charging infrastructure on their property, for a variety of beneficial uses, and provides significant benefits in overcoming barriers to early adoption and enables Avista to develop load management capabilities. Low-cost and reliable charging infrastructure would be installed by Avista, with customers contributing a minimum cost share of 50% of the dedicated circuit wiring from their electric supply panel downstream of the utility meter, to the EV chargers.

Charging infrastructure installed at locations designated for public rural access utilization would not require a customer cost share, as the specific site hosts in the smaller rural towns across Avista's service territory may be limited in means, which would be a significant barrier to adoption. In all cases, commercial customers would pay for the additional electricity supplied by their existing metered service to the EV chargers on <u>their regular monthly bill</u>, with options to collect user/usage fees to help offset modest electricity costs and agree to participate in load management experiments.

Charging infrastructure is proposed to be installed at an estimated 30 sites per year, broken down by 20 workplace, 5 fleet, and 5 rural access locations, at an estimated cost of $345,000. Ongoing maintenance and load management costs are estimated at $15,000 per year. The Company intends to verify that workplace charging stands out as a powerful catalyst for EV adoption, while simultaneously providing grid benefits from reduced EV charging at home during the evening peak hours.

IV. BUDGET AND REPORTING

The Company proposes to fund the programs under its electric tariff Schedule 91, as they will be provided under the Market Transformation Program and associated Research and Development (R&D) outlined in tariff Schedule 90.[6] In its Order No.

[6] On August 30, 2013, Avista applied for an order authorizing it to accumulate and account for customer revenues that provided funding for selected electric energy efficiency research and development (R&D) projects, proposed and implemented by the state of Idaho's four-year Universities. On October 31, 2013, Order No. 32918 was issued authorizing the Company's R&D efforts. Avista now recovers up to $300,000 per year of revenue for research R&D from the Company's Schedule 91 Energy Efficiency Rider tariff.

35129, at page 9, (the Company's request for a prudency determination of its 2018-2019 electric and natural gas energy efficiency), the Commission stated "that the Company may continue with its R&D programs that it has already committed to fund but before committing to future R&D programs the Company shall propose and seek approval of an updated R&D program that includes metrics and measurable targets."

As provided earlier in this application, and in support of the Commission's Order referenced above, the intent of these programs is meant to be scalable given the multiple technology and program options. These proposed programs will provide experience in Idaho and the ability to examine cost-effectiveness and customer acceptance, thereby better defining system and infrastructure requirements, and assessing costs/benefits.

Total annual spending is estimated at $410,000. Avista is not requesting an additional change in the Schedule 91 funding, Avista's tariff Schedule 91 is "trued up" on a regular basis to match revenues with expenses.

Table No. 1

Activity	**Capital**	**O&M**	**Total**
Workplace, Fleet, and Rural Access Charging Infrastructure	$345,000	$15,000	$360,000
Integrated Charging, On-site Renewables, and Battery Storage Research	-	$50,000	$50,000
Total	$345,000	$65,000	**$410,000**

Financial reporting will be included in Avista's annual Demand Side Management (DSM) Report due to the connection of both DSM, Market Transformation, and the R&D programs to Schedule 91. Given the desire to implement these programs within the market transformation and research and development defined in Avista Tariff Schedule 90, the reports will not be accompanied by the traditional cost-effectiveness tests. Avista hosts semi-annual energy efficiency Advisory Group meetings plus webinars on current topics of public interest, attended by the Commission Staff, among other interested stakeholders. The Company will include electric transportation activities on the regularly scheduled meeting agendas.

V. CUSTOMER NOTIFICATION

Notice to the public of the proposed revisions, pursuant to IDAPA 31.21.02.102, will be given simultaneously with the filing of this Application by posting a notice to the Company's Website at www.myavista.com.

VI. CONCLUSION

Avista respectfully requests the Commission issue an Order authorizing the electric transportation programs described herein. The Company proposes to offer and fund these programs under electric tariff Schedule 90 and Schedule 91, effective November 1, 2021, with this Application processed under Modified Procedure through the use of written comments.

Dated at Spokane, Washington this 9th day of September 2021.

AVISTA CORPORATION

By: /s/ David J. Meyer
David J. Meyer
Vice President and Chief Counsel for
Regulatory and Governmental Affairs

Avista Corp.

Electric Vehicle Supply Equipment Pilot Final Report

Front Cover – Avista's DC fast charging site installation in partnership with Kendall Yards in Spokane, Washington

Huntington Park, Spokane, Washington

About Avista

Avista Corporation is an energy company involved in the production, transmission and distribution of energy as well as other energy-related businesses. Its largest subsidiary, Avista Utilities, serves more than 600,000 electric and natural gas customers across 30,000 square miles in eastern Washington, northern Idaho and parts of southern and eastern Oregon.

Avista's legacy begins with the renewable energy we've generated since our founding in 1889, and grows with our mission to improve customers' lives through innovative energy solutions.
Avista – Better Energy for Life!

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October 18, 2019

Submitted to the Washington Utilities and Transportation Commission (UTC)

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Acknowledgments

The following groups are recognized for their many contributions essential to the EVSE pilot's accomplishments

Colvico, Inc.
GEM Electric NW, Inc.
Washington State Transportation Electrification Stakeholder Group
Spokane Transit Authority
Washington Trust Bank
Town of Rosalia
City of Liberty Lake
City of Colville
Port of Clarkston
Town of Garfield
City of Palouse
City of Pullman
City of Spokane
Spokane Regional Health District
Transitions for Women

Whitworth University
Gonzaga University
Washington State University
Alliance for Transportation Electrification
Electric Power Research Institute
Edison Electric Institute
Energy + Environmental Economics (E3)
Forth
Pacific NW Utility Transportation Electrification Collaborative
California Electric Transportation Association
Greenlots
FleetCarma
Efacec
BTC
ClipperCreek

300+ Residential and Commercial Customers

Contents

Executive Summary 2
Background 10
Light-Duty EV Adoption and Forecasts 14
Education and Outreach 19
Community and Low-Income 22
Customer Surveys 24
Installations and Costs 28
    Residential AC Level 2 EVSE 29
    Commercial AC Level 2 EVSE 33
    DC Fast Charger EVSE 36
Reliability and O&M Costs 39
Utilization, Load Profiles & Data Analysis 48
    Residential AC Level 2 EVSE 53
    Commercial AC Level 2 EVSE 62
    DC Fast Charging 71
Telematics Data and Analysis 76
Load Management 82
Grid and Economic Impacts 90
Expenses and Revenues 100
Conclusions and Recommendations 102
References 105
Appendix A: Glossary of Terms & Abbreviations 107
Appendix B: Data Validation 114
Appendix C: Explanation of Box Plots 116
Appendix D: Assorted Charging Profiles 117
Appendix E: Charge Session Box Plots for Workplace Charging sample Group 120
Appendix F: Avista EVSE Network Energy Usage 125
Appendix G: Interoperability 128
Appendix H: Economic Modeling Details 131

Executive Summary

Report Objectives:

- Provide a comprehensive overview of the EVSE pilot's intent and activities
- Present detailed findings and lessons learned
- Lay the groundwork for effective future programs

Avista launched its Electric Vehicle Supply Equipment (EVSE) pilot in 2016, with the main objectives of understanding (1) light-duty electric vehicle (EV) load profiles, grid impacts, costs, and benefits, (2) how the utility may better serve all customers in the electrification of transportation, and (3) begin to support early EV adoption in its service territories.

A total of 439 EVSE charging ports were installed in a variety of locations, including 226 residential, 123 workplace, 24 fleet, 20 multiple-unit dwelling, and 7 DC fast charging sites, through a three year pilot program ending in June, 2019. These EVSE are owned and maintained by Avista, located on residential and commercial property downstream of the customer's meter, except for DC fast charging sites where the utility owns all equipment from the transformer to the EVSE. A combination of both networked and non-networked EVSE from six different manufacturers were installed to compare costs, performance, and customer satisfaction. Networked EVSE allowed for data collection at all locations and direct load management experiments at residential and workplace locations, through the Electric Vehicle Supply Provider (EVSP) that managed the network. Customers accepted this arrangement without a time-of-use (TOU) rate or further incentives, which allowed Avista to gather data for both uninfluenced load profiles, and those altered via direct control of EVSE output subject to customer notifications and demand response (DR) event opt-outs. A total of $3.1 million in capital investments and $740k in operations and maintenance expenses were incurred for the pilot program, which was under budget and in-line with expectations. An estimated 1,319 Avista customers with EVs in Washington will contribute over $323k utility revenue from EV charging in 2019.

Support for EV adoption was accomplished through (1) education and outreach efforts, (2) a program benefiting low-income customers, (3) dealer engagement including a referral program, (4) residential EVSE offerings, and (5) chargers installed at workplace, fleet, multiple-unit dwelling (MUD) and public sites, with the intent to help establish a backbone of EVSE infrastructure in eastern Washington. This activity has correlated with an increasing adoption rate starting at 23% in 2016 and rising to a projected rate of 41% in 2019, which has caught up to the Washington State average. Workplace charging in particular has supported

Figure 1: Residential EVSE charging

adoption, resulting in an over 200% increase in EV commuters at reported locations. However, the number of EVs and per capita ownership remain low compared to western Washington, and future adoption rates remain uncertain, subject to a number of factors including the availability of EVs, purchase costs, gasoline prices, public awareness, dealer engagement, and EVSE infrastructure. While Avista's pilot program supported EV adoption and achieved positive results, it is clear that a sustained and increased effort in partnership with local governments, customers, non-profits and policymakers is needed for continued progress and EV market transformation.

The Company initiated a trial program to directly benefit disadvantaged and low-income groups by collaborating with local stakeholders, evaluating proposals, and implementing EV transportation for a local non-profit and government agency serving these groups. In both cases, Avista provided an EV and an EVSE that was used for a variety of beneficial purposes including transport to critical medical services, job skills training, shuttle services for overnight shelter, and food deliveries. Since implementation, the organizations reported transportation cost savings of 57% and 82%, leveraged to provide additional transportation and other services, as well as additional benefits such as positive education and awareness among employees, and an interest in expanded EV fleets. This year, the Spokane Transportation Collaborative was formed, with broad stakeholder membership from area government agencies and non-profits, recognizing the need to address transportation issues among the disadvantaged, as the most serious issue following the lack of adequate housing. Avista intends to collaborate with this group to most effectively understand transportation issues and how they may be addressed with future electric transportation and mobility programs supported by Avista.

A series of online customer surveys followed immediately after initial EVSE installation and semi-annually thereafter, which showed high customer satisfaction with EVs at 98%, and with the EVSE performance at 98% for non-networked EVSE and 85% for networked EVSE at residential locations. Common feedback included a need for more public EVSE in the region, especially DC fast chargers, and improvement in the reliability and customer experience of networked EVSE at both residential and commercial locations.

EVSE Costs and Performance

Installation and operation and maintenance (O&M) costs show that networked EVSE are significantly more expensive to install and maintain, and have a higher rate of failures requiring troubleshooting and repair, as shown in the following table.[1]

[1] Note that % uptime is defined as the percent of time an EVSE is able to provide a charge, while % online is the percent of time the EVSE is online and communicating with the network. In many cases a networked EVSE may be able to provide a charge even if offline with the network.

Table 1: Average EVSE installation cost, O&M expenses and performance

	Installation cost per port	Annual O&M per port	% uptime	% online
Residential AC Level 2 - networked	$2,445	$370	98%	66%
Commercial AC Level 2 - networked	$6,035	$600	86% - 93%	76% - 86%
DC fast charging site	$128,084	$1,550	87%	87%
Residential AC Level 2 – non-networked	$1,766	$5	100%	NA
Commercial AC Level 2 – non-networked	$4,472	$185	99%	NA

It is expected that networked EVSE performance and costs will continue to improve as the industry matures. In any case, it is also clear that non-networked EVSE are preferable from a customer experience and cost perspective, unless a networked EVSE is required for data collection, point-of-use fee transactions, or DR capability. EVSE-to-network interoperability through the use of industry standards such as the Open Charge Point Protocol (OCPP) is critical to reduce the risk of stranded assets and take advantage of performance and cost improvements in the market.

EVSE Utilization and Load Profiles

Over 53,000 charging sessions were analyzed to determine EVSE utilization and load profiles, based on different locations and driver types including commuters, non-commuters, and vehicle categories of all-battery (BEVs) and plug-in hybrid (PHEVs). Analysis shows that the great majority of charging occurs at residential locations coinciding with system peaks in the late afternoon and early evening, followed by workplace charging which can coincide with morning peaks during colder winter temperatures. Charging behaviors according to EV and driver types showed similar load profile shapes, with higher consumption for battery-electric vehicles (BEVs), commuters, and on weekdays. A smaller dataset for long-range BEVs such as the Tesla model 3 showed an 85% increase in peak demand and a 78% increase in energy consumption compared to average residential charging from other vehicle types, such as shorter-range BEVs and plug-in hybrid vehicles (PHEVs). This may represent a closer approximation of future loads from EV charging, as the industry is expected to produce BEVs with larger batteries that enable longer driving ranges in the years ahead.

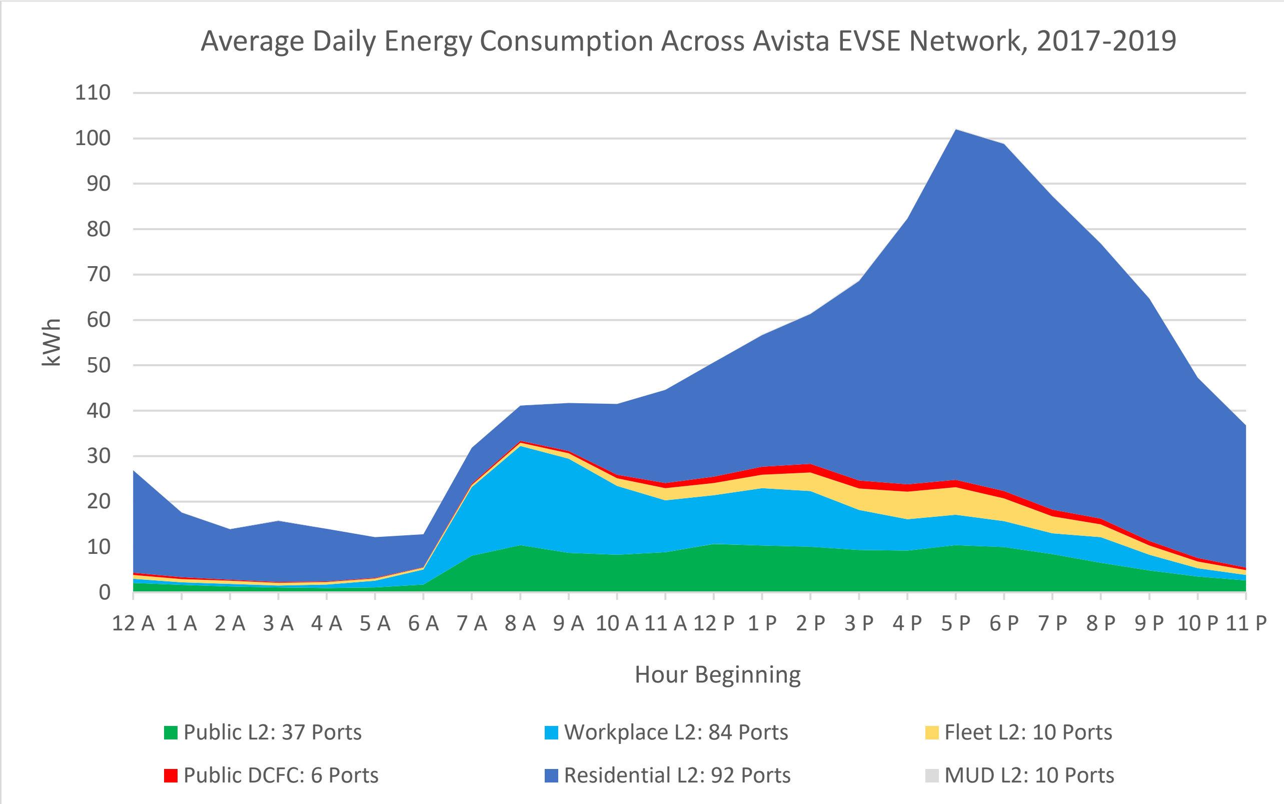

Figure 2: Average daily energy consumption across Avista's networked EVSE

EV commuters with both workplace and residential charging availability charged less at home than those with only residential charging, causing reduced evening peak load. However, this also increased peak load from workplace charging in the morning during colder winter temperatures. Utilization varied considerably, with the most observed at residential, fleet and workplace locations at over 17 sessions per month and average sessions consuming over 7 kWh per session in 1.6 hours, typically charging at 3.3 kW or 6.6 kW. DCFC utilization grew by 19% over the last year, but is still relatively low given the state of early EV adoption in the region. Analysis of DCFC O&M costs, meter billing, and user fee revenue highlight the need to consider alternative rate designs, as demand charges averaged 67% of total bills – making it difficult for revenue to cover ongoing expenses, let alone capital investments.

Load Management

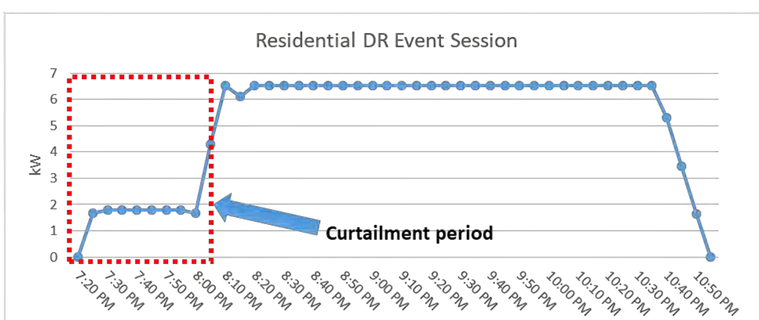

Figure 3: Example DR charging session with 75% peak load reduction

Avista's direct load management experiments using DR technologies at home and at work showed that customers accepted 75% peak load reductions via remote utility controls, without negative effects on driving habits or overall satisfaction ratings. This is because the hourly charging requirements of EVs are very flexible, especially at residential locations where virtually all AC Level 2 charging may be accomplished in the late night and very early morning hours, which coincide with year-round off-peak hours. Even higher rates of peak load reduction through DR may be possible, but require further technology development to attempt and substantiate. Costs to implement DR must also be dramatically reduced in order to provide net grid benefits and the ability to reliably scale up. This effort should continue, with development and experimentation in a variety of methods and technologies, as it will become ever more important to integrate and optimize EV loads in the future as a flexible grid resource.

Grid Impacts and Economic Modeling

Consistent with other studies, Avista's grid impact modeling indicates that light-duty EVs will have little effect on the distribution system over the next decade, even at high adoption rates. To illustrate, only 6% of service transformers were overloaded assuming nearly 25% EV adoption. In contrast, generation capacity costs could factor substantially in the added costs to serve this new load starting in 2027, when Avista is projected to become short on generation capacity. However, base-case modeling indicates that EVs provide $1,206 per EV in net grid benefits, as the billing revenue exceeds utility costs over its service life. This may be increased by another $463 per EV when load management shifts peak loads to off-peak, as was operationally demonstrated in the EVSE pilot.

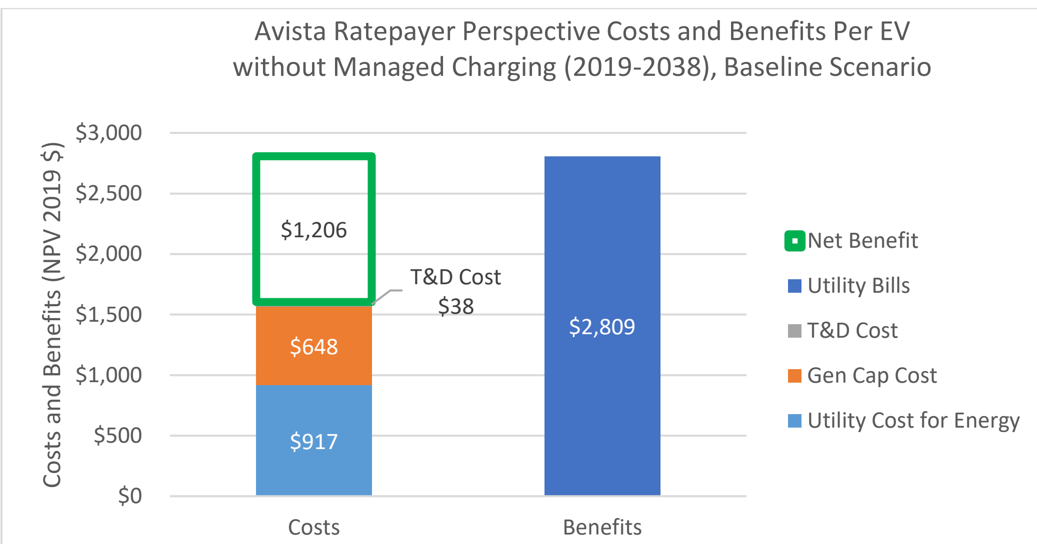

Figure 4: Ratepayer Perspective costs and benefits per EV, without managed charging 2019-2038

In addition, from a regional perspective each EV provides a net benefit of $1,661, mostly due to the substantial fuel cost savings of EV customers. This can have a tremendous ripple effect on the local economy at scale.[2] Perhaps most importantly, each EV avoids close to 4 tons of CO_2 emissions per year, an 80% reduction from the average light-duty vehicle powered by gasoline. This offers a tremendous

[2] Note that these results incorporate information and assumptions from Avista's 2017 Electric Integrated Resource Plan, and do not yet incorporate increased costs that may occur to reach newly established carbon neutrality goals for utility power supply.

societal benefit and return on investment in the effort to reduce harmful greenhouse gas emissions and other air pollutants.

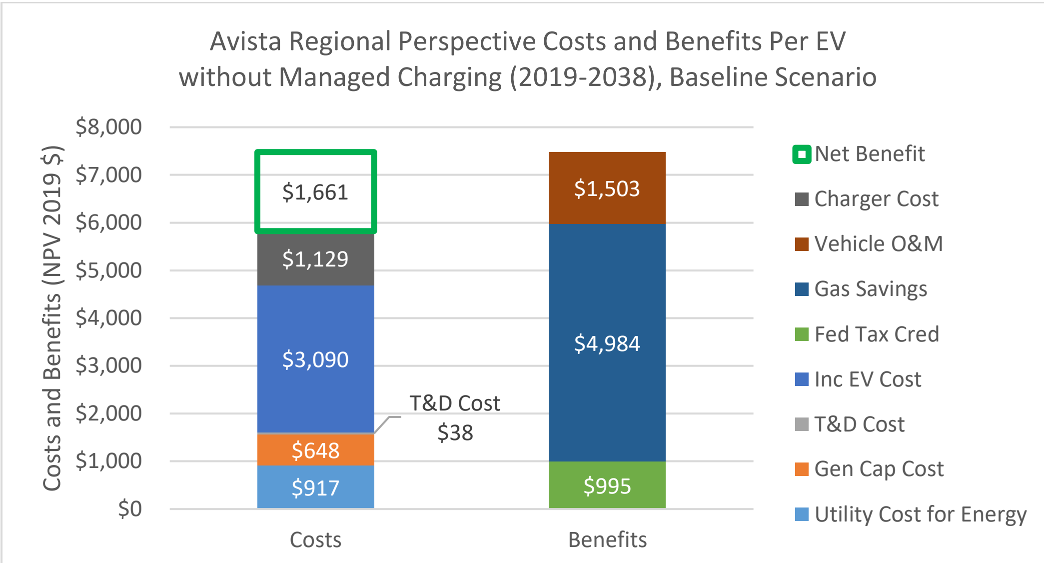

Figure 5. Regional perspective costs and benefits per EV without managed charging 2019-2038

It cannot be over-emphasized that although EVs may be very manageable over the near term, grid impacts and costs resulting from EV peak loads could become significant over longer time horizons, with higher EV adoption, and as other loads and the grid change. The EVSE pilot represents a good start in the Company's ongoing effort to understand how EV loads can affect the grid and how they may be optimally integrated and managed, in an evolving system that brings the most benefit to all customers.

Conclusions and Recommendations

Through the EVSE pilot the Company gained valuable experience, achieving its learning objectives while effectively supporting early EV adoption. Light-duty EV loads will be manageable from a grid perspective over at least the next decade, and EVs offer the potential to provide significant economic and environmental benefits for the long term to both EV drivers as well as all other customers. Participants were highly satisfied with the pilot programs, and Avista is now in an excellent position to propose a comprehensive Transportation Electrification Plan in both Washington and Idaho service territories, that includes major areas of education & outreach, dealer engagement, community & low-income, EVSE infrastructure, load management, commercial fleets, rate design, internal programs, planning, and grid integration. Through this long-term effort, Avista intends to innovate and serve all customers and communities in electrifying the transportation sector, building a better energy future in partnership with industry, customers, local governments and policymakers.

Key Takeaways from the EVSE Pilot

1. Data and analysis show that grid impacts from light-duty EVs are very manageable over at least the next decade, net economic benefits can extend to all customers, and significant reductions of greenhouse gas emissions (GGE) and other harmful air pollutants may be achieved with EVs. However, grid impacts and costs resulting from EV peak loads could become significant over longer time horizons, with higher EV adoption, and as other loads and the grid change. The EVSE pilot represents a good start in the Company's ongoing effort to understand how EV loads may be optimally integrated and managed, in an evolving system that brings the most benefit to all customers.

2. Avista was able to cost-effectively install EVSE, resulting in high customer satisfaction, and the pilot correlated with a significant increase in the rate of EV adoption in the area, demonstrating that utility programs can be effective in supporting and enabling beneficial EV growth. Partnerships with industry providers, a focus on providing value for the customer, and contractor performance were keys to success.

3. Workplace charging stands out as a powerful catalyst for EV adoption, while simultaneously providing grid benefits from reduced EV charging at home during the evening peak hours.

4. Low dealer engagement, a lack of EV inventories, and persistent customer awareness and perception issues continue to be a major barrier to mainstream EV adoption in the region. The utility can help overcome these issues with robust education and outreach programs, including dealer engagement.

5. Avista successfully demonstrated the use of EVs to reduce operating costs for a local non-profit and government agency serving disadvantaged customers. The Company expects local stakeholder engagement to continue in the development and expansion of similar programs, as well as other innovative ways to serve communities and low-income customers, consistent with the UTC Policy Statement.

6. Surveys showed a widespread desire for more public AC Level 2 and DC fast charging sites, which may be supported in future utility programs and rate designs. A new rate should be developed to address operational cost barriers resulting from traditional demand charges, while reasonably recovering utility costs.

Key Takeaways (continued)

7. Networked EVSE reliability, uptime, costs, and customer experience are all important opportunities for improvement, reinforcing the importance of utilizing interoperable networked EVSE. Non-networked EVSE are very reliable and cost effective, and should be utilized wherever possible unless data collection, user fee transactions, remote monitoring, or other requirements necessitate the use of networked EVSE.

8. Load management experiments showed that the utility may remotely curtail residential peak EV loads by 75%, while maintaining customer satisfaction and without a TOU rate or additional incentives other than the installation of the EVSE owned and operated by the utility. More DR experimentation may show the feasibility to shift an even higher percentage of peak loads. While EVSE load management utilizing DR and V1G technology appears acceptable from a customer perspective, reliability and costs must be significantly improved to attain net grid benefits and enable practical application at scale.

9. Data and analysis were somewhat limited by the available pool of participants and EVSE sites, however results compared well with other studies using larger population samples, and EVSE data was satisfactorily replicated and verified by telematics data. As the industry evolves, light-duty EVs with larger battery packs may become the norm. In this respect, the EV load profiles developed and examined in this study may under-predict electric consumption and peak loads to some degree.

Background

On April 28, 2016 the Washington Utility and Transportation Commission (UTC) issued Order 01 in Docket UE-160882 approving Avista's tariff Schedule 77 for its EVSE Pilot Program. The initial two-year installation term of the program began with the first residential EVSE installation on July 20, 2016.

On June 14, 2017, the UTC issued a "Policy and Interpretive Statement Concerning Commission Regulation of Electric Vehicle Charging Stations."[3] It provides background and guidance principles for utility EV charging as a regulated service, and notes that the purpose of Avista's pilot program is to obtain data and experience that will inform future EVSE programs and rate designs.

On February 8, 2018, the UTC issued Order 02 in Docket UE-160882 approving Avista's proposed revisions to tariff Schedule 77. This included extending the installation period of the program with additional EVSE installations through June 30, 2019, as well as adding a program benefiting low-income customers and a few other minor adjustments. Following the installation period, ongoing program management continued including EVSE maintenance, data collection and demand response (DR) through direct load management (V1G) experimentation.

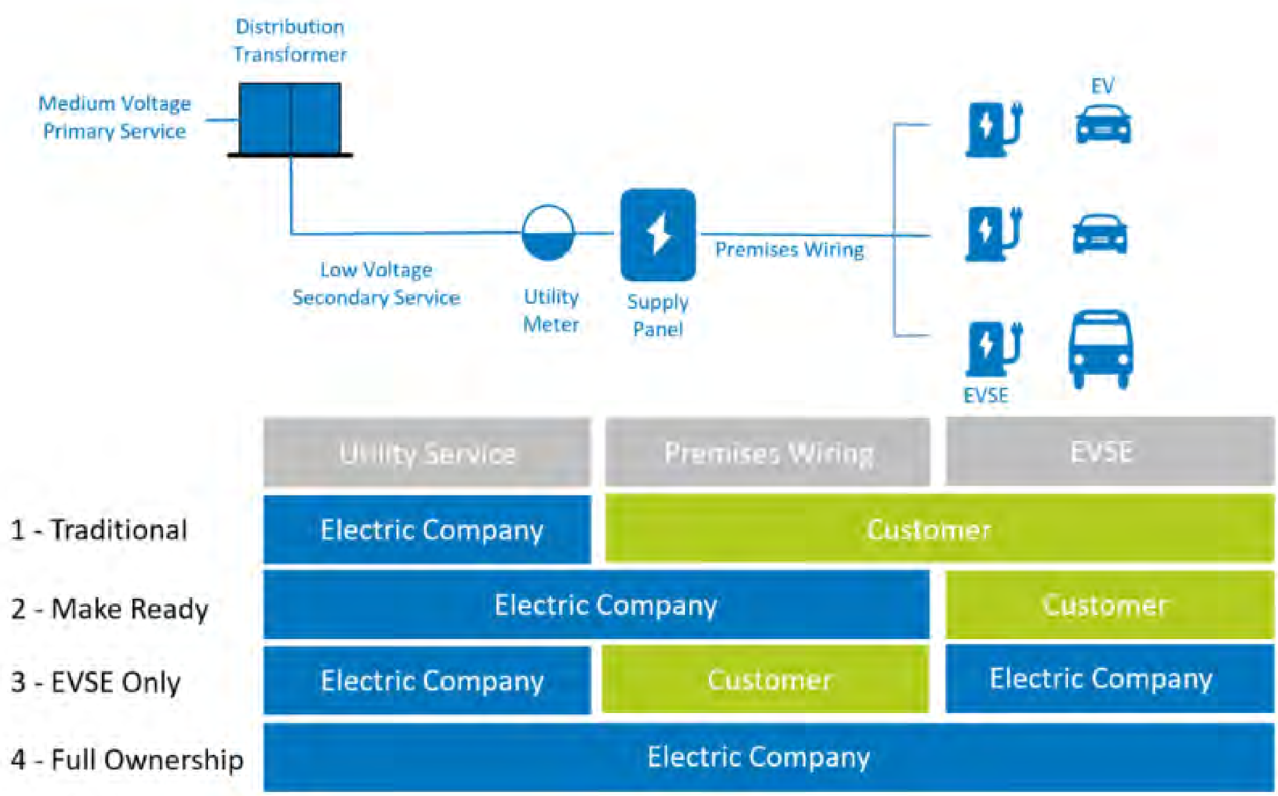

Figure 6: Ownership models for utility and customer EVSE infrastructure

[3] Docket UE-160799 (June 14, 2017).

AC Level 2 EVSE owned and maintained by Avista were installed on residential and commercial sites downstream of the customer's meter and electrical supply panel, while DC fast charging sites involved full utility ownership of all equipment from the transformer to the EVSE. The figure illustrates electrical infrastructure and four basic types of EVSE ownership models between the utility and the customer. Avista's AC Level 2 installations followed the "EVSE only" model in both residential and commercial locations, and DC fast charging sites followed the "full ownership" model.

A simple EVSE rebate program is an example of the "traditional" business model, where nothing is owned by the utility beyond the meter and conditional rebates from the utility are provided for EVSE purchased and installed by the customer. A "make ready" program typically involves new utility commercial service, including dedicated meters and premises wiring or supply infrastructure that is owned and maintained by the utility, stubbed out to the EVSE location. In "make ready" models, the EVSE itself is owned and maintained by the customer, and in some cases the utility may provide subsidies to the customer for EVSE purchase, installation and/or maintenance. Full ownership involves a dedicated transformer, meter, supply infrastructure and the EVSE itself, all owned and maintained by the utility. Public AC Level 2 or DC fast charging sites can fall in this category, with EVSE user fees applied and subject to regulatory oversight.

Avista chose the "EVSE Only" and "Full Ownership" models for the EVSE pilot as an alternative to other more common utility EVSE rebate and make ready programs. It was felt that by utilizing existing supply panels and other supply infrastructure in residential and commercial locations in the "EVSE Only" model, costs could be much lower than comparable "make ready" installations with new dedicated services and infrastructure. Further, it seemed possible that utility EVSE ownership and maintenance might be an effective way to provide the most value and satisfaction for customers in terms of reducing the costs, risks and difficulties of installing EVSE, while providing a means for effective DR without the need for further incentives or a time-of-use (TOU) rate to shift peak loads. Due to the more substantial investments and effort to implement DCFC sites and maintain them, the full utility ownership model was chosen to ensure long-term DCFC operability and public access.

Figure 7: Integrated EVSE network design

In order to comprehensively understand EV charging behavior and electrical loads from different locations, it was necessary to build an EVSE "ecosystem" that was integrated by a single network, capturing the charging data for individual EV drivers wherever they might charge – at home, at work, or in the public, for both AC Level 2 and DC fast charging. It was important to incorporate hardware and software that was "interoperable", using industry standard communication protocols such as the OCPP standard, so that risks and operational flexibility could be well managed. This enables "plug and play" deployment of alternative

EVSE or EVSP providers in the future as the competitive market and products mature. The overall design is depicted here, with the maximum allowed number of ports in each major category.

The numbers and proportions of EVSE in each category were carefully chosen to accomplish learning objectives and begin to support EV adoption in Avista's service territory, while containing costs to a modest level. Uninfluenced load profiles for different EV driver types and in different locations could be reasonably established in the first phase of the pilot, followed by direct load management of networked AC Level 2 EVSE at residential, workplace, fleet and multiple unit dwellings (MUD) locations.[4] These comparisons allow for a better understanding of customer behaviors and more robust grid impact and economic modeling, influencing future program designs. The proportional targets were also informed by the literature, showing different volumes and supporting roles that EV charging plays in each segment. As shown by the "Charging Pyramid", all types of charging are important in the overall light-duty EV "ecosystem", but as much as 90% or more of all charging occurs at residences, fleet locations, and at the workplace, where EVs are parked for long periods of time and may charge at lower power levels and at reduced costs. This is especially so if the charging may be reliably and economically shifted to off-peak times, maximizing benefits for all utility customers.

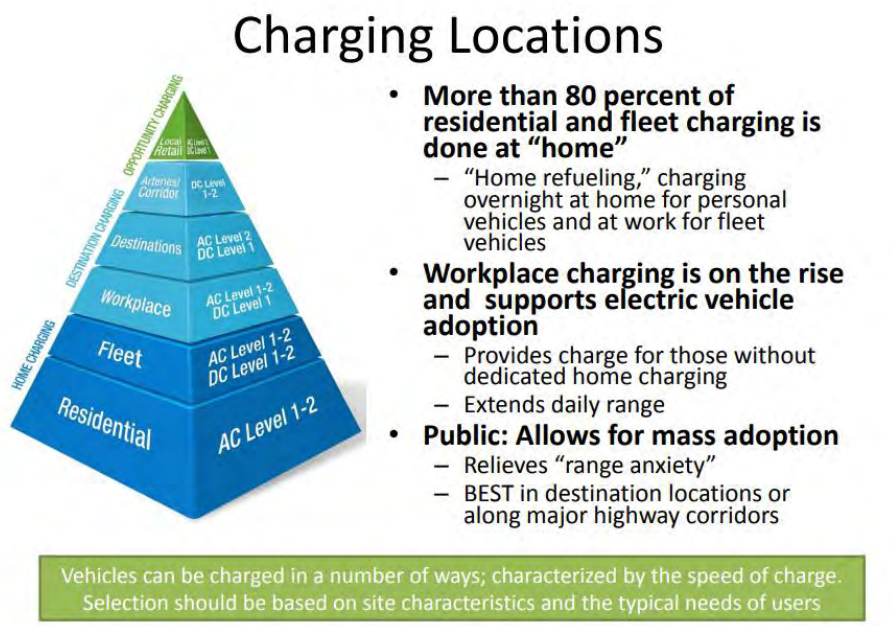

Figure 8: The Charging Pyramid (courtesy EPRI)

Program design also incorporated the objective of providing support for early EV adoption. This could be accomplished by addressing the barriers of low awareness and lack of EVSE infrastructure, through initial education & outreach efforts, dealer engagement including a referral program and residential EVSE offerings, as well as commercial EVSE buildout at workplace, fleet, and public locations, all intended to help form the first substantial backbone of EVSE infrastructure in eastern Washington.

Finally, with the backdrop of legislation passed in Washington State in 2015 and 2019[5] and growing consensus and support on a global scale, a societal purpose has been established for the reduction of greenhouse gas emissions (GGEs). It is recognized that the transportation sector is the largest

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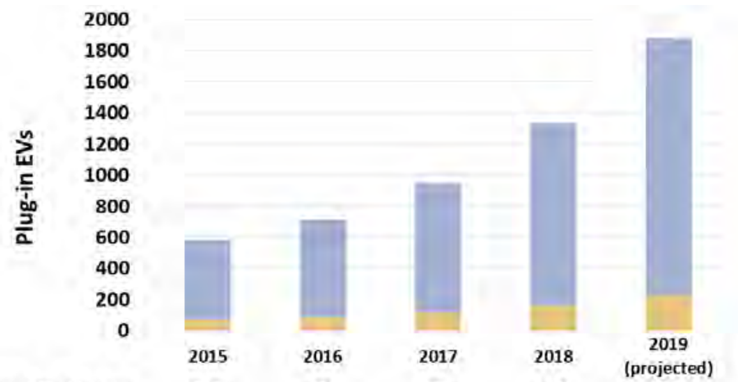
[4] Load management of public AC Level 2 and DC fast chargers is not feasible as EV drivers need maximum charge for limited periods of time at public locations.

[5] See Washington State HB1853 (2015), HB2042 (2019), and SB5116 (2019). https://app.leg.wa.gov/billinfo/

contributor of GGEs and other hazardous air pollutants, that electrification of the transportation sector can provide a high return on investment in reducing emissions, and that utilities must be fully engaged to play a key role in this transformation. The EVSE pilot was therefore launched as a starting point to explore how the Company may better serve all customers, achieving major economic and environmental benefits in the long-term effort to electrify transportation, partnering with industry, customers, local governments and policymakers.

Light-Duty EV Adoption and Forecasts

The chart below shows the growth in registered light-duty, plug-in electric passenger vehicles from 2015 to 2019 in Avista's service territories in Washington and Idaho. Registration data in Washington is taken from the Washington Department of Licensing,[6] and in Idaho from extrapolation of early data provided by the Electric Power Research Institute (EPRI).



	2015	2016	2017	2018	2019 (projected)
Avista Territory: Washington	512	628	829	1171	1649
Avista Annual % increase		23%	32%	41%	41%
Avista Territory: Idaho	72	88	116	164	231
Washington State Total EVs	16579	21991	27858	40323	52637
Washington Annual % Increase		33%	27%	45%	31%

Figure 9: Light-duty EV Adoption in Avista Service Territory

This shows that EV adoption in Avista's service territories initially lagged behind Washington State as a whole in 2016, a 23% annual increase compared to the State's overall increase of 33% that year. Since then, adoption has risen to a comparable level and has surpassed the State average to date in 2019, at 41% increase compared to 31%.

Although the rate of local EV adoption is now on par with the State average, the overall number of EVs in Avista's service territory is still relatively small, with lower per-capita adoption. For example, according to Atlas EV Hub, Spokane County currently has 1.8 EVs per 1,000 population, compared to 11.9 in King county and 6.3 for the State.[7] This compares to a total of 2,900,000 automobiles serving a population of 7.5 million in Washington State, or 387 automobiles per 1,000 population.[8] In terms of vehicles registered by Avista's 379,000 residential electric customers in Washington and Idaho, given an estimated range of 1.5 to 1.9 vehicles per household, yields a total of 570,000 to 720,000 light duty vehicles in the current fleet. In addition to this are an unknown number of light-duty commercial vehicles, as well as medium and heavy duty vehicles that over time may transition to electric transportation.

Local sales data are not currently available, however Washington State EV sales increased from 7,068 in 2017 to 12,650 in 2018, increasing in overall vehicle market share from 2.5% to 4.3% of total vehicle sales. This compares to national sales of 199,826 in 2017 to 361,307 in 2018, and 2.1% market share.

[6] Washington Department of Licensing website https://data.wa.gov/Transportation/Electric-Vehicle-Population-Data/f6w7-q2d2
[7] Atlas EV hub website https://www.atlasevhub.com/materials/state-ev-registration-data/
[8] US Department of Transportation, Federal Highway Administration data: https://www.fhwa.dot.gov/policyinformation/statistics/2017/pdf/mv1.pdf>.

Recent U.S. sales data for 2019 indicate a flat to slightly negative year-over-year change in EV sales through the third quarter.[9]

Globally, China has taken the lead with more light-duty EV sales than all other countries combined in 2018, followed by Europe, which is led by countries such as Norway where EV sales reached 46% of vehicle market share. The chart below shows forecasts for EV adoption by global regions over both the short and long term, according to Bloomberg New Energy Finance.[10] Many industry experts predict a dramatic increase in EV adoption in the 2023-2024 timeframe, as a number of new makes and models, and investments in EV production capacity are brought to market.

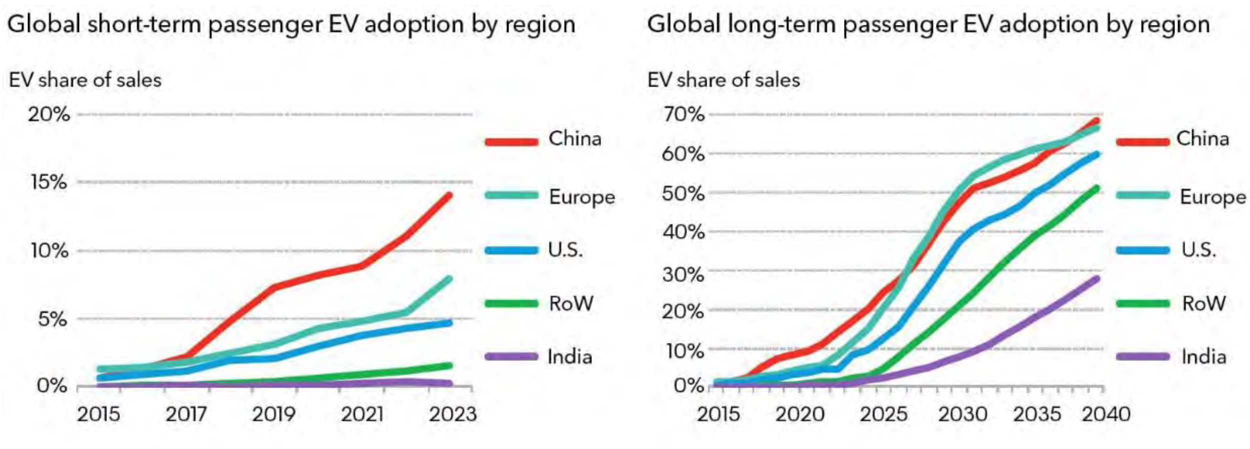


Figure 10: Global EV adoption by region (source Bloomberg NEF)

Based on residential customer applications for Avista's EVSE pilot, a breakdown of EV makes and models is shown below. Most recently, of the 39 applications received in 2019, Nissan LEAF owners accounted for 12 applications (30%), followed by seven Tesla Model 3 applications (17%), among a total of 20 different EV makes and models. This indicates a continued high variety of EV sales in the local area, with relatively strong engagement by one of the area Nissan dealerships. The percentage of Tesla participants in Avista's EVSE program (15%) is also markedly lower than the national percentage of Tesla cumulative EV sales (35%), which saw a dramatic increase since the third quarter of 2018 following the launch of the Model 3. The table below shows statistics for Avista's EVSE pilot participants compared to cumulative sales for different EV types, makes and models at the regional and national level.

[9] Atlas EV hub: https://www.atlasevhub.com/materials/state-ev-registration-data/
[10] Bloomberg New Energy Finance: https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport

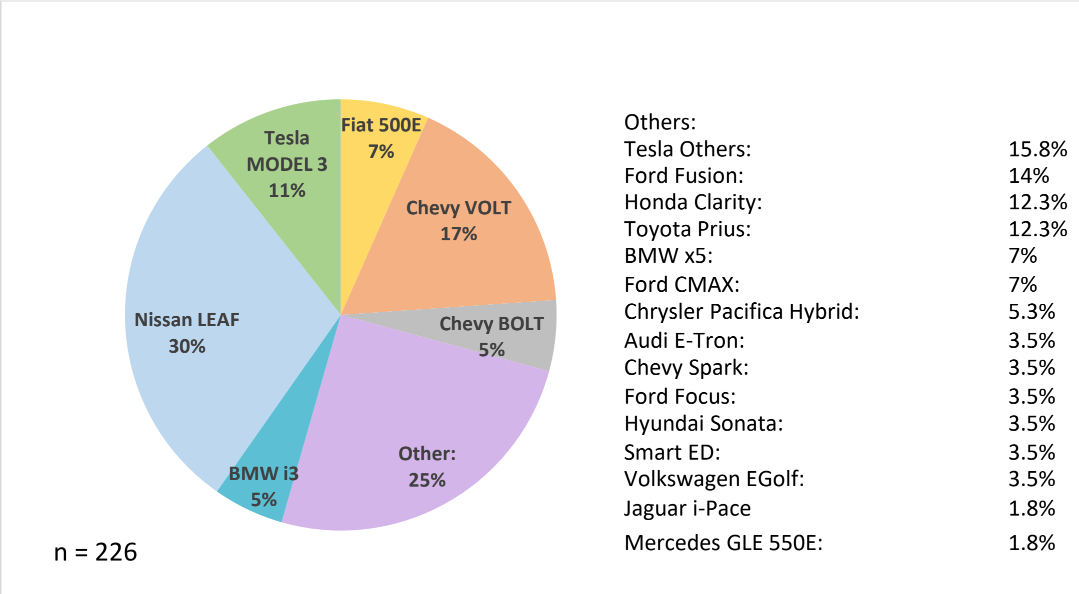


Figure 11: Avista pilot participation by EV Make and Model

	Avista EVSE pilot	Spokane Co.	WA State	US
BEV	66%	58%	69%	59%
PHEV	44%	62%	31%	41%
Tesla	15%	25%	33%	35%
GM	23%	23%	15%	17%
Nissan	30%	22%	24%	11%

Table 2: Cumulative EV sales statistics

Due to uncertainty in the large number of variables involved and the important dynamic effects between them, it is not possible to forecast EV adoption with any reasonable level of confidence. This is demonstrated by a survey of reputable EV forecasts in the literature, which show a wide range of outcomes.[11] As part of an effort to model and understand the range of possible effects, Avista worked with Energy and Environmental Economics (E3) to develop plausible forecasts for high, low and base case EV adoption scenarios in Avista's service territory, as shown below. A forecast through 2036 was selected to coincide with and compare results to a separate E3 grid impact analysis for the Pacific Northwest region as a whole.[12]

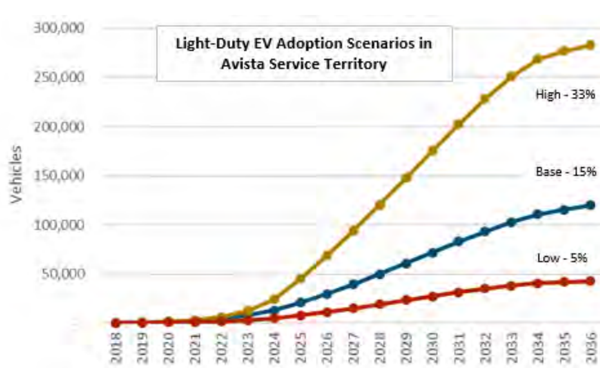


Figure 12: Light duty EV adoption scenarios

Note that these projections are for light-duty passenger vehicles on the road, owned by Avista's residential customers in Washington and Idaho, out of an assumed 600,000 vehicle fleet starting in 2018, not including commercial light-duty, medium and heavy duty vehicles of various applications. With assumed 2% annual growth, this fleet increases to a total of 857,000 vehicles by 2036. In the high scenario, 33%

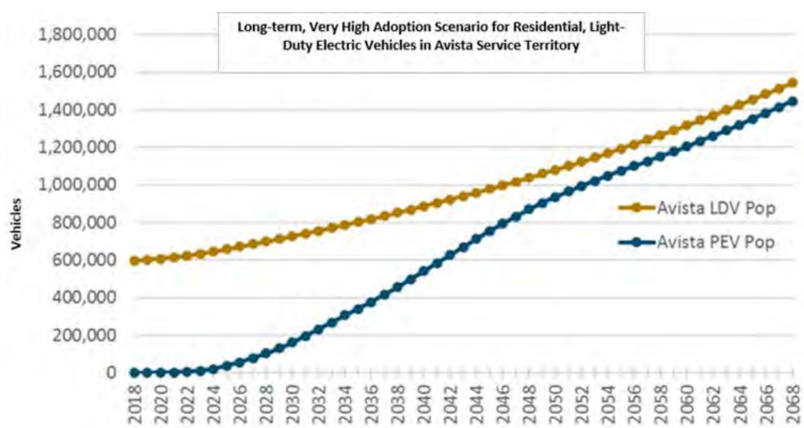
[11] Bloomberg New Energy Finance: https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport

[12] Economic & Grid Impacts of Electric Vehicle Adoption in Washington & Oregon (2017)

of the operational fleet are EVs by 2036, followed by 15% in the base scenario, and 5% in the low scenario. Given that fleet turnover may be gradual due to typical vehicle service lives of ten or more years, a high percentage of EV sales especially in the later years is required to reach higher levels of adoption.[13] As shown, the rate of adoption begins to decrease in the 2033 timeframe. Alternatively, if EVs eventually dominate, then a continued steep increase beyond 2030 could be expected rather than the beginning of the classic "S" curve, where adoption starts to become saturated in the mainstream market.

Key factors that increase EV adoption include policy support, lower upfront purchase costs, greater vehicle variety, availability and inventory levels, technology advances, superior operational performance and customer experience, greater driving range, adequate charging infrastructure, and higher gasoline prices that translate to more EV operational savings. In at least the near term, higher personal incomes and population density are also factors with high correlation to EV ownership. Avista serves a population with relatively lower personal incomes, and more rural geographies with lower population densities. This may continue to dampen EV adoption in the Company's service territories. As such, it could be reasonably argued that without market interventions such as Avista's EVSE pilot, actual adoption would track somewhere between the low and base scenarios.

Although the future is uncertain, Avista may prepare for a variety of plausible scenarios, with the goal to support market transformation and optimize grid integration, so that benefits and costs are optimized for all customers and communities served. From this perspective, a longer term, very high adoption scenario is also considered.



In this scenario, the transportation sector undergoes a major transformation away from petroleum fuel over the next three decades, reaching 90% of EV fleet adoption by 2050. Assuming 2% annual growth of the 2018 fleet of 600,000 vehicles owned by Avista residential electric customers, by 2050 nearly 950,000 EVs would be registered out of 1,130,00 total vehicles. This scenario is intended to represent an upper bound of transportation electrification in the light-duty sector, which could occur but the likelihood of which is unknown. Of course, a number of other factors could affect the total number of fleet vehicles and energy consumption over several decades, including societal changes in work and living habits, and the availability of autonomous EVs, which could greatly alter driving behaviors, vehicle ownership and total energy

[13] For example, assuming an average fleet turnover every 15 years and 600,000 vehicles in the fleet, this equates to 40,000 new vehicles entering the fleet each year, approximately 25,000 of which must be EVs each year by 2030 in the high adoption scenario – a sales rate of 60% or more.

consumption.[14] Note that as before, these figures do not include commercial light-duty, medium and heavy duty vehicles of various applications, e.g. forklifts, parcel delivery, school and mass transit buses, etc. Nor does it include other modes of freight and passenger movement such as rail, aviation and marine transportation, which may also become electrified to some degree.

[14] RethinkX – Rethinking Transportation: https://www.rethinkx.com/transportation

Education and Outreach

As stated in the UTC Policy Statement,[15] Education and Outreach is an important element of utility support for EV adoption, in order to help address issues of low awareness and negative perceptions of EVs. The Company accomplished this in a number of areas during the EVSE pilot, and continues to provide related support resources for customers as outlined below.

Avista provides information on its customer webpage[16] to help answer FAQs related to electric vehicles, charging needs and installations, vehicle purchase and operational cost comparison tools, web links to other sources of helpful information, and contact information via email and phone for more detailed inquiries.[17] During the pilot customers could also review program information, as well as download and electronically submit applications from the website. Incoming phone calls and email to the main service centers are routed through customer service representatives and appropriate staff to assist with more detailed inquiries. This may involve email correspondence, discussions over the phone, as well as in-person meetings and consultations.

Throughout the course of the EVSE pilot, Avista received a number of media requests which helped raise public awareness, promulgating important information about the benefits of electric transportation and Avista's programs through various media channels, including TV, radio, print and social media. Utility bill inserts were sent to customers once in 2017 and a second time in 2018, which also helped raise awareness. However, word-of-mouth referrals accounted for the majority of source information on Avista's programs for residential customers.

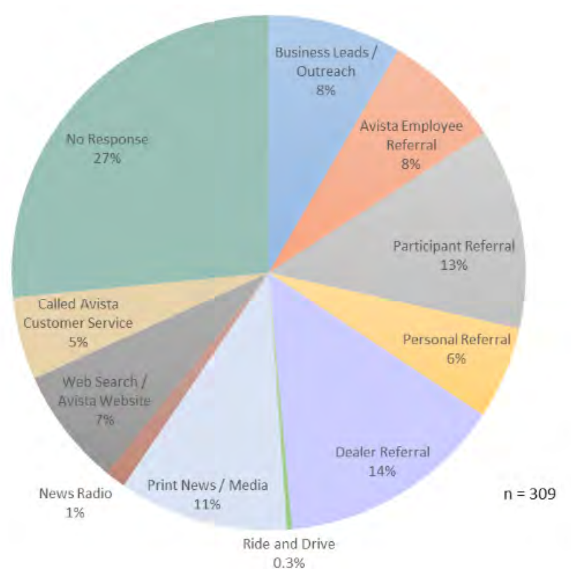


Figure 13: Information Sources for Residential Applicants

In turn, residential customers were by far the most productive source for qualified commercial leads and contacts via their respective employers, resulting in a satisfactory level of workplace charging installations in the program. This had the added benefit of providing an important dataset for those participants with AC Level 2 charging available at both home and at work,

[15] p. 41
[16] Avista electric transportation webpage: myavista.com/transportation
[17] Webpage information links: https://www.plugshare.com, https://pluginamerica.org, https://gis.its.ucdavis.edu/evexplorer/#!/locations/start

useful in drawing comparisons and contrasts to other participants that did not have access to either home or workplace charging.

Since 2015, the Company supported five EV Ride & Drive events led by local volunteers, as part of National Drive Electric Week.[18] In 2018, Avista partnered with Forth, a non-profit EV research and support organization, Kendall Yards private development, auto dealerships, and other local volunteers, coordinating a large EV Ride & Drive event in downtown Spokane that was well attended and received. EV Ride & Drive events can be very positive and help raise public awareness in an enjoyable atmosphere. However, in terms of EVSE program participants they were the reported source of only one residential program application, and while clearly beneficial it is unclear to what degree they can increase EV adoption.

During the course of the pilot, a concerted effort was also made to engage with auto dealers, including meetings with owners, general and sales managers, presenting at sales staff meetings, providing informational materials for customers, and an initial offering of $100 to sales staff for each customer referral. The referral was valued as a way to raise public awareness and participation levels in the EVSE pilot, as well as identify residential locations of early EV adoption. It was also hoped that by partnering with auto dealers in this way, EV sales would benefit by mitigating customer concerns about charging, while providing an additional sales incentive.[19]

For the first 18 months of the pilot program, a total of 16 dealer referrals were received. The incentive amount was increased to $200 for the remaining 18 months of the program, resulting in 22 referrals – an increased number but still well short of initial expectations – yielding a total of $6,000 paid over three years out of a maximum $25,000 budgeted. Speaking with dealer management and staff, as well as other subject matter experts, it is apparent that while the customer referral and Avista's EVSE program add value and assist the sales process, they are inadequate by themselves to surmount a number of issues. On the dealer side these include limited new and used EV inventory stock, high sales force turnover, and higher levels of work with low initial return on investment, and on the customer side persistent low awareness of the benefits and risk perceptions of EVs.

[18] National Drive Electric Week webpage: https://driveelectricweek.org/

[19] The referral process involved obtaining customer consent and sending a completed form with contact information to Avista. Upon receipt, Avista contacted the customer and discussed the EVSE pilot, initiated the application and EVSE installation process as chosen by the customer, and mailed payment for the referral in the form of a check to the respective sales representative.

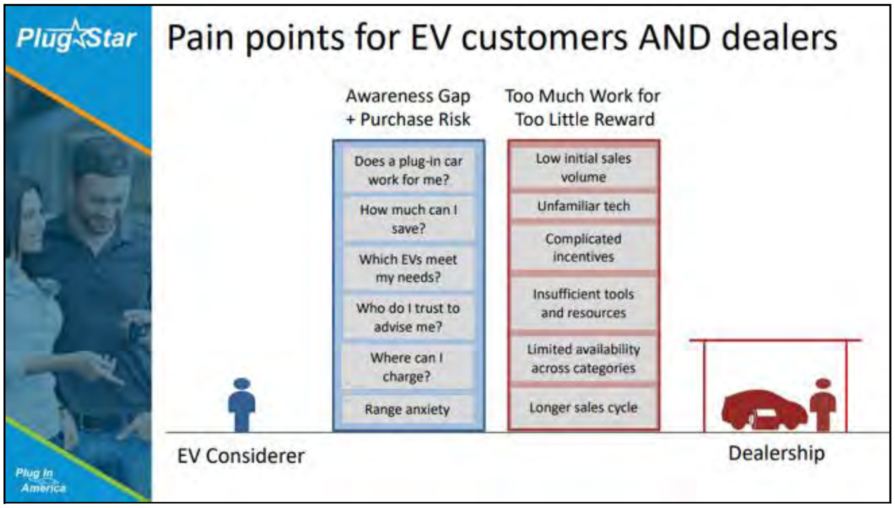


Figure 14: EV Sales Issues (courtesy Plug-In America)

As a trusted energy advisor with strong community and customer relationships, it is clear that the local utility can play an important role to help overcome these obstacles. However it is also clear that a deeper understanding of the issues and effective strategies to overcome them must be undertaken, in partnership with dealers and other stakeholders. Consequently, Avista has initiated consultation with Plug-In America's Plugstar program and Chargeway, to help develop a more comprehensive understanding of the market situation, and effective education and outreach strategies.[20]

Installations of commercial AC Level 2 EVSE available for public use also provided greater public visibility and awareness, especially in smaller rural towns where it was often the first sign of electric transportation options and charging availability for area residents.

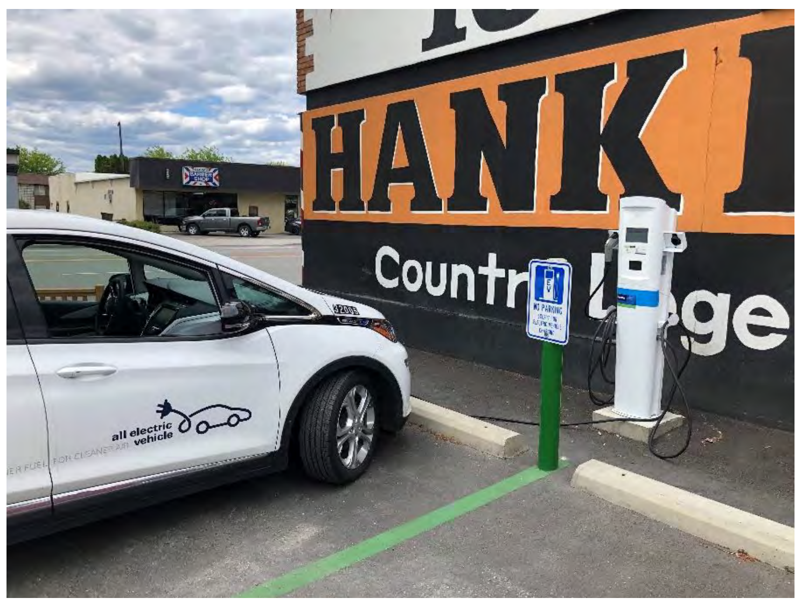


Figure 15: Public EVSE installation in partnership with the City of Colville

Finally, Avista continues to present information in a variety of forums including community events and meetings with local government, industry groups and non-profit organizations, and online public webinars, as a way to help raise education & outreach in the area.

[20] See www.chargeway.net, and www.plugstar.com

Community and Low-Income

The Company initially held a meeting in late 2017, with attending representatives from 15 local agencies and non-profit organizations serving low-income and disadvantaged individuals and community groups. Discussion topics included basic information about EVs and charging, ideas on how electric transportation could serve disadvantaged individuals and communities, and a request for proposals to Avista. Six proposals were received and competitively evaluated based on cost and benefit criteria, with the top two proposals selected for implementation from the Spokane Regional Health District (SRHD), and Transitions for Women organizations. In both cases, the Company provided an EV and an EVSE used for a variety of beneficial purposes including transport to critical medical services, job skills training, shuttle services for overnight shelter, and food deliveries. Each organization secured insurance and accepted responsibility for vehicle maintenance and operational costs.

Since implementation, both organizations were able to increase the volume of transportation services while realizing substantial cost savings. Performance and comparisons are listed in the table below for the one year period from June 16, 2018 through June 15, 2019.

Table 3. EV use and operational cost savings for Transitions and SRHD, June 2018 – June 2019

	Transitions for Women	**Spokane Regional Health District**
vehicle	Mitsubishi Outlander (PHEV)	Nissan LEAF (BEV)
# trips	408	443
# total miles driven	4,592	6,576
# e-miles driven	2,672	6,576
average passengers per trip	1.7	1.3
gasoline fuel	$354	$0
electricity fuel	$89	$219
maintenance & repairs	$100	$0
insurance	$1,332	$1,200
average monthly operational costs	$156	$118
2018-19 EV operating cost per passenger-mile	$0.24	$0.16
2017 (non-EV) operating cost per passenger-mile	$0.56	$0.89
operational cost savings	**57%**	**82%**

Additionally, the organizations reported EV educational benefits for both staff and customers using the EVs, as they are introduced and become accustomed to the benefits of driving and riding in EVs. This has created stronger interest in purchasing EVs for personal and fleet use. Also in the case of Transitions staff utilizing the PHEV, a higher percentage of electric miles driven were realized after drivers were educated on the lower costs and emissions of driving electric, how to charge the vehicle after each trip, and minimize the use of gasoline.

Avista staff hosted a follow-up meeting in early 2019, with attending representatives from the Spokane Regional Transportation Council, Spokane Transit Authority, Spokane Housing Ventures, Spokane Neighborhood Action Partners (SNAP), and Habitat for Humanity. Discussion topics included a review of pilot activity with Transitions and SRHD, and ideas for future programs taking into account demographics, access, cost effectiveness, and awareness issues. Since that time, the Spokane Transportation Collaborative has been formed, led by a volunteer steering committee and with broad stakeholder membership from area government agencies and non-profits. This has come about due to heightened awareness of the need to address transportation issues among the disadvantaged, recognized as the most serious issue following the lack of adequate housing. Avista intends to collaborate with this group to most effectively understand transportation issues and how they may be addressed with future electric transportation and mobility programs supported by Avista, and in partnership with the Collaborative's members. Additionally, Avista may work with local government and non-profits outside of the Spokane area with future experiments and programs tailored to their needs and opportunities. This may include building on the success of the pilot with SRHD and Transitions by utilizing a similar approach with other organizations, partnering with organizations such as Envoy for car-sharing services, and other innovative programs that may be developed.

With regard to providing greater availability of public EVSE in low-income communities and multiple unit dwellings, this may become a more effective benefit when the EV market matures over time and more low-income residents drive EVs. However, EVSE in these communities that may be utilized by EVs on transportation network company (TNC) platforms such as Uber and Lyft, could arise more quickly as a way to provide direct or indirect benefits. The EVSE pilot has also shown that public EVSE installed in smaller rural towns with relatively high percentages of low-income populations such as Rosalia, Garfield, and Palouse, are broadly supported by the local community and are felt to provide benefits in terms of public visibility and business development as part of the regional public EVSE infrastructure, as well as in many cases the lone public EVSE available for early EV adopters in those municipalities.

Customer Surveys

Two different online surveys were utilized, each tailored for residential and commercial customers – the first to gauge experience with the installation process and EV purchase decisions immediately following EVSE installation, and the second to solicit periodic feedback at semi-annual intervals, primarily related to EV and EVSE use and satisfaction. A final set of surveys was completed in July, 2019, following conclusion of the pilot program's EVSE installations. Overall response rates were as follows, with much higher response rates from residential compared to commercial customers.

Table 4: Customer survey response rates

Customer	Post-installation	Semi-Annual
Residential	47% (107 of 226)	56% (362 of 646)
Commercial	13% (11 of 86)	35% (60 of 170)

General comments and suggestions were very positive overall and encouraged more utility programs beyond the EVSE pilot. Constructive feedback included the need for more public charging (especially DC fast charging) and workplace charging, informing and educating the public about EVs and EVSE locations, and improving the reliability and user experience of networked EVSE.

One notable result was the difference in residential customer satisfaction of networked EVSE compared to non-networked EVSE in the quarterly survey. 98% of customers were satisfied with their non-networked EVSE (either satisfied or very satisfied) and 0% were dissatisfied, compared to 85% satisfaction and 6% dissatisfaction with the networked EVSE. This was due to the more hassle-free experience of non-networked EVSE that do not have connectivity issues, occasionally resulting in troubleshooting with the EVSP and EVSE manufacturer.

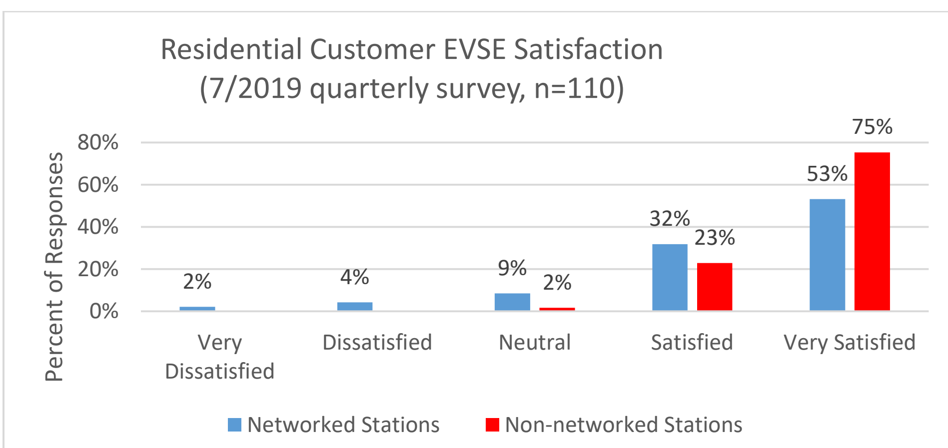
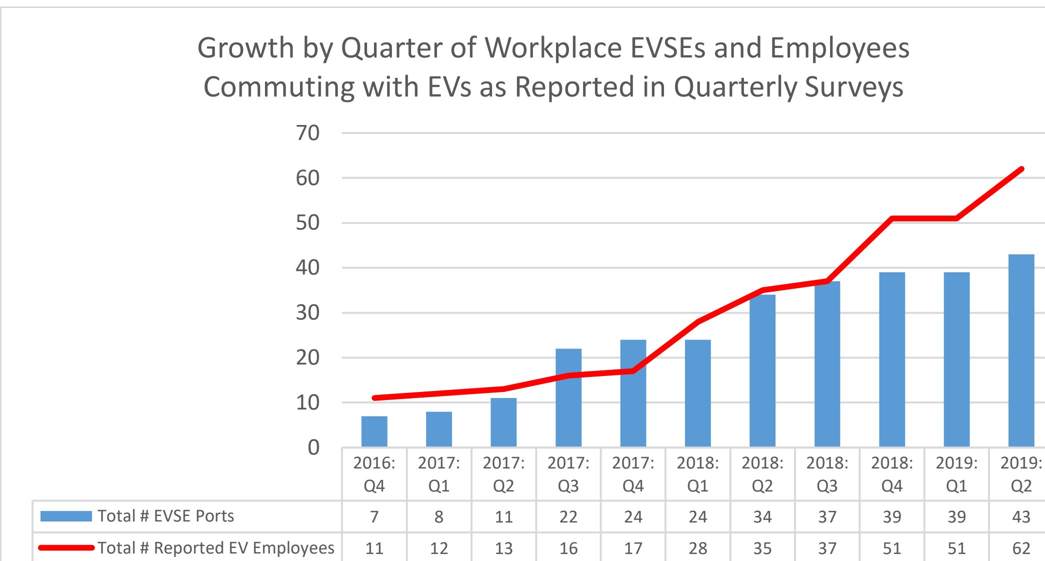


Figure 16: Residential Customer EVSE Satisfaction

While all but one residential customer was satisfied with their non-networked EVSE, eight of these 61 customers indicated that they would like to know how much electricity their EV was using. Electricity consumption may be approximated given the miles driven and an estimated efficiency of 3.3 kWh/mile, but cannot be captured and reported to the customer by a non-networked EVSE.

When contacted by phone, 11 of 21 commercial customers indicated they would be interested in installing more EVSE at the same or different facility locations. Survey responses from employers that installed workplace charging (16 responses out of 87 customers with workplace charging) also showed a significant increase in EV adoption at their facilities. From this sample with a total of 43 workplace ports installed, employees commuting with EVs increased from 31 to 63, a 203% increase over an average 1.4 year period, significantly higher than the average increase of overall EV adoption. Even with this relatively small sample of survey responses, it supports strong evidence in the literature that workplace charging is an effective catalyst for EV adoption, as it can "make or break" the EV purchase decision for many commuters.[21]

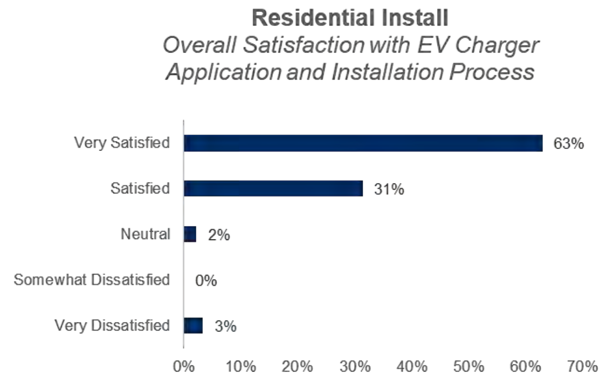


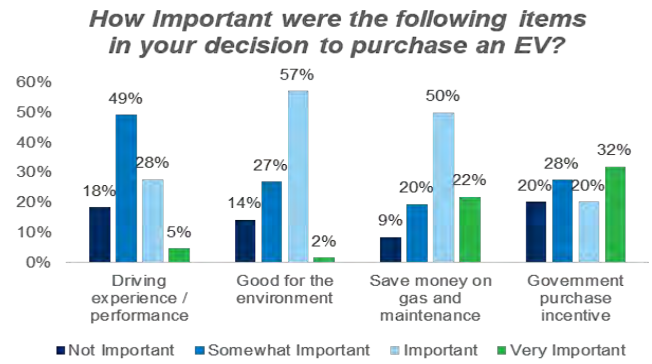
	2016: Q4	2017: Q1	2017: Q2	2017: Q3	2017: Q4	2018: Q1	2018: Q2	2018: Q3	2018: Q4	2019: Q1	2019: Q2
Total # EVSE Ports	7	8	11	22	24	24	34	37	39	39	43
Total # Reported EV Employees	11	12	13	16	17	28	35	37	51	51	62

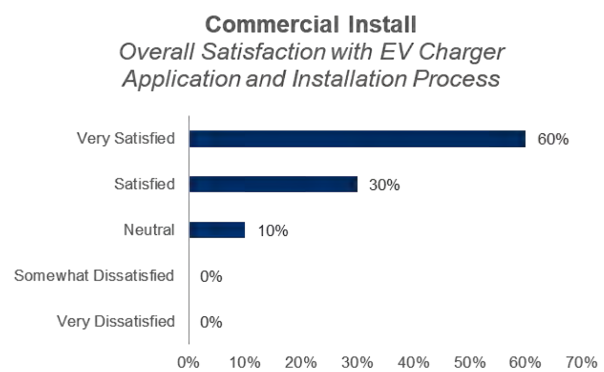
Figure 17. Workplace EVSE and User Growth by Quarter as reported in Quarterly Surveys

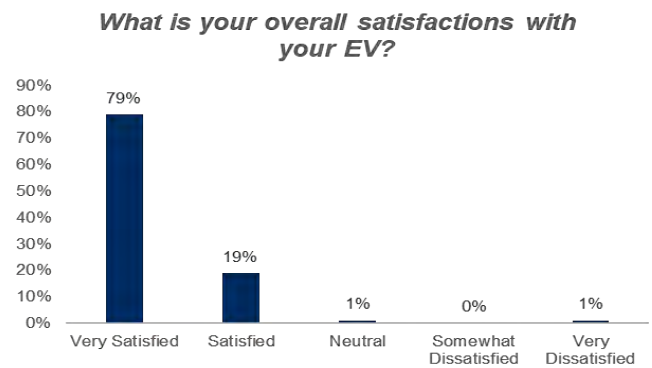
Other highlights of the customer surveys are illustrated in the charts that follow.

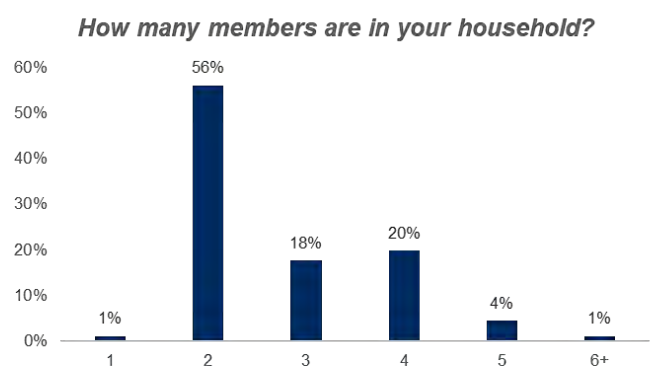
[21] See USDOE workplace charging challenge documentation, https://afdc.energy.gov/fuels/electricity_charging_workplace.html

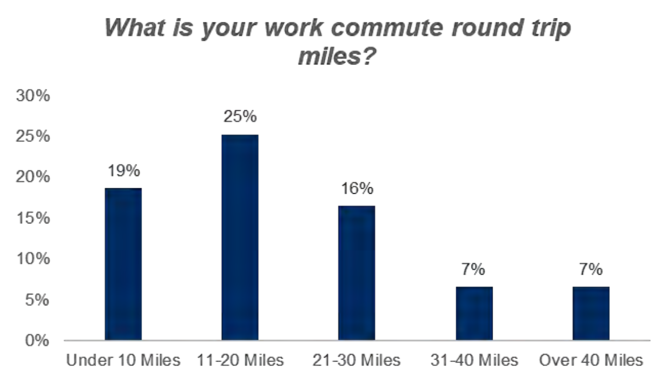

Residential Install
Overall Satisfaction with EV Charger Application and Installation Process
Very Satisfied 63%
Satisfied 31%
Neutral 2%
Somewhat Dissatisfied 0%
Very Dissatisfied 3%
0% 10% 20% 30% 40% 50% 60% 70%

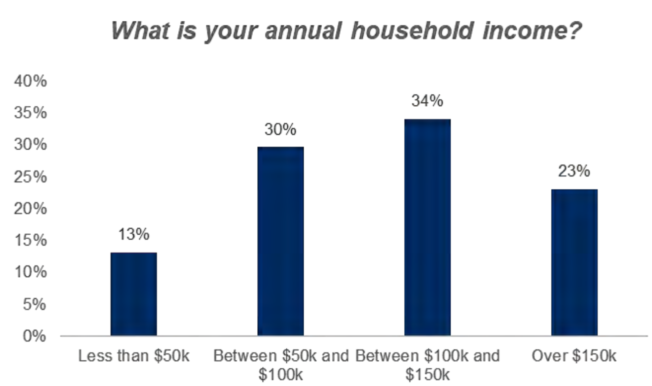

How Important were the following items in your decision to purchase an EV?
60% 50% 40% 30% 20% 10% 0%
Driving experience / performance: 18% 49% 28% 5%
Good for the environment: 14% 27% 57% 2%
Save money on gas and maintenance: 9% 20% 50% 22%
Government purchase incentive: 20% 28% 20% 32%
Not Important
Somewhat Important
Important
Very Important

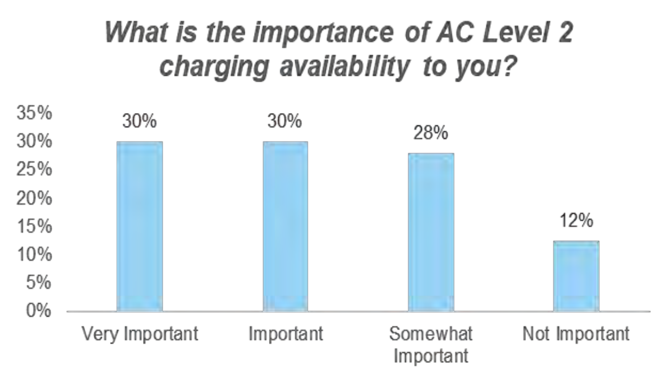

Commercial Install
Overall Satisfaction with EV Charger Application and Installation Process
Very Satisfied 60%
Satisfied 30%
Neutral 10%
Somewhat Dissatisfied 0%
Very Dissatisfied 0%
0% 10% 20% 30% 40% 50% 60% 70%

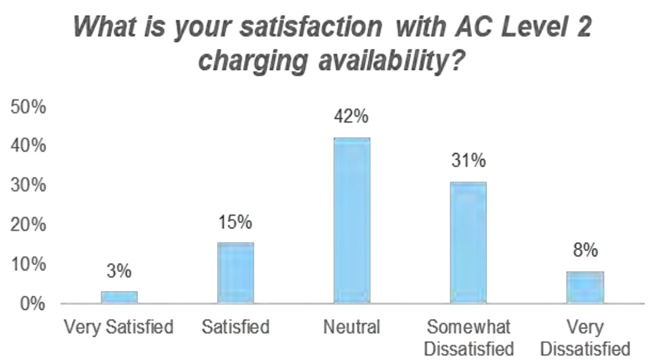

What is your overall satisfactions with your EV?
90% 80% 70% 60% 50% 40% 30% 20% 10% 0%
Very Satisfied 79%
Satisfied 19%
Neutral 1%
Somewhat Dissatisfied 0%
Very Dissatisfied 1%

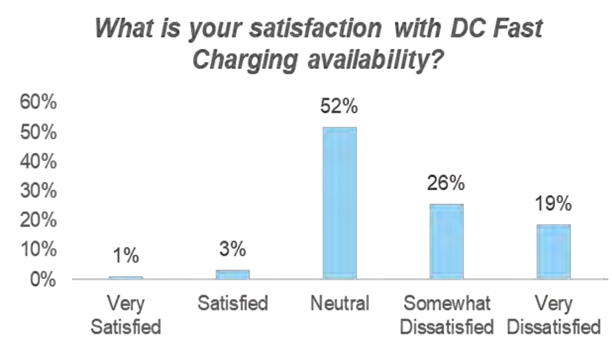

How many members are in your household?
60% 50% 40% 30% 20% 10% 0%
1 1%
2 56%
3 18%
4 20%
5 4%
6+ 1%

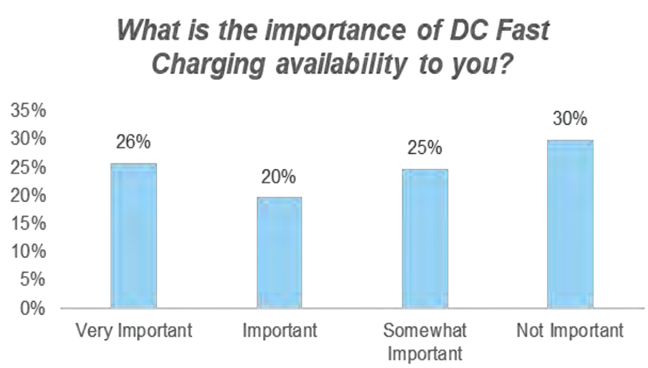

What is your work commute round trip miles?
30% 25% 20% 15% 10% 5% 0%
Under 10 Miles 19%
11-20 Miles 25%
21-30 Miles 16%
31-40 Miles 7%
Over 40 Miles 7%


What is your annual household income?
40% 35% 30% 25% 20% 15% 10% 5% 0%
Less than $50k 13%
Between $50k and $100k 30%
Between $100k and $150k 34%
Over $150k 23%


What is the importance of AC Level 2 charging availability to you?
35% 30% 25% 20% 15% 10% 5% 0%
Very Important 30%
Important 30%
Somewhat Important 28%
Not Important 12%


What is your satisfaction with AC Level 2 charging availability?
50%
40%
30%
20%
10%
0%
3%
15%
42%
31%
8%
Very Satisfied
Satisfied
Neutral
Somewhat Dissatisfied
Very Dissatisfied


What is your satisfaction with DC Fast Charging availability?
60%
50%
40%
30%
20%
10%
0%
1%
3%
52%
26%
19%
Very Satisfied
Satisfied
Neutral
Somewhat Dissatisfied
Very Dissatisfied


What is the importance of DC Fast Charging availability to you?
35%
30%
25%
20%
15%
10%
5%
0%
26%
20%
25%
30%
Very Important
Important
Somewhat Important
Not Important

Installations and Costs

EVSE installations were completed through June 30, 2019 as follows:

	Max Allowed Port Installations	# Ports Installed & In-Service
ACL2 Residential	240	206
ACL2 Workplace\Fleet\MUD	175	167
ACL2 Public	60	46
DC Fast Chargers (DCFC)	7	7

Table 5: Overall EVSE Installations

Note that in some cases commercial AC Level 2 EVSE may be used for more than one purpose (workplace, fleet, MUD, or public). For example, an employer may have workplace charging for employees installed in a location that is also available to the public, or shared with a fleet vehicle. However, the installed and in-service ports listed above reflect primary use. AC Level 2 EVSE installed in residential locations were rated between 24 and 32 amps, supplied by a 40A, 240VAC protected circuit to a standard NEMA 6-50 receptacle. This allowed EVSE with plug options to be wall-mounted nearby and plugged into the receptacle, rather than hard-wired to the circuit in the junction box. AC Level 2 EVSE installed in commercial locations were rated from 30A to 50A, supplied by 208/240 VAC with dedicated circuit breaker protection, and mounted either directly on building walls or on pedestals usually anchored to small concrete pads in the ground. At DC fast charging sites, DCFC rated at 50kW and backup AC Level 2 EVSE were supplied by three-phase, 480 VAC from a dedicated 225kVA transformer, service meter and supply panel, with capacity for future expansion of an additional 150kW DCFC and dispenser units. Avista coordinated installations with two local electrical contractors, GEM Electric and Colvico that performed the work and coordinated local permitting and inspections. Contractor performance was excellent and proved to be a critical factor in meeting cost and customer satisfaction goals.

Figure 18: Fleet installation

The heat maps below show the geographic dispersion and concentrations of commercial EVSE (blue) and residential EVSE (red), in eastern Washington and concentrated in the area surrounding Spokane.

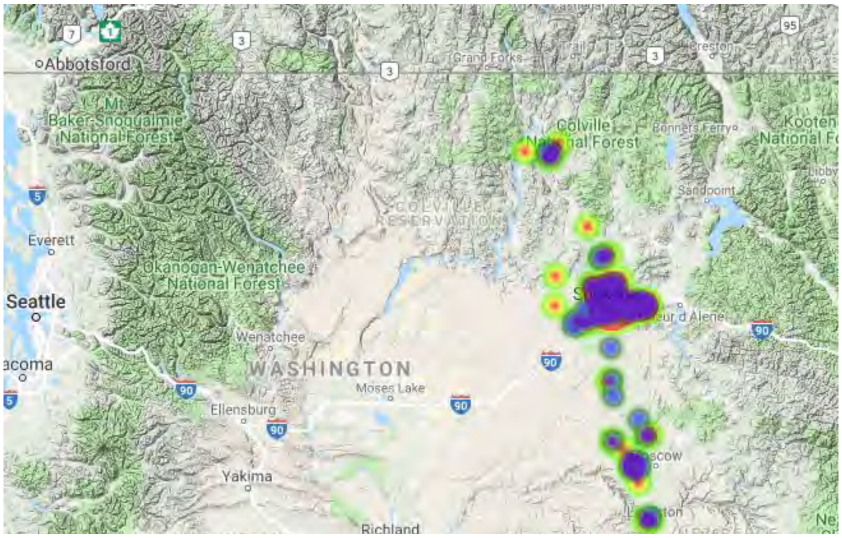


Figure 19: EVSE installed in E. Washington

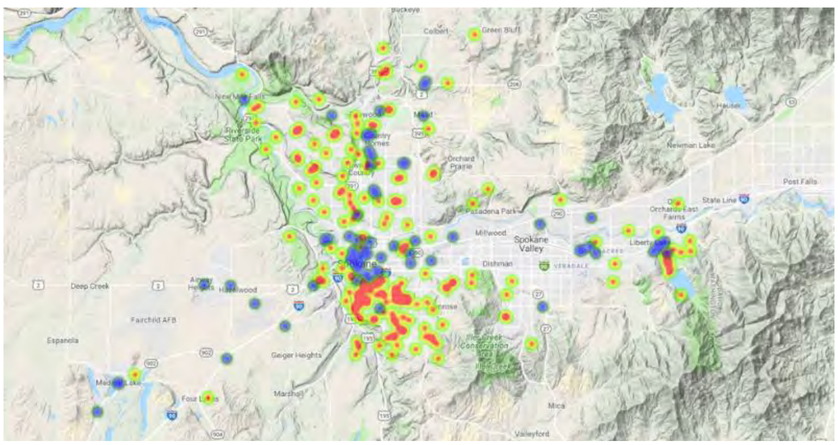


Figure 20: EVSE installed in the Spokane area

In the Spokane region, commercial EVSE are somewhat concentrated in the downtown core, with some dispersion to the east and north, while residential EVSE is more concentrated to the south. DCFC on the north, east and west outskirts, and in the downtown core support longer distance travel on the I-90 and US-395/195 corridors, as well as rapid urban charging. South of Spokane in the Palouse region, two DCFC installs and multiple workplace, fleet and public installations have begun to enable EV driving between Spokane, Pullman and Clarkston. To the north, Avista partnered with site hosts to install public charging in Deer Park and as far north as Colville.

In order to gain operational experience and comparison of costs, reliability, and customer satisfaction, a variety of EVSE from six different manufacturers were utilized. This included both non-networked and networked EVSE with direct load management (demand response, V1G) capability. Networked EVSE communications were implemented via WiFi using the customer's internet broadband connection, or cellular communications depending on location and site host capabilities.

The remainder of this section details EVSE installations and upfront costs categorized by residential, commercial, and DC fast charging locations. The subsequent section provides reliability results for the various EVSE, as well as estimates of ongoing operations and maintenance (O&M) costs.

Residential AC Level 2 EVSE

The following chart shows the status of residential EVSE installations as of September 15, 2019, by categories of Battery Electric Vehicle (BEV) Commuter, BEV Non-Commuter, Plug-In Hybrid Electric (PHEV) Vehicle Commuter, and PHEV Non-Commuter.

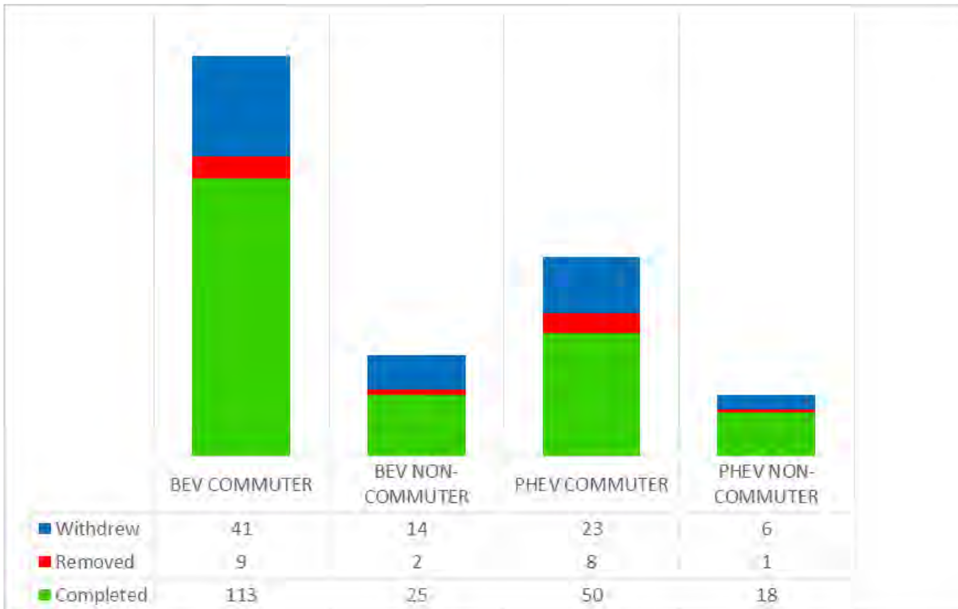


Figure 21: Residential AC Level 2 EVSE Installs by Driver Categories

At least 20 installations in each category are desired in order to attain a significant level of statistical sampling of the overall EV population, for both installation cost and load profile analysis. This has been met and exceeded for both BEV and PHEV commuter categories, and marginally met for the non-commuter category. Note that in addition to 206 residential EVSE installations currently in service, 20 additional installations were completed over the course of the pilot and later removed as customers moved to a new residence. This is expected to continue at a rate of approximately 5% each year.

Residential customers were eligible for participation if they were an Avista electric customer in Washington, and either owned an EV or could show ownership pending delivery. After reviewing application information and verifying eligibility, Avista staff discussed the program and process with the customer, prior to coordinating installation with a 3rd party contractor. A positive customer experience and lower operational costs were achieved by streamlining effective communications and process steps, reducing lead-time and minimizing customer inconvenience. For example, application review and approvals for installation in most cases occurred within one business day, and an onsite quote and EVSE installation was completed in a single site visit at a time and date chosen by the customer. A large number of installations were relatively low cost, when the supply panel was located in an unfinished garage and the EVSE could be located near the panel with a short and direct circuit run. On a few rare occasions, existing 240V circuits and receptacles were available for use, incurring zero or very minimal premises wiring costs.

A total of 84 out of 310 residential customers (27%) approved for installation withdrew from the installation process for a variety of reasons. The most common reason was due to higher cost estimates from required supply panel upgrades, work interferences from household goods, and/or extensive installation work involving long circuits requiring many floor and wall penetrations, disturbance and restoration of finished interiors, outdoor conduit, etc. In these situations, roughly 65% of customers opted to withdraw, while the remaining 35% chose to proceed with the installation. This required the customer to bear a higher percentage of the premises wiring costs, above and beyond Avista's maximum reimbursement of $1,000. The data shows that 17 out of 226 installations with more extensive work averaged $2,659 total installation costs, compared to the average of $1,197 for all other installations – an average increase of 122%. Older homes with 100A to 125A service generally required panel upgrades, while homes built since the 1970s typically had 200A or larger service panels that did not require upgrades to install a new 40A, 240V circuit for the EVSE. Based on conversations with area electricians, an estimated 30% of residential homes in the region have older service less than 200A capacity.

Overall, residential installation costs met expectations and compare well to costs reported in other studies, even with several years separation between them. [22,23,24]

Program/Study	Timeframe	Installations	Average Install Cost
Avista EVSE Pilot	2016 - 2019	226	$1,316
EV Project	2012 - 2013	4,777	$1,375
EPRI	2009 - 2013	214	$1,613
North Carolina	2011 - 2012	143	$1,098

Figure 22: Comparison of Average Costs for Residential Installations (not including EVSE)

Geography is a significant cost factor. For example, the Idaho National Laboratory's EV Project reported 2013 average installation costs of $1,828 in Los Angeles, $775 in Atlanta, and $1,338 in Seattle.

In comparing networked -vs- non-networked EVSE installs, networked installations including the cost of the EVSE averaged $2,427, which is 38% higher than the non-networked average of $1,775. The majority of the cost differential is accounted for by the EVSE itself, with networked EVSE more than double the cost of non-networked EVSE. Premises wiring costs were not significantly different. Direct installation costs for networked EVSE were slightly higher, reflecting the additional work to establish EVSE connectivity via the customer's WiFi, and typically requiring a boost to the WiFi signal in the garage using a repeater or wireless access point.

Table 6: Average Residential EVSE Install Costs

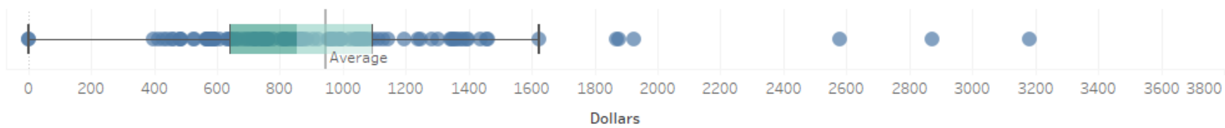
	Premises Wiring Cost	Direct Installation Cost	Total Installation Cost	EVSE Cost	Total Costs Installation + EVSE
Networked (110)	$946	$438	$1,384	$1,061	$2,445
Non-networked (113)	$1,016	$237	$1,251	$515	$1,766

[22] Brazell, M., Joffe, E., & Schurhoff R. Electric Vehicle Supply Equipment Installed Cost Analysis. Electric Power Research Institute (2013)
[23] Idaho National Laboratory. How do Residential Level 2 Charging Installation Cost Vary by Geographic Lecation. The EV Project (2015)
[24] North Carolina EV Taskforce, "Plug-in Electric Vehicle (EV) Roadmap for North Carolina." (2013)

Given the relatively early stage of the market, EVSE purchase costs may decrease somewhat over time with market competition, product improvements and higher production volumes, while installation costs could be expected to gradually rise with labor and material cost inflation. Changes to new building codes could also result in lower lifecycle costs, for future EVSE installations.

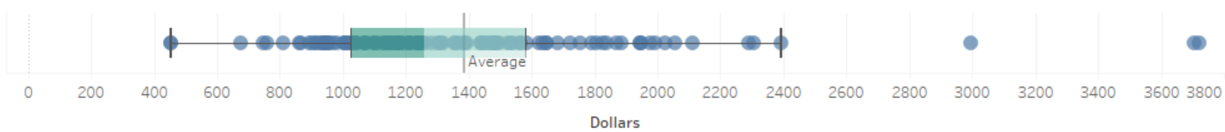
The box plots below show the distribution of residential installation costs (not including the cost of EVSE), when utilizing networked and non-networked EVSE.[25]

Residential Networked EVSE: Premises Wiring Cost

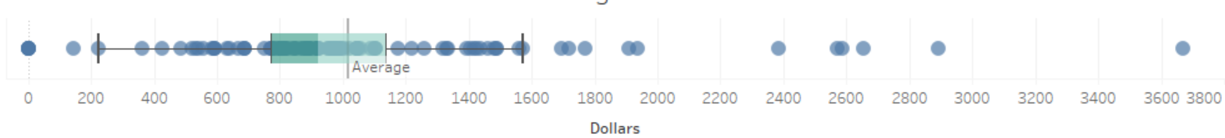


Residential Networked EVSE: Direct EVSE Install and Hardware Costs

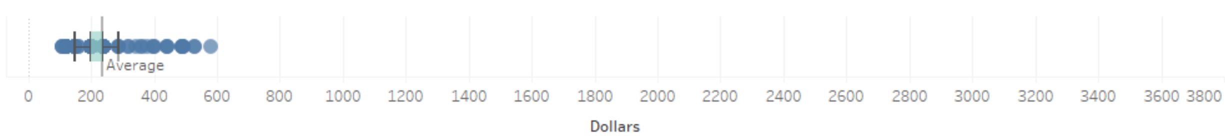
Residential Networked EVSE: Total Installation Cost



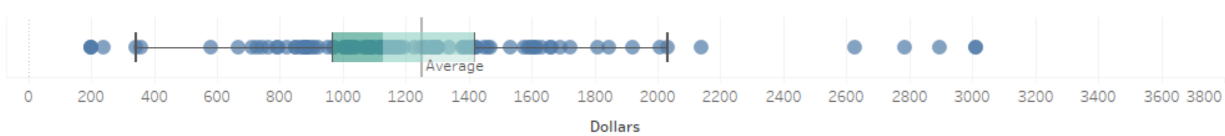
Residential Non-Networked EVSE: Premises Wiring Cost



Residential Non-Networked EVSE: Direct EVSE Install and Hardware Costs



Residential Non-Networked EVSE: Total Installation Cost



[25] Box plots are a useful way to visualize data and statistics, grouped by "quartiles" of the data set, and outlier data points. See Appendix C for a more detailed explanation of box plot information.

Commercial AC Level 2 EVSE

The following chart shows the number of commercial EVSE installations in service as of September 15, 2019, by usage categories of workplace, public, fleet, and MUDs.

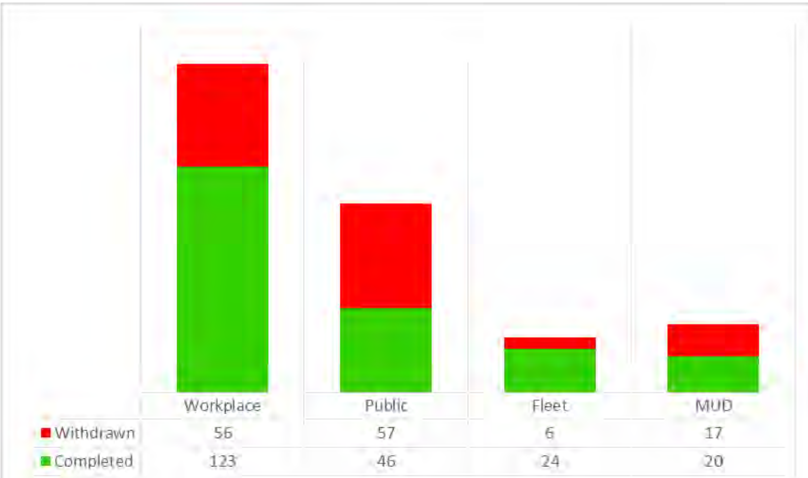


Figure 23: Commercial AC Level 2 EVSE Ports Installed, by Usage Categories

Typically, significant outreach and consulting work is required to inform and assist commercial customers to install an AC Level 2 EVSE on their property. Some of the concerns include the projected cost of electricity billing, liability risks, and potentially adverse impacts on parking areas that are highly utilized. In some cases, contract negotiations and revisions to the customer site agreement resulted in significant legal work and delays. The application through installation process for commercial customers was very similar to the residential process, but usually involved one or more site visits and consultations before installation. The number of ports installed at each facility was limited by estimated initial utilization and growth, averaging 2.5 ports per site. In the case of public installations, the proximity of amenities for drivers and geographic location was also taken into consideration in the application and approval process, as well as guiding outreach efforts. For example, EVSE at urban shopping centers and the smaller towns throughout eastern Washington were identified as highly desirable locations, in order to establish an effective regional network of public EVSE.

Compared to residential EVSE, a higher percentage of commercial customers withdrew from the installation process (39%), and no commercial EVSE have been removed after installation. Again, the most common reason for withdrawal was due to higher installation costs where the maximum reimbursement of $2,000 for premises wiring per port was reached and additional costs beyond the 50% reimbursement were borne by the customer. Prior to 2018, the Company was allowed to reimburse commercial customers 80% of premises wiring costs between the meter and the EVSE, up to a maximum of $2,000 per port connection. This was reduced to a rate of 50% for installs in 2018 and 2019, up to the same maximum of $2,000 per port. This change did not significantly change the rate of

Figure 24: Public EVSE installation

withdrawals, as the $2,000 limit was the more important factor. Public installations saw the highest rate of withdrawals at 55%, correlating with the higher costs associated with many public installations requiring extensive trenchwork and electrical upgrades. For example, an installation with a very desirable location at a large shopping mall was withdrawn, as concrete and asphalt trenchwork over one hundred feet into the parking lot and electrical upgrades in the building resulted in an estimated cost of more than $15,000 per EVSE port – more than double the average cost of other networked installations as shown in the table below.

Category	# of sites	Premises Wiring Cost	Direct Install Cost	Total Install Cost	EVSE Cost[26]	Total Cost EVSE + Installation	Avg. # Ports	Total Cost per Port
All	86	$5,270	$3062	$8,332	$4,781	$13,113	2.5	**$5,544**
Networked	59	$5,703	$3,195	$8,898	$5,963	$14,861	2.5	**$6,035**
Non-networked	27	$4,325	$2,771	$7,095	$2,198	$9,293	2.4	**$4,472**

Table 7: Average Commercial EVSE Install Costs

Significant cost variations resulted from a wider variety of site conditions and installation configurations, compared to residential installations. Networked cost per port at $6,035 were 35% greater than non-networked cost per port at $4,472. Lower costs correspond to simpler installations avoiding service upgrades and trench work, lower cost non-networked EVSE, and/or a smaller number of port connections. Conversely, higher costs are associated with multiple installed EVSE ports and networking, required upgrades to supply panels, and/or trench work, which in many cases involved concrete and asphalt trenching and restoration. Wall mounted EVSE often require no trench work and reduce the length of both above-ground and underground conduit, while pedestal mounted EVSE typically require trench work and relatively longer conduit lengths. In order to minimize costs, where practical the Company advised customers to utilize wall mounted EVSE, and to minimize trenching and conduit lengths by locating the EVSE as close as practicable to the nearest power source. Other factors such as desired location, accessibility, communication signal strength, and safety concerns are also of high importance when consulting with commercial customers on EVSE siting and configuration determinations. The Company also advised customers to install additional conduit where feasible, to allow for inexpensive future expansion.

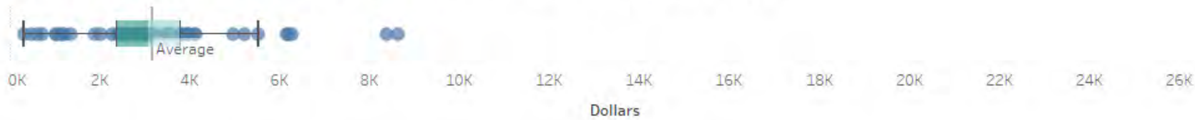
Figure 25: Low-cost wall mounted EVSE in mall parking garage

[26] EVSE cost includes pedestal hardware, where applicable

The box plots below show the distribution of costs and ports installed for networked and non-networked commercial installations.

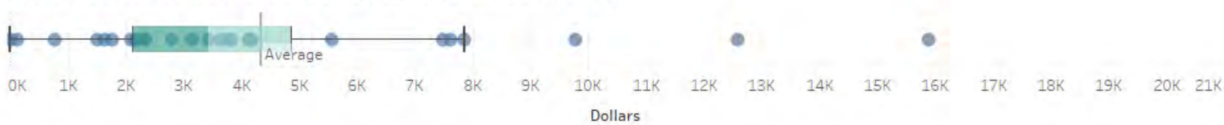
Networked Commercial EVSE: Premises Wiring

Networked Commercial EVSE: Direct EVSE Install + Hardware Cost

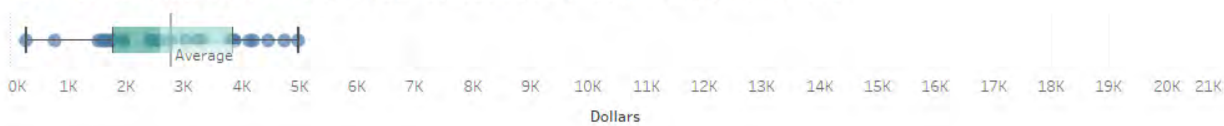


Networked Commercial EVSE: Total Installation Cost per Port

Non-Networked Commercial EVSE: Premises Wiring



Non-Networked Commercial EVSE: Direct EVSE Install + Hardware Cost



Non-Networked Commercial EVSE: Total Installation Cost per Port

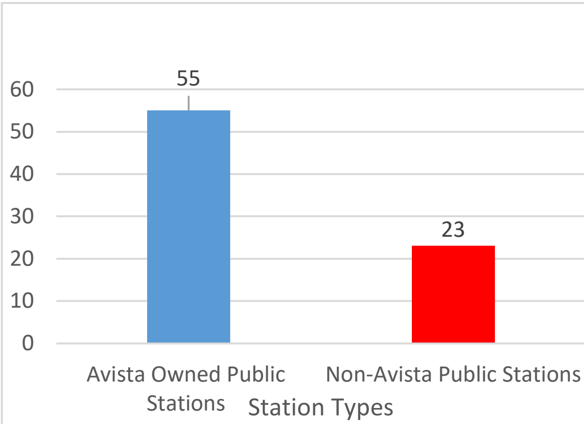


Figure 26: Avista and non-Avista EVSE stations available for public use in Avista's Washington service territory

The Company installed 46 charging ports used primarily for public access. In addition, some workplace, fleet and MUD site hosts agreed to open their EVSE for public use, listing them on station locator services such as PlugShare, Google Maps and Chargeway. A review of these locator services and the USDOE Alternative Fuels Data Center show that a total of 78 locations in Avista's service territory have EVSE available for public use (J1772 connectors), 23 of which (29%) are owned and operated outside of Avista's network.

DC Fast Charger EVSE

The Company installed DCFC at seven different sites in the region from early 2017 through mid-2019, with a goal of establishing the first backbone of public DCFC in eastern Washington that begins to enable rapid charging in urban core areas and longer distance EV trips. In consultation with WSDOT and outreach with local EV owners, strategic locations were identified along the I-90 and US-395/195 travel corridors and in the downtown of Spokane, the largest population center in the region. Specific sites within these areas were then determined based on criteria of cost, site host partnership, easy access, and nearby amenities.[27] Two of the sites are positioned east and west of Spokane's outskirts on the I-90 corridor, one north of Spokane on US-395, and two to the south on US-195 in Rosalia and Pullman. Future DCFC installations may extend both east-west along I-90 eventually linking Idaho to western Washington, and north-south along US-395/195 linking Canada to southeast Washington and Oregon, along with adequate buildout in urban areas proportional to localized EV adoption.

[27] For DCFC siting best practices, see Pacific Gas & Electric's EPIC Final Report, Appendix A – Expert Siting Criteria https://www.pge.com/pge_global/common/pdfs/about-pge/environment/what-we-are-doing/electric-program-investment-charge/EPIC-1.25.pdf

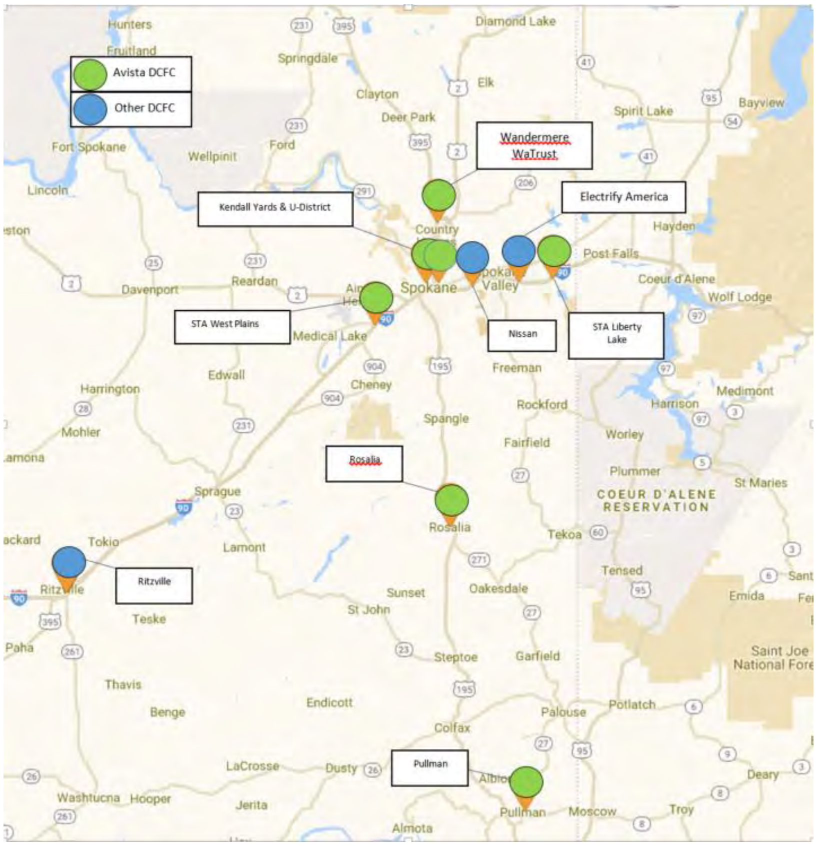


Figure 27: DCFC sites in eastern Washington, September 2019 (courtesy Plugshare)

Avista adopted a standard DCFC site design that included an operational 50kW DCFC with both CCS and CHAdeMO connectors, and a dual-port AC Level 2 EVSE as a backup. The installations required adequate property easements and/or site agreements for future expansion, supplied by three-phase, 480 VAC from a dedicated 225kVA transformer, service meter and supply panel, and conduits with capacity for low-cost future expansion of an additional 150kW DCFC and dispenser units.

The Company has found public DCFC installations to pose a number of challenges requiring extra attention compared to public AC Level 2 installations. Most notable of these was the site acquisition process, which did not significantly impact direct costs but required substantial effort and caused extended delays. Much of this was similar to AC Level 2 installations in terms of overcoming site hosts' unfamiliarity and perceived risks of various issues, multiplied by the added concern of committing to long-term obligations in the form of property easements and access agreements.

Lead times for DCFC site design, equipment procurement and construction were generally under two months, while site acquisition including contracts and property easements typically took six months or longer to complete. Three of the seven DCFC sites were constructed on private property with relatively shorter site acquisition lead times, and no payments required for access easements. The remaining four were constructed on public property, in collaboration with local government and transit agencies.

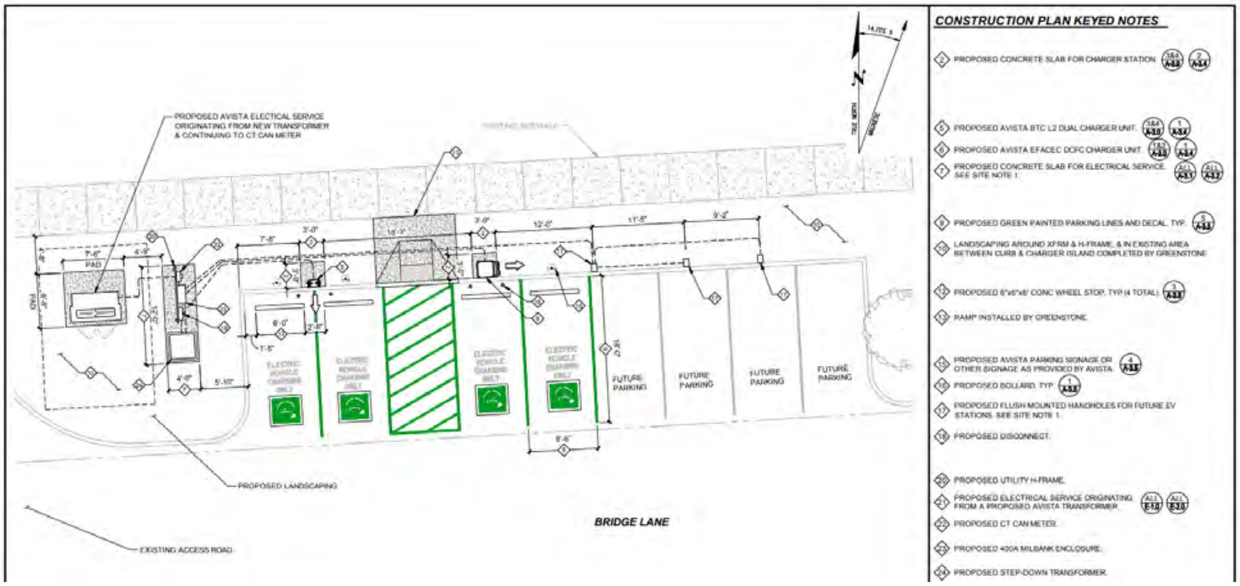


Figure 28: example DCFC standard site design

DCFC costs averaged $128,084 per site. The availability of nearby three phase power and minimized construction disturbances such as asphalt and concrete tear-out and restoration are the most important factors in reducing costs. Cost components for DCFC sites were distributed as follows:

Table 8: DCFC average cost categories

Construction Labor & Materials	49%
Utility Labor & Materials	19%
EVSE	25%
Project Management	3%
Engineering & Design	3%
Site acquisition	2%

Reliability and O&M Costs

EVSE reliability is critical to customer satisfaction and EV adoption, especially in the early stages of market development where relatively few EVSE may be available. Particularly for DC fast charging sites, EV drivers may be travelling longer distances and depend upon them to provide a charge when needed, or face long trip delays. In addition, the frequency, type and severity of problem occurrences, and lead times to correct them directly influence operations and maintenance (O&M) expenses. Specific knowledge and operational capabilities are required to maintain EVSE reliability at satisfactory levels while minimizing O&M expenses. These include prompt and effective problem notifications, response and repair lead times with both remote and onsite technician resources, optimized spare parts inventories, etc.

The following table shows the percent uptime categorized by the type and number of deployed EVSE ports, as tracked from October 28, 2018 through September 18, 2019. "Uptime" is defined as the percent of time that the EVSE is able to provide a charge, as opposed to the percent "downtime" where the EVSE is in a faulted condition and unable to provide a charge. These faulted conditions include a number of possible software and hardware or physical problems with the EVSE itself, as well as possible network issues in the case of networked EVSE.

EVSE Type	Networked ports / % uptime	Non-networked ports / % uptime	Overall % uptime	WiFi connections	Cellular connections	% networked	% online
Residential L2	92 98%	114 99.9%	99%	92	0	45%	66%
Workplace L2	84 78%	43 100%	85%	11	26	66%	86%
Fleet L2	10 83%	12 99.3%	92%	1	5	45%	85%
MUD L2	10 68%	8 100%	82%	2	4	56%	76%
Public L2	37 78%	9 100%	82%	1	24	80%	86%
Public DCFC	7 87%	-	87%	0	7	100%	87%

Note that networked EVSE in residential locations were able to maintain a high uptime of 98%, despite being online with the network only 66% of the time due to issues maintaining connectivity via homeowner WiFi, which were isolated to the EVSE. This is because the networked residential EVSE were programmed to initiate a charge upon physical connection to the vehicle regardless of network connectivity, rather than requiring user authentication via smartphone app or RFID card, as was the case for EVSE located outside the home. This was possible for residential EVSE as the user was known and captured by default in the dataset for home charging, and no payment transaction was needed to initiate a charge. Other networked commercial AC Level 2 performed at 68% to 83% uptime, and DCFC at 87%. Non-networked EVSE were highly reliable in all respects, at 99% uptime or greater across all locations.

While many customer ratings on Plugshare.com are positive for EVSE both on and outside Avista's network in the region, negative ratings and comments indicating the customer was unable to get a charge or was otherwise inconvenienced are common, rather than the rare exception. While industry standards have not been well established for uptime performance of AC Level 2 EVSE, consultation with EV drivers indicate that high uptime per site location and fast problem resolution are necessary to achieve customer satisfaction and support EV growth in the mainstream market segment – perhaps 95% or greater, especially for DCFC sites. This is because the EV fueling experience must meet or exceed the fueling experience of gasoline vehicles that customers are accustomed to. Consider from personal experience upon arriving at a gas station, how often fuel is unavailable at any of the gas pumps – and if that were to occur, how likely it would be to quickly arrive at another nearby gas station with fuel availability. The state of EVSE uptime in the 85% range – particularly at sites where there is no EVSE redundancy – must be dramatically improved to meet or exceed this standard. Thus far, only non-networked EVSE have demonstrated this level of performance outside the home.

Problem Tracking and O&M Expenses

Problem severity	Criteria
Urgent	DCFC or high-use L2 EVSE, no site redundancy, safety issue
High	High use, remote location, limited redundancy
Medium	Lower use, adequate redundancy
Low	Safely functional, minor issue

Table 9: Prioritization matrix for EVSE issues

Determining the priority of problem resolution depends upon the severity of the issues involved, which may include station type, redundancy or backup in the immediate vicinity, utilization, and public visibility. Based on these factors Avista developed a matrix to help categorize and prioritize issues, establish goals including corrective lead times, and efficiently deploy resources in partnership with the EVSP, equipment manufacturers and local electrical technicians. Safety issues and EVSE that are unable to provide a charge fall into the Urgent, High or Medium categories, while EVSE that have minor issues but can still safely provide a charge fall in the Low category.

Starting in the fall of 2018, Avista staff recorded problems that could not be immediately or remotely resolved, tracking details from the initial time of notification through the full resolution process. The table below summarizes these issues according to problem severity, including issues at both DCFC and AC Level 2 installation sites.

Problem severity	# of occurrences	Annual rate of occurrences per port	Mean time to repair (days)	Average cost to repair
Urgent	24	0.2	15	$214
High	45	0.4	18	$481
Medium	39	0.3	48	$553
Low	12	0.1	104	$224

Table 10: Problems tracked from October 28, 2018 through September 18, 2019

Problem notifications were received by the EVSP, email or phone calls from site hosts and EV drivers, periodic on-site inspections and testing, as well as online monitoring of sources such as PlugShare.com and a local EVSE Facebook group. In addition to these recorded occurrences, approximately five issues per week for networked EVSE are resolved by power cycling the unit (similar to rebooting a computer), and an unknown number of other minor problems and resolutions may occur without notification to Avista.[28] Note that repair costs listed above are inclusive of both warranty and non-warranty labor and material costs, whether direct or indirect in resolving the problem.[29] This results in an annual cost of $435 per port overall for unplanned problem resolutions. Out of 120 recorded problems, 101 were attributed to sites with networked ACL2, six to non-networked ACL2, and 19 to DCFC. Thus far, most of these problems were partially if not entirely covered under warranty. Many also appear to be issues related to new technology and systems that may be eliminated over time, as EVSE and network service quality matures and improves. As there is limited EVSE performance history, it is uncertain how problem types and occurrence frequency may change as the equipment ages. Considering the experience gained thus far and consulting with industry experts on problem types, frequency and expected costs, the following table reflects best estimates of annual O&M costs per port. This includes maintenance of various EVSE and sites over their assumed 10-year service life, assuming moderate to high utilization and some product improvements and scaling efficiencies as the market matures.[30]

Table 11: Annual O&M costs per port, not including electric billing

	DCFC	Commercial Networked ACL2	Commercial Non-Networked ACL2	Residential Networked ACL2	Residential Non-Networked ACL2
Network support & communications	$250	$250	$0	$250	$0

[28] Annual inspections and testing are recommended for each EVSE site, to help uncover unreported problems with the EVSE and site conditions

[29] Technician labor time on-site, travel costs, and equipment or component purchases are examples of direct costs, while office staff time on the phone to help discuss and resolve a problem is an example of indirect cost.

[30] Not inclusive of spares inventory costs and electric meter billing, net of any user fees applied by the site host.

Planned maintenance	$400	$0	$0	$0	$0
Unplanned repairs (non-warranty)	$500	$100	$35	$70	$5
Minor connectivity restoration	$50	$50	$0	$50	$0
Tests & inspections	$200	$100	$50	$0	$0
Site & access maintenance[31]	$150	$100	$100	$0	$0
Total	**$1,550**	**$600**	**$185**	**$370**	**$5**

In addition to these O&M expenses, the table below lists average electric usage and meter billing for utility energy charges by EVSE type, as derived from recent EVSP data.

Table 12: Average electricity usage and billing by EVSE type, per port (March 2019 – May 2019)

EVSE type	kWh per session	Monthly sessions	Monthly kWh	Energy billing rate[32] per kWh	Monthly energy billing
Residential ACL2	7.6	20.8	158.0	$ 0.090	$ 14.20
Workplace ACL2	8.8	16.6	145.9	$ 0.105	$ 15.30
Fleet ACL2	12.2	17.4	212.6	$ 0.105	$ 22.30
Public ACL2	9.4	9.6	90.4	$ 0.105	$ 9.50
MUD ACL2	9.1	0.7	6.4	$ 0.105	$ 0.70
DCFC	13.6	9.8	131.1	$ 0.105	$ 13.80

No basic charge is included in these figures, as residential and commercial ACL2 EVSE are supplied by existing meters and panels, and no offsets are included here for commercial ACL2 and DCFC that may collect user fees. If separately metered, a basic charge of $20 per month would apply to commercial customers. In addition, some demand charges may be expected for larger commercial ACL2 installations

[31] Site and access maintenance activities such as snow plowing and trash removal may already be in place and are not necessarily additive with the installation of the EVSE

[32] Based on current Avista rate schedules 001 for residential service and 011 for commercial general service. Does not include basic charge, tiered energy charges (which may apply when added to other building loads), or demand charges for schedule 011.

with higher utilization, when demand from all metered loads at a given facility rise above the 20kW threshold established in Schedule 011.

DCFC sites are equipped with dedicated service and meters that supply both a 50kW DCFC and a dual port ACL2. Review of 107 monthly meter bills for DCFC results in the following minimum and maximum total bills for all sites since commissioning from January 2017 through June 2019, and more recent average monthly billing from January through June of 2019.

Table 13: DCFC monthly meter billing, all sites (Jan 2017 – June 2019)

	kWh energy consumption	kW peak demand	basic charge	energy charge	demand charge	total bill	% demand charge	effective energy charge per kWh
min	80	0	$18	$ 9.29	$ 0	$ 27.29	0%	$0.34
max	1058	66.2	$20	$126.35	$300.04	$446.39	67%	$0.42
avg	473.9	43.6	$20	$ 56.81	$161.84	$238.65	64%	$0.63

Note the % demand charge of the total bill, and the effective energy charge per kWh which is determined by dividing the total bill by the kWh energy consumption. Although the average 64% demand charge coincides with a $0.63/kWh effective energy charge, in one month a DCFC site saw only a few DCFC sessions resulting in low energy consumption, 86% demand charges out of the total bill of $224, and an effective energy charge of $1.87/kWh. This shows that in cases of lower utilization a competitive user fee of $0.35/kWh cannot recover electric billing costs, let alone other O&M expenses estimated at $1,550 per year to maintain service, and installation capital averaging over $128,000 per DCFC site. Under current commercial rates and average DCFC charging sessions at 13.6 kWh and $5.05 user fee revenue, breakeven with electric billing occurs at 55 charge sessions per month, and at 91 sessions per month to cover both billing and other O&M expenses. This is far higher than even the most utilized DCFC in the network at Kendall Yards, now averaging 27 charges per month. These results highlight the need to consider alternative utility rate schedules to support DCFC operated by Avista and other customers, as DCFC are a critical component of the overall "charging pyramid", essential for sustained EV adoption and market transformation.

Analysis of Problem Types and Solutions

As stated earlier, the rate of non-networked EVSE problems was dramatically less than networked EVSE, with simpler designs allowing for faster repairs and less external support. Electronic components, network communication, and software integration issues in networked EVSEs require more technical training and/or assistance from EVSE manufacturers and EVSPs, either remotely or onsite in more problematic cases. Further analysis of tracked issues shows that software integration and component failures were the most common, followed by remote start integration issues. These three types represented 77% of all tracked issues, with 76 of the 78 problems in these categories involving networked EVSE.

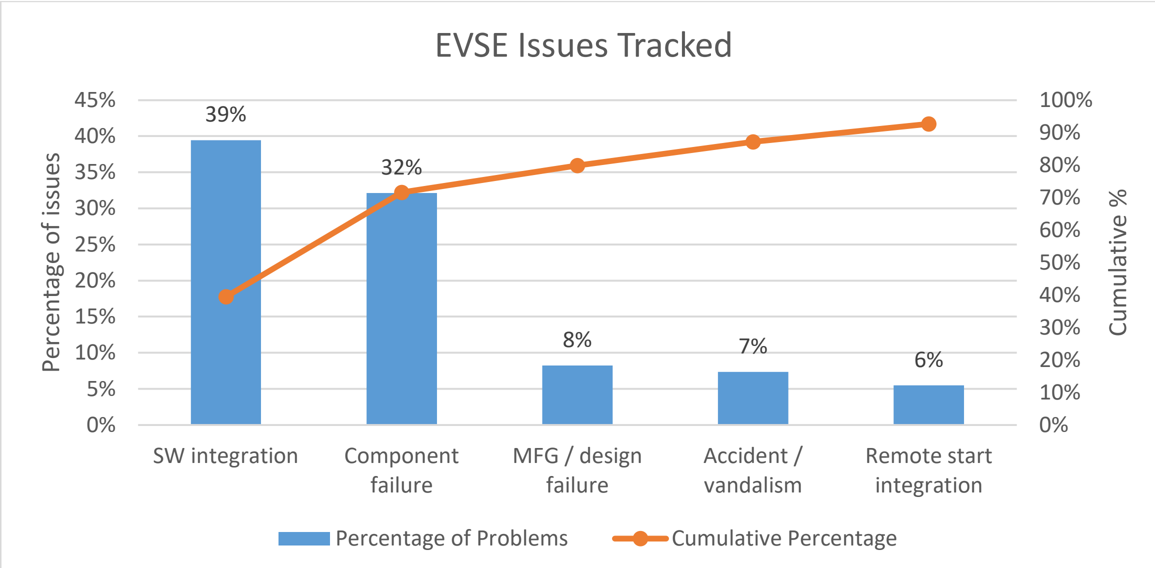


Figure 29. EVSE Issues Tracked

A few problems involved defective manufacturing and design, preventable with improved production methods and processes. Examples include improper seating of electronics connectors, insecure compression sleeve fittings for charging cables, or outsourced subcomponents that do not meet required working tolerances.

Figure 30. Example J1772 connector plate-to-latch tolerance

An example of an avoidable manufacturing issue, and how it can create additional problems, is found in the case of a J1772 connector. As shown, the distance from the back plate to the latch inner surface is within tolerance and will properly connect with a vehicle or EVSE holster. A very small reduction in this required distance however, prevents the connector from fully clipping into the EV connector pins when plugged in, and does not allow a charge to initiate.[33] Additionally when the connector is inserted into the station's connector holster, the retainer latch will not fully clip in and the user may apply extra force causing it to fracture or to damage the connector pins on the EV itself. This is a good example of product defects that are expected to be resolved and eliminated with

[33] SAE 1772 standard available at https://www.sae.org/standards/content/j1772_201001/

improved manufacturing and best practices in the field.

Accidents and vandalism causing physical damage were infrequent, but did occur on a few occasions. Examples include cut connector cables, damaged user interface screens, and in one case a tour bus backing into the EVSE, narrowly missing the protective bollard. Vandalism occurred at three different sites, all open to the public and not activiely monitored. Vandalism is somewhat dependent on location and site conditions and may be difficult to prevent, although video monitoring with some warning signage can help mitigate risk.


Figure 31. EVSE damage from a vehicle impact

Effective problem resolution, root cause analysis and systematic improvement for prevention requires full engagement and coordination between the manufacturer, EVSP and network manager.

In terms of problem resolutions, power cycling addressed 33% of the total tracked issues, however on many occasions problems resurfaced and multiple power cycles were required, and in 35% of cases another solution was needed to permanently resolve the issue.

22% of solutions involved component repair or replacement, and 13% full EVSE replacement. In one example, a DCFC had persistent connectivity issues that were temporarily resolved by power cycling, which would resurface within a few days. Working with the manufacturer and EVSP over multiple site visits, the EVSE was checked for properly seated connections, acceptable cellular signal strength, and excessive EMF interference. Ultimately, a faulty modem was identified as the root cause of the issue and, once replaced, permanently resolved the issue.

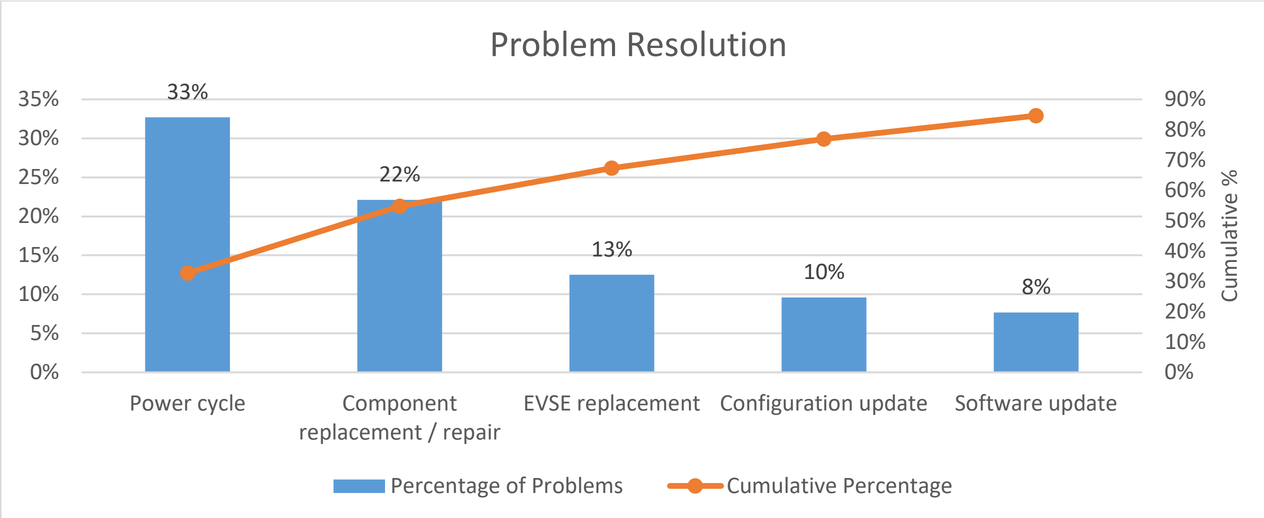


Figure 32. Avista network tracked issues resolution

Configuration and software updates accounted for 18% of solutions and were accomplished remotely, with some exceptions. Given the experience of EVSE issues and resolutions over the course of the EVSE pilot, the overall impression is that some of the physical issues relevant to all EVSE, and most of the problems relevant to only networked EVSE are preventable – and may be eliminated with improved production, integration, and remote monitoring capabilities of EVSP and EVSE industry partners.

Problems with connectivity did not affect uptime in residential installations, but were common in both residential and commercial EVSE installations, making data collection and analysis more difficult. Internet broadband connections, WiFi, and cellular communications will periodically fluctuate in available speed and signal strength due to interferences and other factors. Hardware and software of networked EVSE must be robustly designed and tested to accommodate these conditions within specific limits that are known and verified prior to EVSE installation. In the case of residential and some commercial installations, this required a boost to the WiFi signal in the garage using a repeater or wireless access point. In the case of commercial installations utilizing cellular communications, signal strength was verified prior to EVSE installation. Even so, cellular communications were a frequent problem due to internal modem issues and fluctuating signal strength.

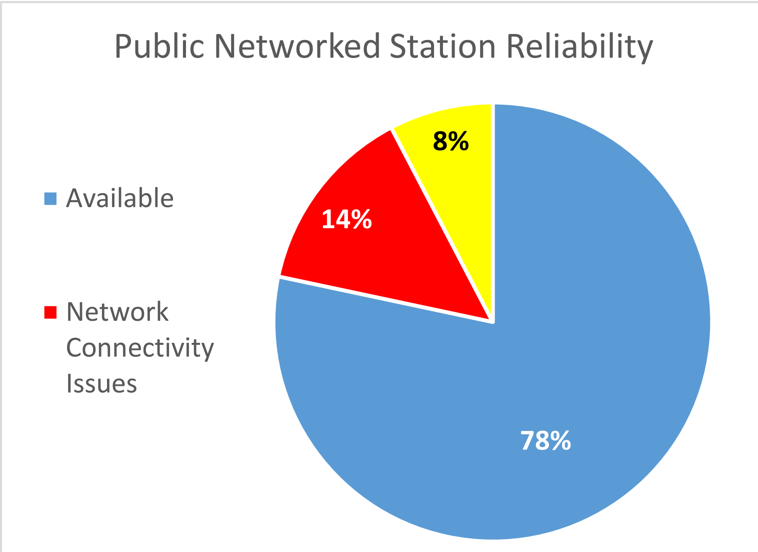


Figure 33. Public networked EVSE availability

Another way of categorizing reliability problems with networked EVSE is in terms of (1) EVSE-to-server communications issues, and (2) local issues related to EVSE physical, hardware and software problems, which may be undetectable by remote EVSP monitoring.

Faulty modem communications that render the EVSE offline with the EVSP and/or manufacturer's server, and software bugs in smartphone apps that affect uptime are examples of the former, while internal breaker trips, control unit malfunctions, and physical damage are examples of the latter. Open source communication protocols such as OCPP, with adequate integration and testing between the EVSE manufacturer and the EVSP, can enable detection of many if not all physical, hardware and software issues. This is especially important for public EVSE, which over the course of 18,785 days in service were unavailable 3,476 days due to network connectivity issues and 1,441 days due to undetectable local issues, resulting in an uptime of 78%.

As EVSP remote monitoring and notifications do not occur for undetectable local issues, site hosts and EVSE owner/operators will instead receive problem notifications from customers through a variety of communication channels, often with significant delays from the time that the problem surfaces. In order to maximize uptime and a positive customer experience, continuous improvement effort is essential to identify and eliminate root causes, including an effort to increase the number of remotely detectable issues. Site hosts and owner/operators should coordinate EVSE inspection and testing at appropriate frequency to identify undetectable problems, particularly for more underutilized EVSE. Finally, coordinated staffing and standard processes must continuously work to minimize corrective lead times, from problem occurrence through notification, response, and final resolution.

Utilization, Load Profiles & Data Analysis

Data analysis begins with a raw dataset of 64,574 charging sessions logged by networked EVSE from January 1, 2017, through May 24, 2019. Of the 64,574 sessions, 11,218 were removed due to data anomalies. The remaining 53,356 sessions were utilized for analysis of user and location load profiles across networked residential, workplace, public, fleet, MUD and DCFC sites. High confidence in the accuracy and validity of the dataset provided by the EVSP was established by close comparison with a sample of identical charging sessions captured separately by vehicle telematics devices, as detailed in Appendix B.

Residential stations logged the most charge sessions with 68% of the total. Workplace came in second at 16%, followed by public and fleet at 11% and 4%, respectively. A smaller number of MUD installations were completed with relatively low utilization, resulting in 0.3% of the dataset. 90% of public charging sessions occurred at public L2, with 10% at DCFC.

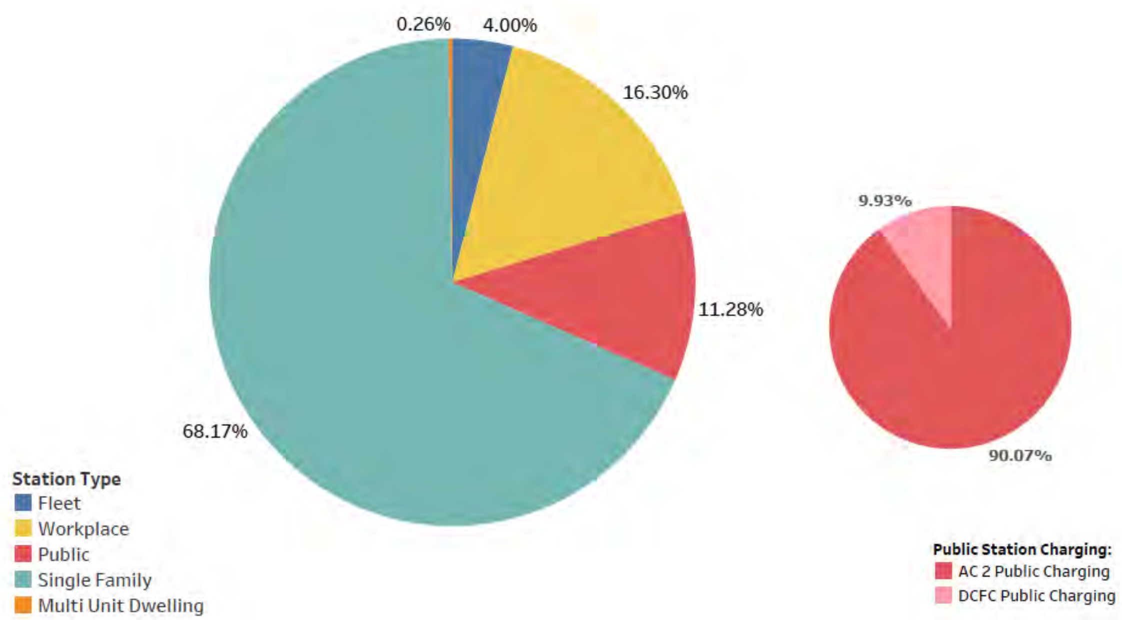


Figure 34. Percent of Charge Sessions by Station Type

Overall Load Profile

Residential charging comprised the majority of demand, except between the hours of 7am to 10:30am, where workplace charging was the largest source of demand and accounted for 48% to 53% of total energy consumption across networked EVSE. Combined energy consumption for all station categories peaked during the 5pm to 6pm hour, with residential L2 accounting for 76% of the total at that time.

See Appendix E for values of hour-by-hour energy consumption in the various categories. The chart below shows average charging over nearly 2.5 years of EVSE installations and utilization. Note that this differs from the current state of the network as a proportionately higher number of networked residential EVSE were installed in the earlier phases of the pilot program, with more workplace, fleet, public L2 and DCFC installed in later phases. In addition, some inaccuracies exist in use categorization as EVSE primarily used for one type of charging are on occasion used for another type. For example, a charging station primarily used for "public" charging and designated as such, may on occasion be effectively used as "workplace" charging, etc. The Avista data also does not include any L1 charging, which is currently used by some EV drivers in the larger population for residential charging, and to a lesser extent in other types of use.

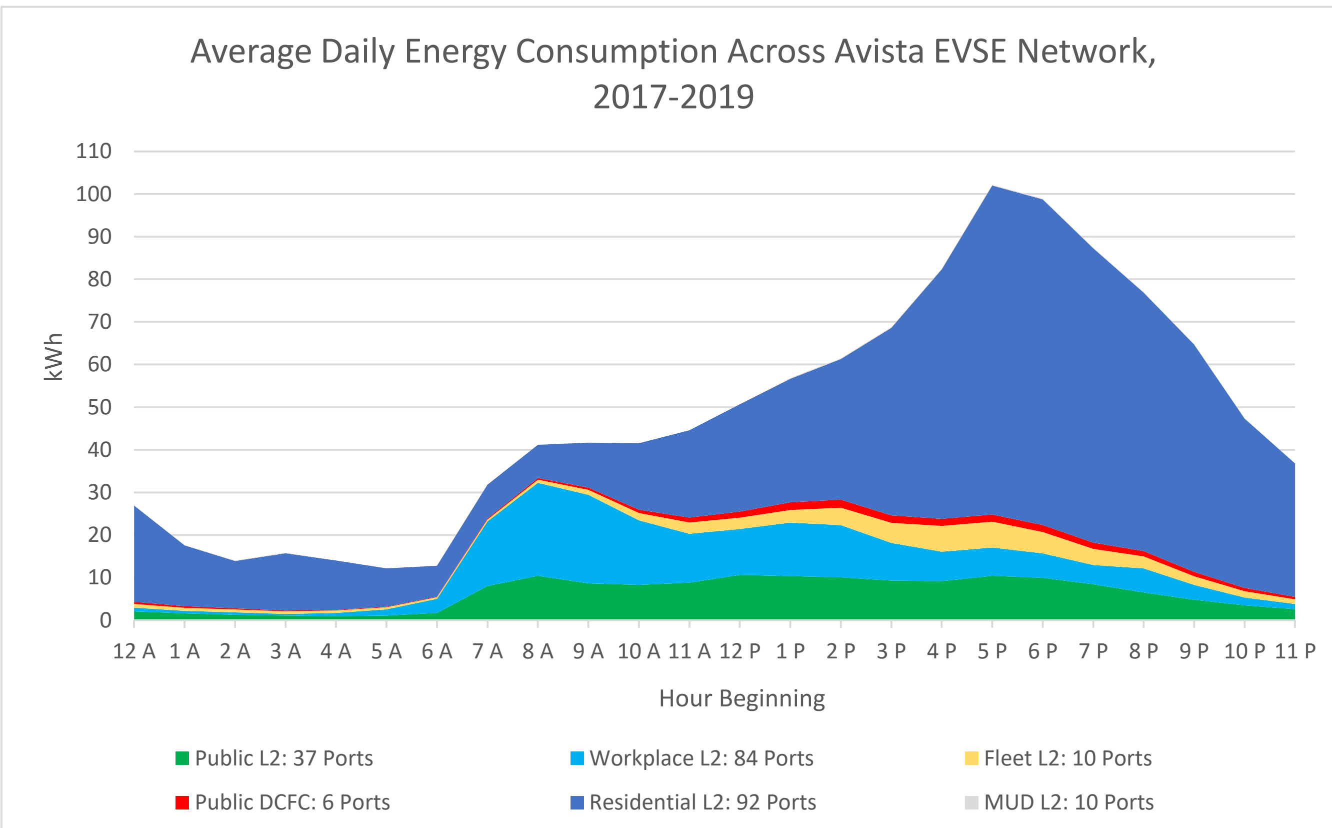


Figure 35. Average daily energy consumption across Avista's networked stations

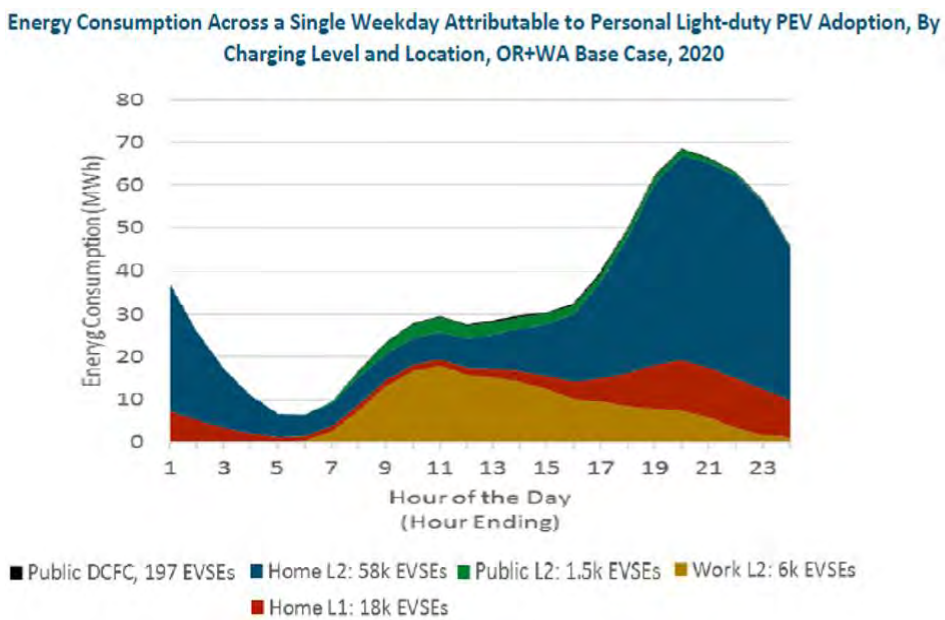
Comparison with E3 Modeling

Average daily electricity consumption from Avista's EVSE data compares well with modeling completed by Energy + Environmental Economics (E3),[34] in terms of the overall shape and composition of EV load from different use categories. E3's load profile data was developed using inputs from five different

[34] Economic & Grid Impacts of Electric Vehicle Adoption in Washington & Oregon. E3 (2017)

regional utilities serving the Pacific Northwest region. These inputs included empirical data as well as load profile projections based on adoption rates, vehicle types, energy rates and a variety of other factors that produced the 2020 Base Case in the figure below. Comparing this with Avista's EV load profile provides some general confidence in both the validity of E3's model and Avista's data. After factoring out MUD and fleet data from Avista's network, similarities include overall and peak demand dominated by residential charging, with roughly 90% of peak load from residential L1 and L2 occurring between 6pm and 10pm, compared to 82% of peak load from residential L2 in the Avista network from 5pm to 8pm. Furthermore, E3's morning workplace model showed a peak between 9am and 1pm with 58% of total energy usage from workplace charging, while Avista's workplace demand data showed a peak between 7am and 10:30 am, accounting for 48% of total energy usage.[35] Note that between the two charts, Avista's data is shown with an "hour beginning" convention, while the E3 model uses an "hour ending" convention.

Figure 36: E3 Pacific Northwest modeled EV energy consumption in 2020 (E3)



Two notable differences between E3's model and Avista's data, are that the E3 model shows a peak occurring later in the evening and has significantly more residential charging occurring later in the evening and early morning timeframe, compared to Avista's data. This could be due to E3 modeling charge sessions starting later in the day, and a slower overall rate of L2 charging as well as L1 charging, which results in longer charge sessions lasting into the early morning hours.

AC Level 2 EVSE Charging Session Characteristics

Analysis of connection times for EVSE types revealed that fleet and residential EVSE have the longest connection times with an average of 16 hours and 10 hours, respectively, and with larger ranges.

[35] See Appendix E for tables of hourly energy usage and distribution comparisons

Remaining EVSE types showed substantially shorter connection times averaging below 5 hours, and narrower ranges.

Connection Time by EVSE Type

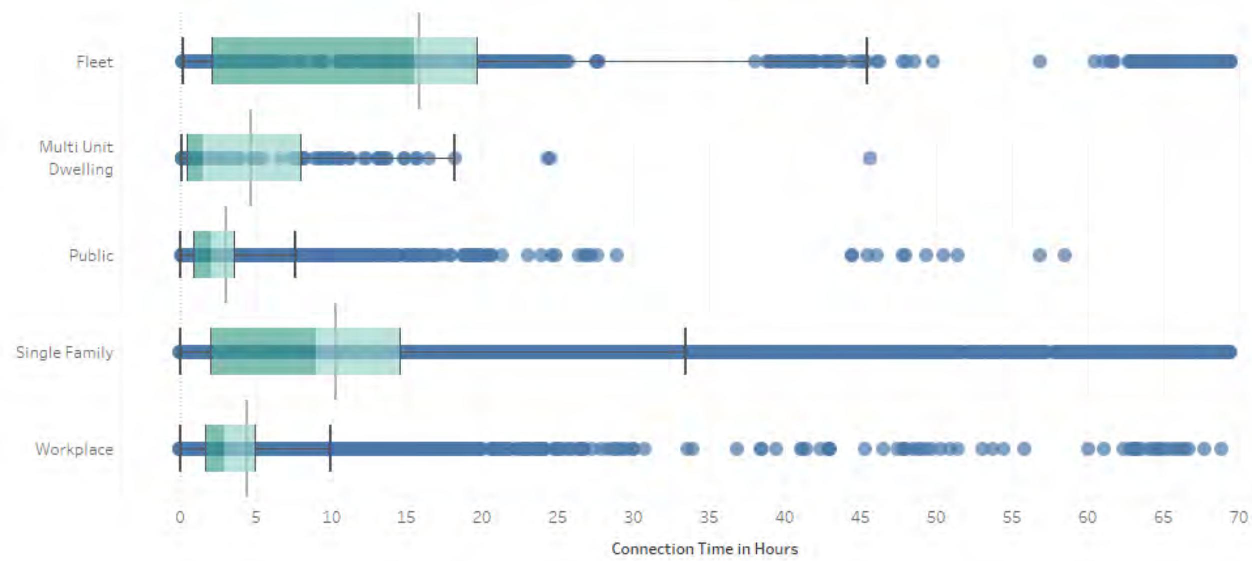


Figure 37. EVSE Connection Time by Station Type

Session charging times revealed close averages between the different EVSE types, at approximately 1.6 hours per session, and similar ranges from roughly 1.3 hours to 1.7 hours for the majority of sessions, other than the MUD category which had a much smaller number of recorded sessions.

Session Charge Time by EVSE Type

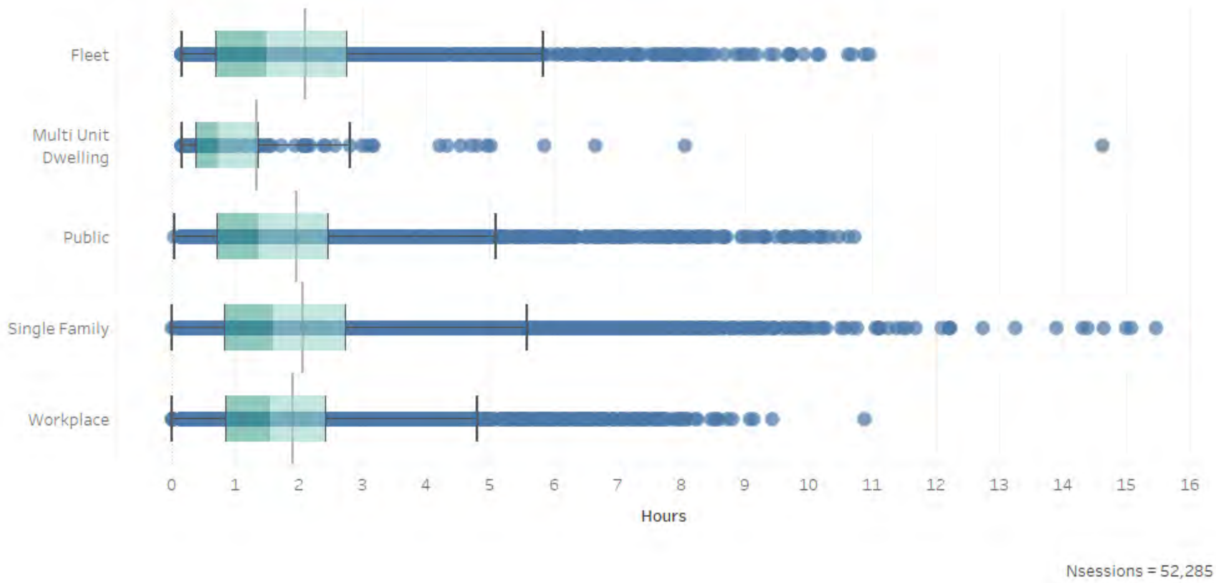


Figure 38: Charging Time by EVSE Type

Session energy usage is also very similar across different EVSE categories.

Session Energy Usage by EVSE Type

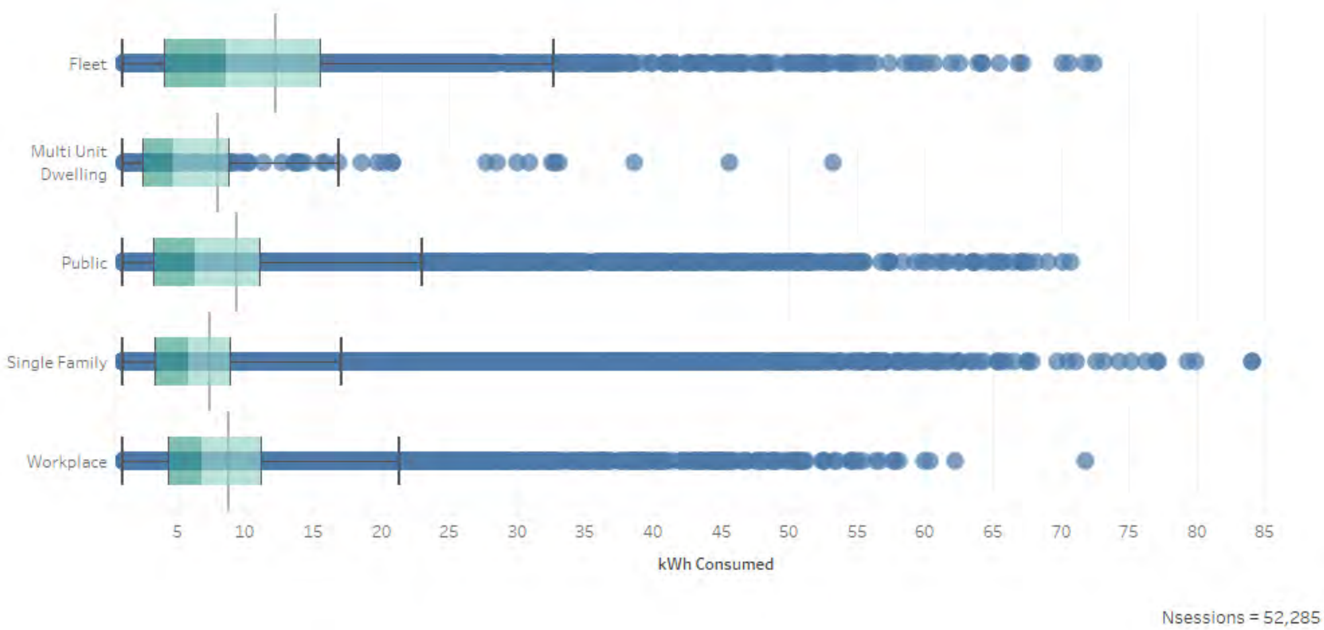


Figure 39. Session Energy by Station Type

Residential AC Level 2 EVSE

Below is a visualization of two different EV charging sessions, typical of session data coinciding with EV drivers that routinely arrive home in the afternoon or early evening, and initiate a charge.

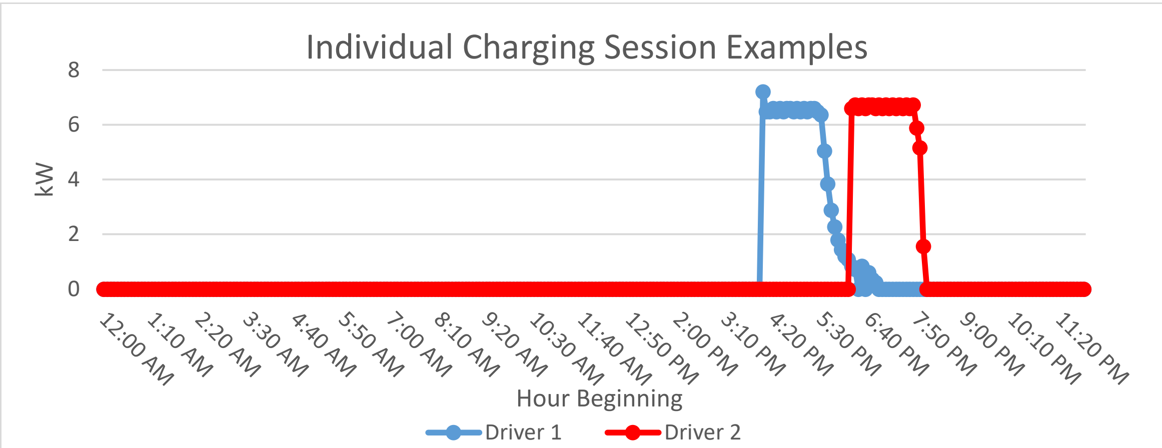
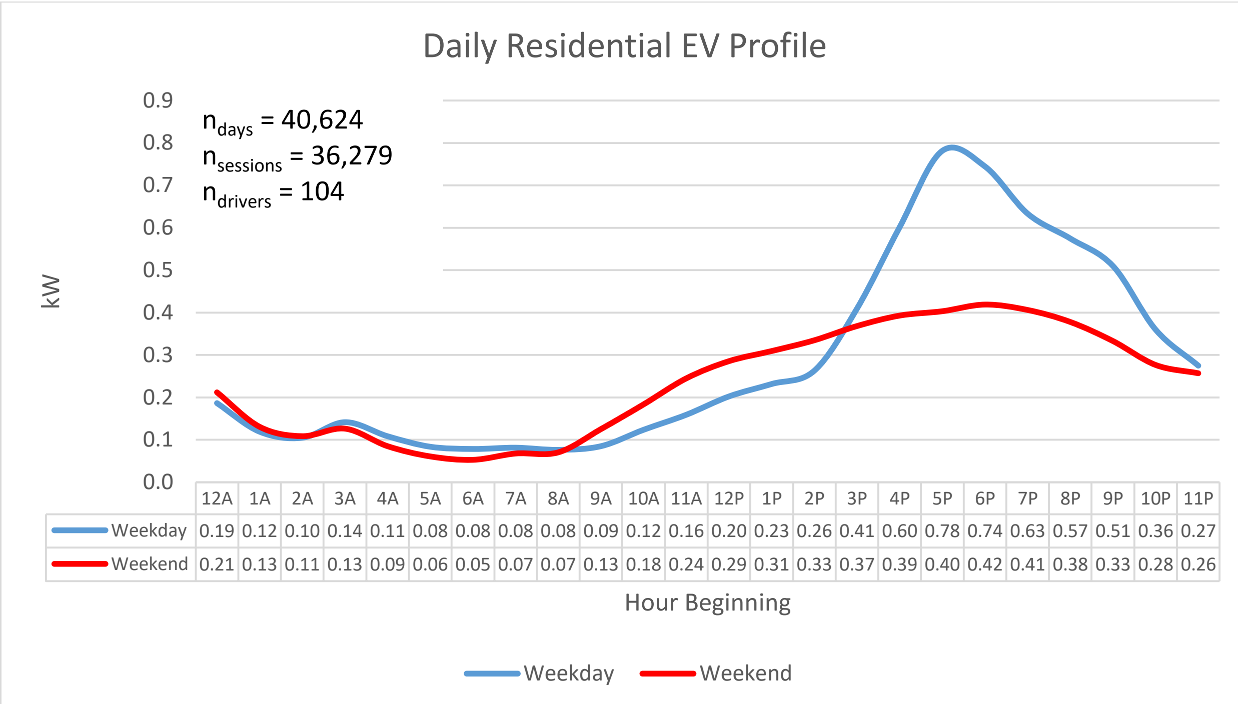


Figure 40. Example of individual residential EV charging sessions

In these charging sessions, the charge rate of the vehicle rapidly ramps up to the maximum allowed by the EV's rectifier at 6.6kW in this case, and charges for 1 to 2 hours at this level, with a ramp-down period of 45 to 60 minutes when the battery approaches a state of full charge. When taken together with other coincident loads in a given neighborhood, a total load on the local distribution transformer, feeders and substation may be determined.

An average daily load profile for an EV may be determined by combining all charging sessions such as the ones illustrated above, divided by the number of operating days over a given period of time. When the average load profile is multiplied by the total number of EVs in a given service area, the total expected energy on a per hour basis is determined for the system, which is important to understand from a generation capacity or power supply perspective. The average load profile includes many days where no charging occurs, and EV drivers have different charging habits that vary daily by location, time and amount of energy consumed. Combining all charging sessions in this way results in an aggregated, average daily profile per EV. Using the same procedure, load profiles may be specified for different types of EVs and usage, as well as by location type. Note that care must be taken to properly account for any days were the EVSE was offline and no data was transmitted. These days must be removed from consideration rather than assumed that no charging occurred.

Residential EVSE Daily Profile



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.19	0.12	0.10	0.14	0.11	0.08	0.08	0.08	0.08	0.09	0.12	0.16	0.20	0.23	0.26	0.41	0.60	0.78	0.74	0.63	0.57	0.51	0.36	0.27
Weekend	0.21	0.13	0.11	0.13	0.09	0.06	0.05	0.07	0.07	0.13	0.18	0.24	0.29	0.31	0.33	0.37	0.39	0.40	0.42	0.41	0.38	0.33	0.28	0.26

Figure 41. Residential EV aggregate load profile

The load profile above includes both weekday and weekend charging sessions, with an afternoon peak reaching an average of 0.78 kW per EV between 5pm and 6pm, coinciding with a large number of drivers arriving home in late afternoon and early evening. Demand drops to 0.36 kW by 10pm on weekdays and continues to decline to 0.12 kW by 1am, until beginning to rise again near 8am. Weekends have less consumption overall and a more gradual rise to a lower peak value of 0.42 kW at 6pm.

Trip distances, driving patterns, destination arrival times and charge initiation, the distribution of vehicle types, use of workplace and public charging, EVSE and rectifier ratings, and battery sizes in the overall EV population all have an effect on daily load profiles.

Comparison to the EV Project Residential Data

The 2015 EV Project (EVP) is the most extensive study of light-duty EVs published to date, analyzing charging patterns from thousands of drivers over a multi-year period.[36] An aggregated profile from Washington State residential weekday charging was adjusted for the 658 EVSEs in the EVP Washington network using Q4 2013 data. Washington EVP drivers consisted of 82% Nissan Leafs and 18% Chevy Volts.

[36] Francfort, J. et al. "The EV Project." Idaho National Laboratory, (2015).

In the chart below, the EVP load profile is compared to Avista's weekday residential profile. While the load profile shapes are similar, the EVP's profile peaks during the 7pm to 8pm hour, one hour later than Avista's profile peak. The Avista peak was also lower than the EVP peak by 12%, at 0.79 kW compared to 0.91 kW. Average weekday energy consumption for Avista residential customers was also lower, at 6.9 kWh compared to average EVP drivers' consumption of 8.6 kWh – a difference of 1.7 kWh, or 20%.

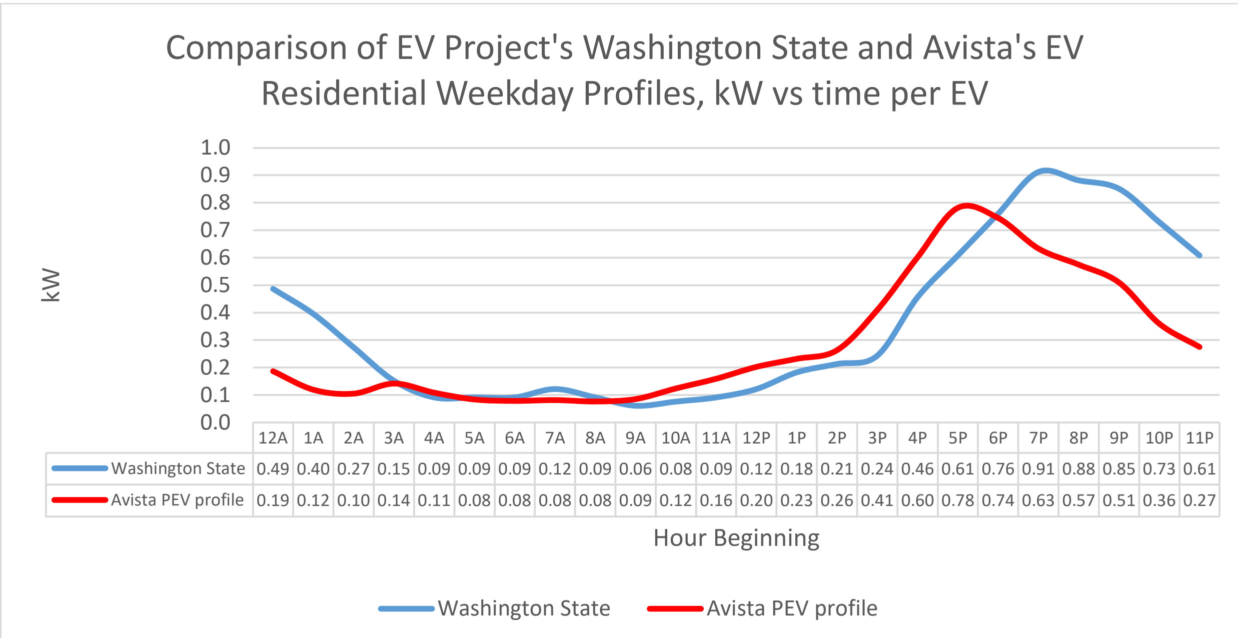


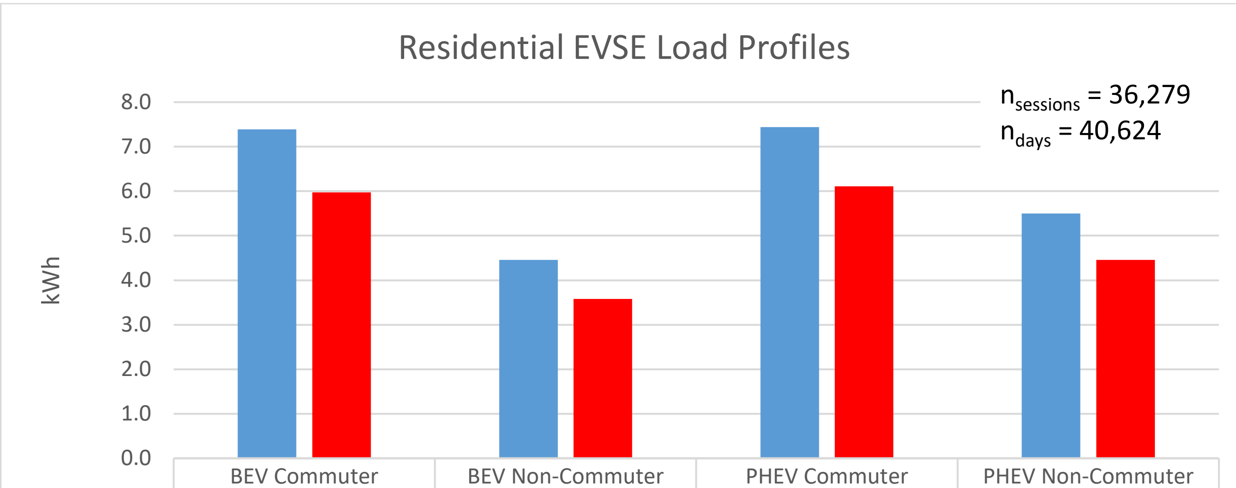
Figure 42. Comparison of Avista and the EV Project's Weekday Profiles

Many factors may affect the profiles, however driving patterns and rectifier capacity may be the most important in explaining the differences in consumption and load shape between the two curves. While both datasets originated from customers in Washington State, EVP drivers were exclusively in western Washington while Avista's pilot customers were in eastern Washington. Lower miles driven each day could account for the lower energy consumption in the Avista profile, as Avista commuters averaged 21 miles roundtrip compared to 27.4 miles for EVP Washington commuters. With a difference of 6.4 miles per round trip commute and assuming fuel efficiency of 3.35 miles per kWh, on average Washington EVP commuters would use an additional 1.9 kWh compared to Avista's EV commuters, which closely approximates the observed 1.8 kWh difference between the two profiles. Also the EVP peak occurs a little later in the evening and load is noticeably shifted to the later evening and early morning hours. This could be due to later arrivals in the evening for the overall EVP population, as well as lower EVSE output and older EVs with smaller rectifier ratings, such that charging sessions take longer to complete.

Overall, the similarities between the two datasets lend credibility to the studies, while observed differences highlight the value of more detailed information that can apply to unique utility service territories and systems – even within the same state – that will change to some degree as EVs and driving behaviors evolve.

Residential Driver Type Usage

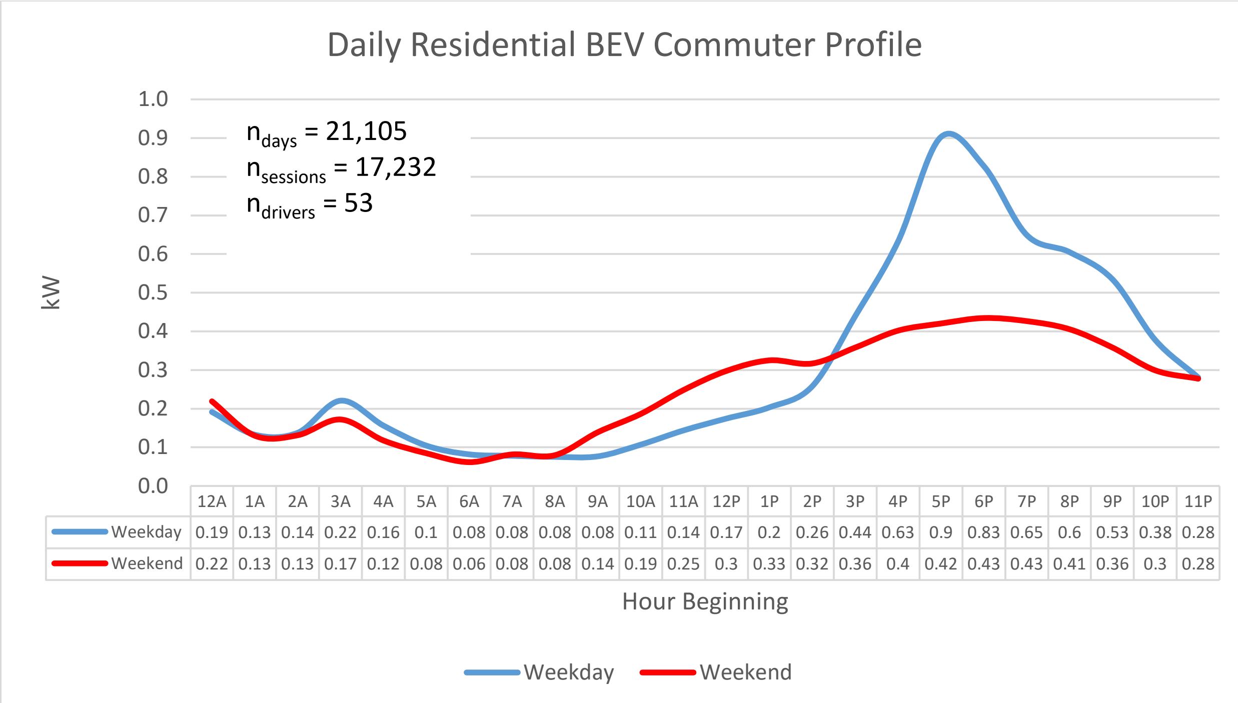
Average weekday energy consumption is highest for BEV and PHEV commuters at over 7.4 kWh, followed by PHEV and BEV non-commuters at 5.5 kWh and 4.5 kWh, respectively. Daily energy consumption in all categories is lower on the weekend compared to weekdays as seen in the chart below.



	BEV Commuter	BEV Non-Commuter	PHEV Commuter	PHEV Non-Commuter
Weekday	7.4	4.5	7.4	5.5
Weekend	6.0	3.6	6.1	4.5

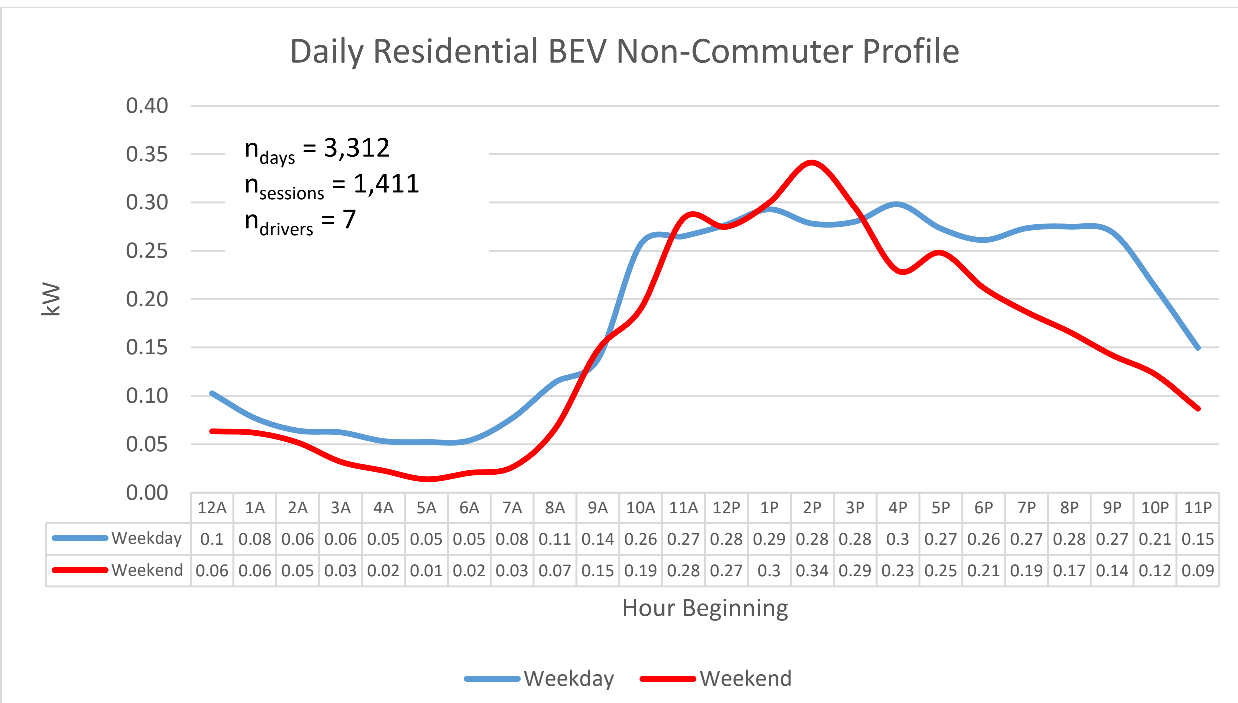
Figure 43. Average daily residential energy consumption by driver type

Detailed load profiles for each driver type are shown in the figures that follow. Within each category, the weekday and weekend load profiles tend to be similar during off-peak hours, and then diverge during peak times in the afternoons and evenings. BEV commuters have the highest peak weekday demand of 0.9 kW, occurring during the 5 pm hour. With BEV commuters, weekend demand is lower and steadily increases throughout the day, peaking at 0.4 kW at 6 pm. Other profiles have lower weekend peaks and flatter afternoon demand. Both BEV and PHEV non-commuters have sharp increases in both weekday and weekend power demand occurring earlier in the afternoon than commuters. The data shows that commuter charging behavior is more noticeably different between the weekday and weekend, compared to non-commuters. BEV non-commuter power demand is also the lowest during the weekday of the different driver types, at 0.3 kW. BEV non-commuters were also the only driver type to have higher average weekend peak demand than on the weekday. This could be influenced by the fact that most of the BEV non-commuters were retirees, charged less frequently than other driver types and had the fewest networked stations of all groups.



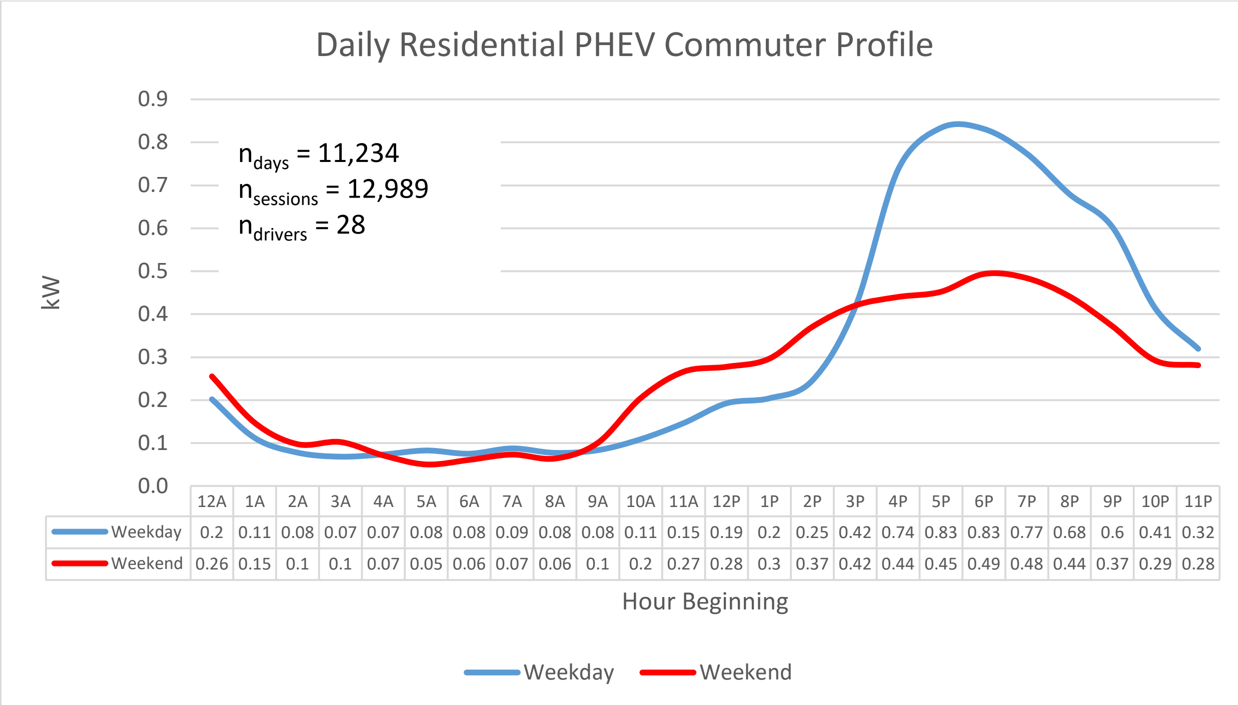
	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.19	0.13	0.14	0.22	0.16	0.1	0.08	0.08	0.08	0.08	0.11	0.14	0.17	0.2	0.26	0.44	0.63	0.9	0.83	0.65	0.6	0.53	0.38	0.28
Weekend	0.22	0.13	0.13	0.17	0.12	0.08	0.06	0.08	0.08	0.14	0.19	0.25	0.3	0.33	0.32	0.36	0.4	0.42	0.43	0.43	0.41	0.36	0.3	0.28

Figure 44. Residential BEV commuter aggregate load profile



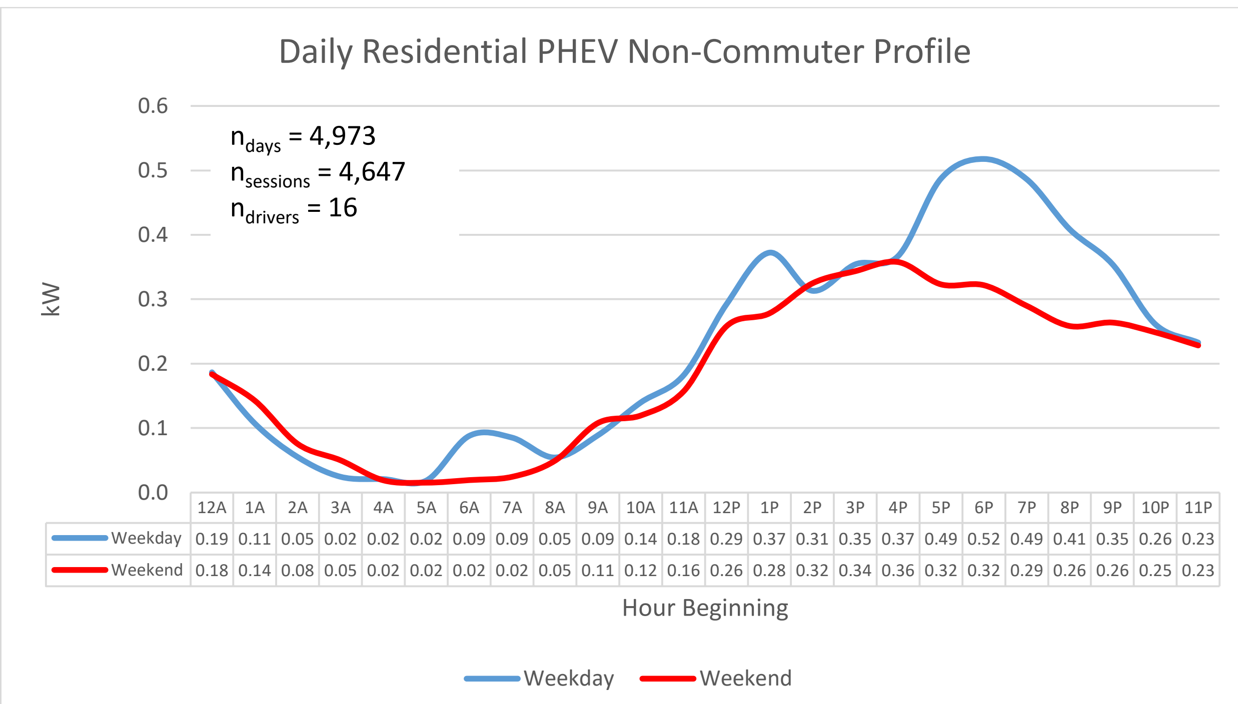
	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.1	0.08	0.06	0.06	0.05	0.05	0.05	0.08	0.11	0.14	0.26	0.27	0.28	0.29	0.28	0.28	0.3	0.27	0.26	0.27	0.28	0.27	0.21	0.15
Weekend	0.06	0.06	0.05	0.03	0.02	0.01	0.02	0.03	0.07	0.15	0.19	0.28	0.27	0.3	0.34	0.29	0.23	0.25	0.21	0.19	0.17	0.14	0.12	0.09

Figure 45. Residential BEV non-commuter aggregate load profile



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.2	0.11	0.08	0.07	0.07	0.08	0.08	0.09	0.08	0.08	0.11	0.15	0.19	0.2	0.25	0.42	0.74	0.83	0.83	0.77	0.68	0.6	0.41	0.32
Weekend	0.26	0.15	0.1	0.1	0.07	0.05	0.06	0.07	0.06	0.1	0.2	0.27	0.28	0.3	0.37	0.42	0.44	0.45	0.49	0.48	0.44	0.37	0.29	0.28

Figure 46. Residential PHEV commuter aggregate load profile



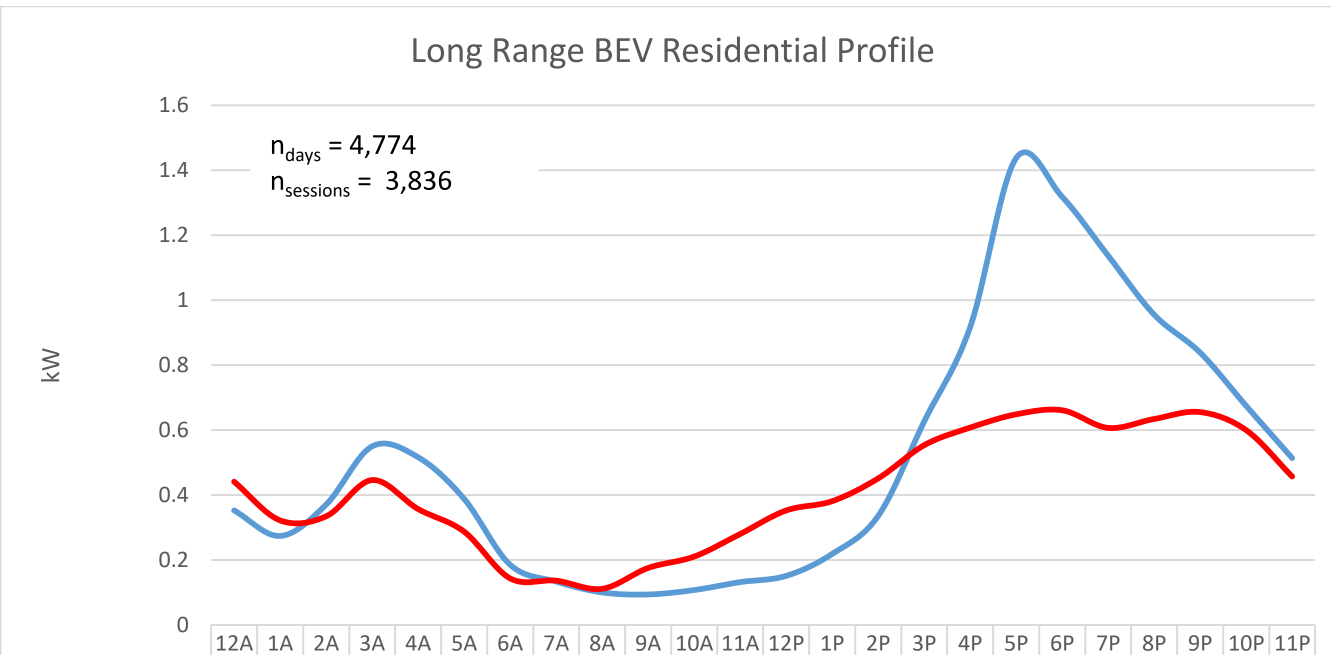
	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.19	0.11	0.05	0.02	0.02	0.02	0.09	0.09	0.05	0.09	0.14	0.18	0.29	0.37	0.31	0.35	0.37	0.49	0.52	0.49	0.41	0.35	0.26	0.23
Weekend	0.18	0.14	0.08	0.05	0.02	0.02	0.02	0.02	0.05	0.11	0.12	0.16	0.26	0.28	0.32	0.34	0.36	0.32	0.32	0.29	0.26	0.26	0.25	0.23

Figure 47. Residential PHEV non- commuter aggregate load profile

Residential Long Range BEV (LRBEV) Daily Profile

BEVs with larger batteries allowing over 200 miles driving on a single charge are considered LRBEVs. Although Avista had only 11 LRBEV drivers with reliable residential EVSE data in the program, there was a distinct difference in this driver group compared to the average EV driver.

LRBEV drivers had higher residential energy and power demands than those with shorter range BEVs, and charged at home with slightly more frequency. LRBEV drivers had peak demand of 1.4 kW occurring during the 5pm to 6pm hour – resulting in an 85% increase above the overall EV residential peak. For LRBEV drivers, total energy consumption of 12.3 kWh per day was also 78% higher compared to the average EV driver. Reasons for this higher usage include longer commute distances than average for two participants, a higher proportion of commuters (9 of 11 LRBEVs were commuters), and a smaller LRBEV sample size potentially skewing the results somewhat. LRBEV drivers also averaged 5.6 sessions per week, compared to shorter range BEV drivers that averaged 4.9 sessions per week. This subset of the EV fleet is important and will likely grow as auto manufacturers supply more LRBEV models with larger batteries and longer driving ranges in the future.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.35	0.27	0.37	0.55	0.52	0.39	0.19	0.13	0.1	0.09	0.11	0.13	0.15	0.22	0.34	0.63	0.92	1.44	1.32	1.14	0.96	0.84	0.67	0.51
Weekend	0.44	0.32	0.33	0.45	0.36	0.29	0.14	0.14	0.11	0.18	0.21	0.28	0.35	0.38	0.45	0.55	0.61	0.65	0.66	0.61	0.63	0.66	0.6	0.46

Figure 48. Residential long range BEV aggregate load profile

Residential Charging Sessions by Commuter Type

Residential session data was analyzed by examining the charge times, connection time, and the energy consumed in each of the four driver categories. Of the 36,281 sessions logged by all four commuter types, BEV commuters logged 47% of the sessions, followed by PHEV commuters at 36%, PHEV non-commuter at 13%, and finally BEV non-commuters at 4%.

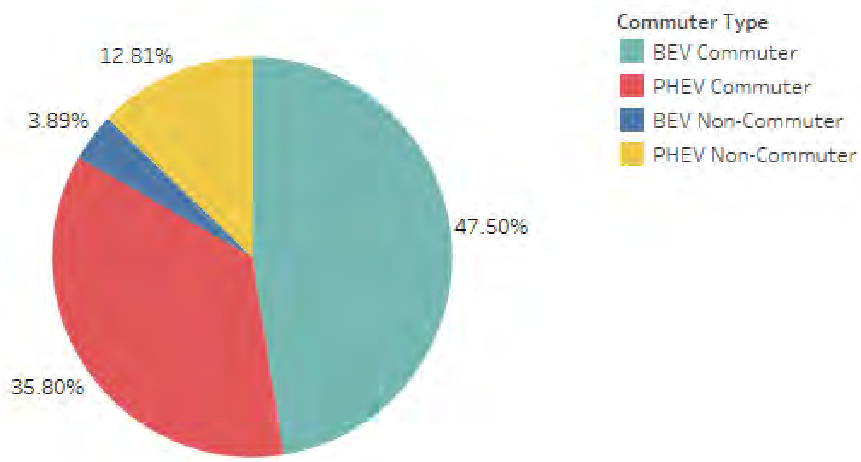


Figure 49. Residential Sessions by Commuter Type

Analysis of connection time revealed average times ranging from 9.4 hours to 11 hours with BEV commuters displaying the highest average connection time, and BEV non-commuters displaying the lowest average connection time.

Residential Session EVSE Connection Duration by Commuter Type

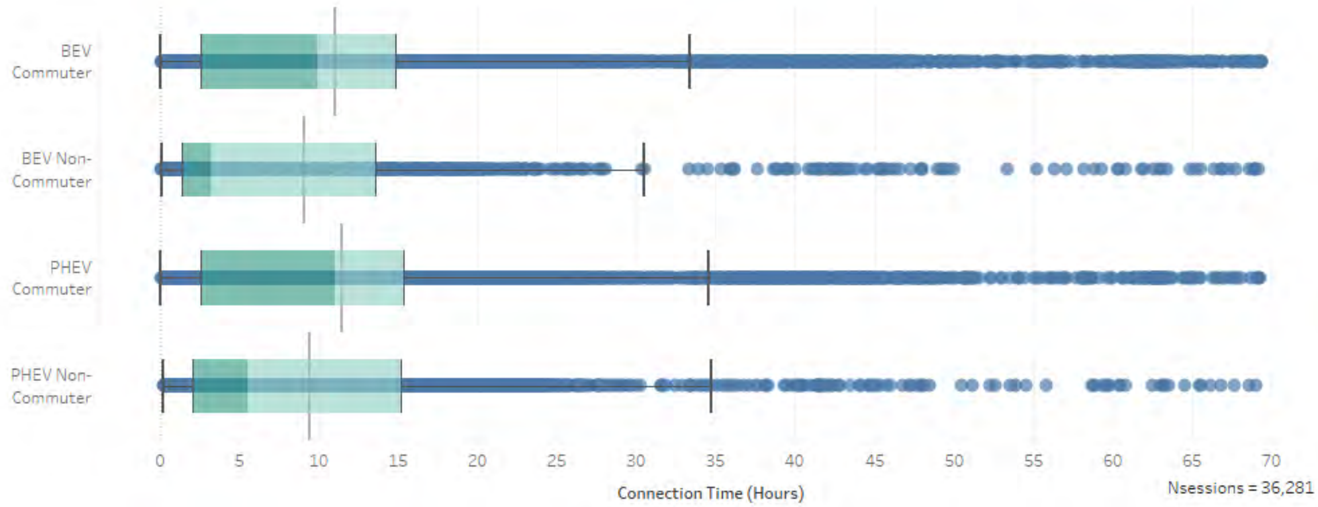


Figure 50. Residential EVSE Session Connection Duration by Commuter Type

The Average charge time ranged between 1.9 hours and 3 hours, with BEV Commuters displaying the longest average charge time and PHEV Non-Commuters the shortest.

Residential Session Charge Duration by Driver Type

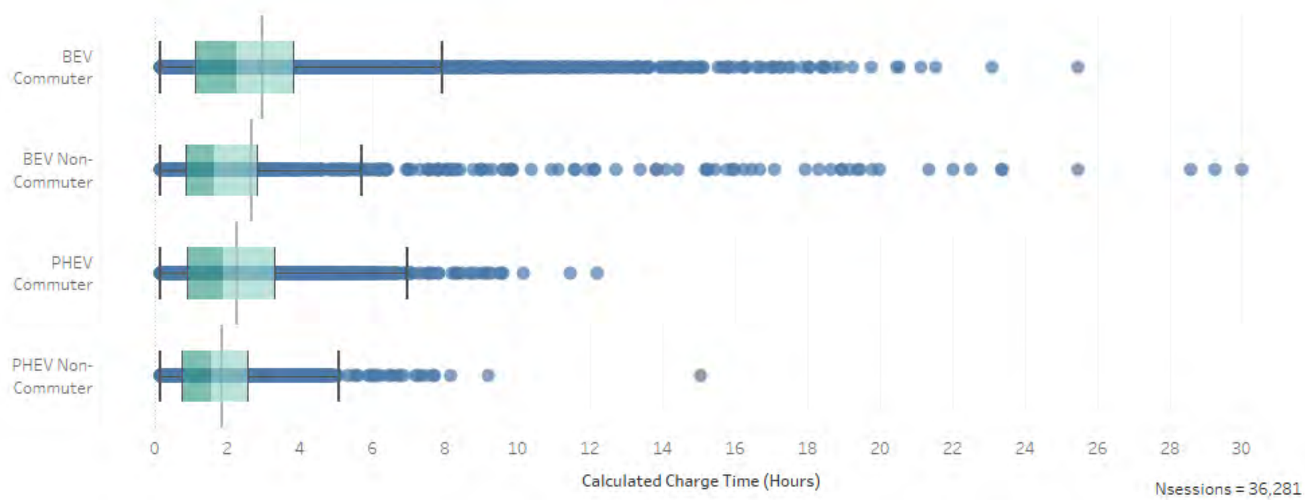


Figure 51. Residential EVSE Session Charge Duration by Driver Type

Considering session energy usage, on average BEV drivers consume more energy than PHEV drivers, and commuters consume more than non-commuters. Increased session energy usage can be attributed to greater average distances per trip logged by BEV and PHEV commuters. According to responses from quarterly surveys, BEV and PHEV commuters tend to drive on average 9 miles more than non-commuters per day.

Residential Session Energy Usage by Driver Type

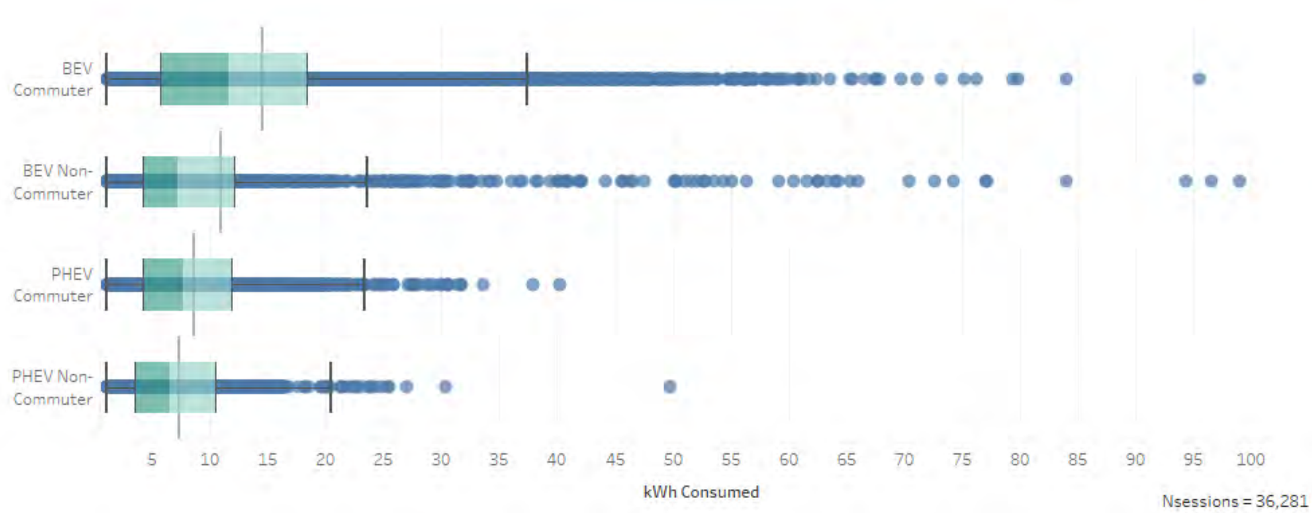


Figure 52. Residential EVSE Session Energy Provided by Driver Type

On average BEV non-commuters consume the most average energy at 14.6 kWh per charge session followed by the next highest average from BEV commuters at 11 kWh per session. PHEV commuters and non-commuters have lower average energy consumption rates of 8.5 kWh and 7.3 kWh respectively.

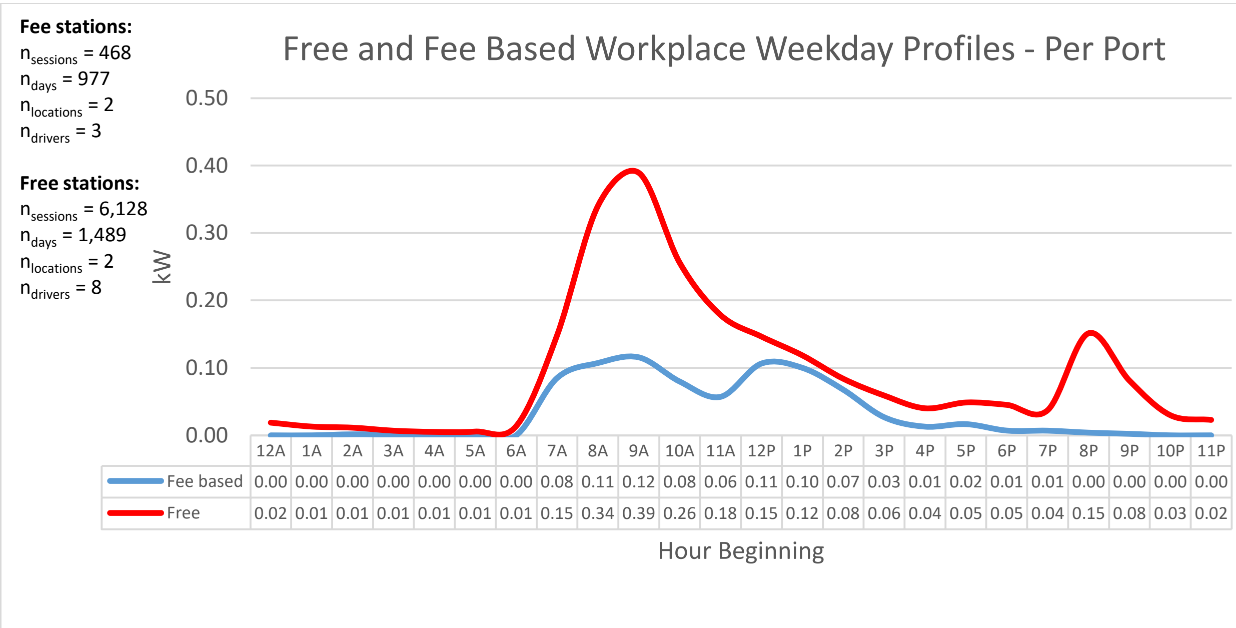
Commercial AC Level 2 EVSE

Workplace charging is the largest of the four commercial components in Avista's pilot project with 50 charging sites and a total of 123 L2 ports. Of these, 97% of ports require no fee for employees to charge their EVs while at work. When surveyed, multiple employers commented that they saw the charging station as a low cost benefit for employees. Averaged among all workplace stations in the Avista network, electricity consumption per workplace charging session was 8.7 kWh. This equates to $0.96 per session in electricity billing to the employer. Each employee charged an average of 17 times per month at work, resulting in an electricity cost of under $17 per month, per employee. This in turn provides a leveraged benefit for employees of over 3x transportation cost savings as well as a 79% reduction of CO_2 emissions compared to driving a vehicle powered by gasoline.[37]

Only two charging locations on the network require a fee for workplace charging, in both cases choosing a fee of $0.13 per kWh intended to offset the cost of meter billing. Comparing these fee-based sites with two other similar free sites, all with active commuters, shows that free sites have significantly higher weekday usage at 2.4 kWh per port compared to 0.8 kWh per port for the fee-based sites. As a result of

[37]Assuming 26 mpg and $3/gal for fuel costs, cost of driving 100 miles is $11.55 for gasoline powered passenger vehicle. At $.12 / kWh and 3.29 mi/kWh, driving 100 miles electric is $3.65 (3.2x cost savings). 4.9 tons of CO2 annually for gasoline vehicles vs 1.0 tons of CO2 annually for EVs from Avista Corp generation mix, at 0.27 metric tons of CO2 per MWh compared to 19.4 pounds of CO2 per gallon of gasoline https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

higher utilization, morning peaks are higher by more than three times (0.4 kW vs 0.1 kW) during the 9am hour for the free station group.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Fee based	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.08	0.11	0.12	0.08	0.06	0.11	0.10	0.07	0.03	0.01	0.02	0.01	0.01	0.00	0.00	0.00	0.00
Free	0.02	0.01	0.01	0.01	0.01	0.01	0.01	0.15	0.34	0.39	0.26	0.18	0.15	0.12	0.08	0.06	0.04	0.05	0.05	0.04	0.15	0.08	0.03	0.02

Figure 53. Comparison of fee-based and free workplace load profiles

As expected, the 178 sessions per year at each free port was much higher than the 21 sessions per year for each fee-based port. Even given the small sample size of fee-based ports, the implication is that fee-based charging significantly reduces the utilization of workplace EVSE.

Workplace charging is a major catalyst for EV adoption and was the most popular of the commercial programs offered by the Company. Avista workplace EVSEs logged 8,675 workplace charge sessions. Of the 8,675 charge sessions occurring at workplace chargers, 5,667 sessions, or 65% are logged by "visitors" – those not participating in the program with a networked residential EVSE installed at their home. Some of these visitors have non-networked EVSE at home and others do not have any EVSE at home, to an unknown degree.

Workplace Charging for Avista Residential Pilot Program Participant Vs. Non-Participant

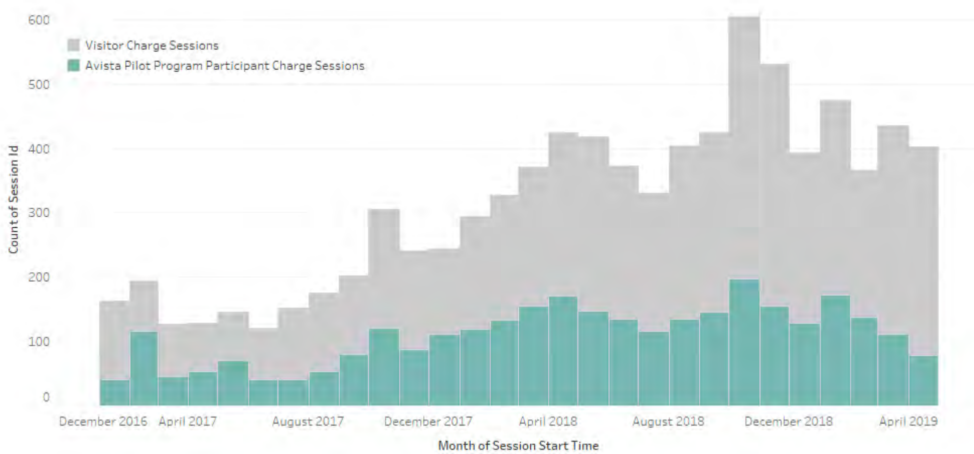
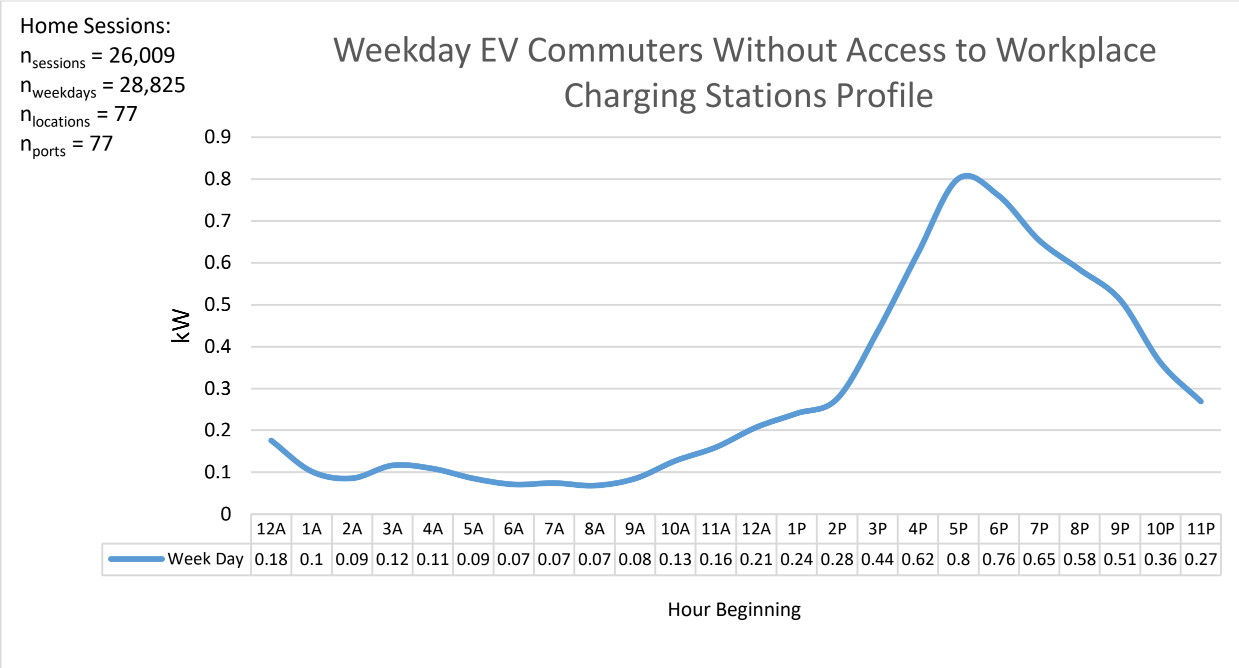


Figure 54. Public EVSE Session Useage

Data from 12 drivers had both home and workplace networked EVSE that were consistently online and transmitting data from both locations. The 12 drivers within this sample group logged 2,571 charging sessions and used 23,253 kWh at workplace chargers over 5,596 operating days. These participants also logged 4,013 charge sessions consuming 30,626 kWh of energy over 6,169 operating days of residential charging sessions. When aggregated into a daily load profile, workplace charging peaks at 0.64 kW per vehicle and residential charging peaks at 0.54 kW per vehicle. See Appendix E for charge session data distributions for connection time, charge time, and energy usage of this subset group. Drivers with networked EVSE at home who did not utilize workplace EVSE logged 26,009 days of charge sessions at home, resulting in 195,311 kWh of energy consumed.

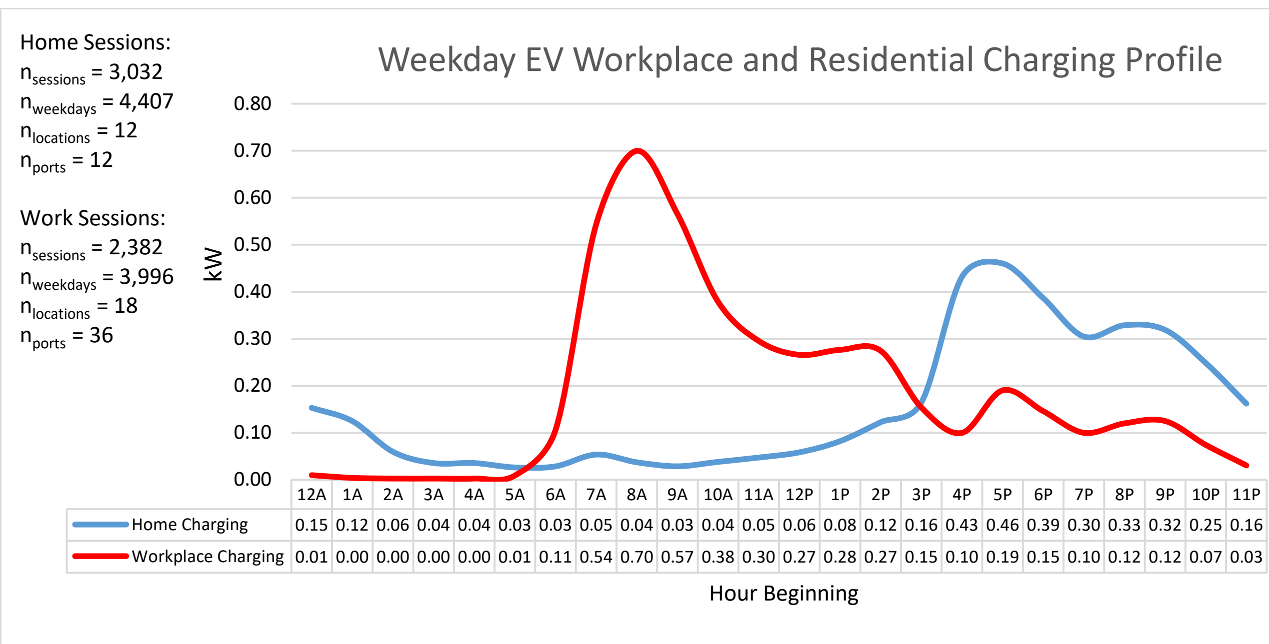
To understand how workplace charging can impact the grid, we consider energy consumption from commuters with and without workplace charging availability. Commuters without workplace charging are limited to their home and a small number of public EVSE. Data shows most charging for this group occurs between 4pm and 8pm, creating a daily peak of 0.8 kW per EV between 5pm and 6pm.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12A	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Week Day	0.18	0.1	0.09	0.12	0.11	0.09	0.07	0.07	0.07	0.08	0.13	0.16	0.21	0.24	0.28	0.44	0.62	0.8	0.76	0.65	0.58	0.51	0.36	0.27

Figure 55. Residential Only Commuters Weekday Charge Profile

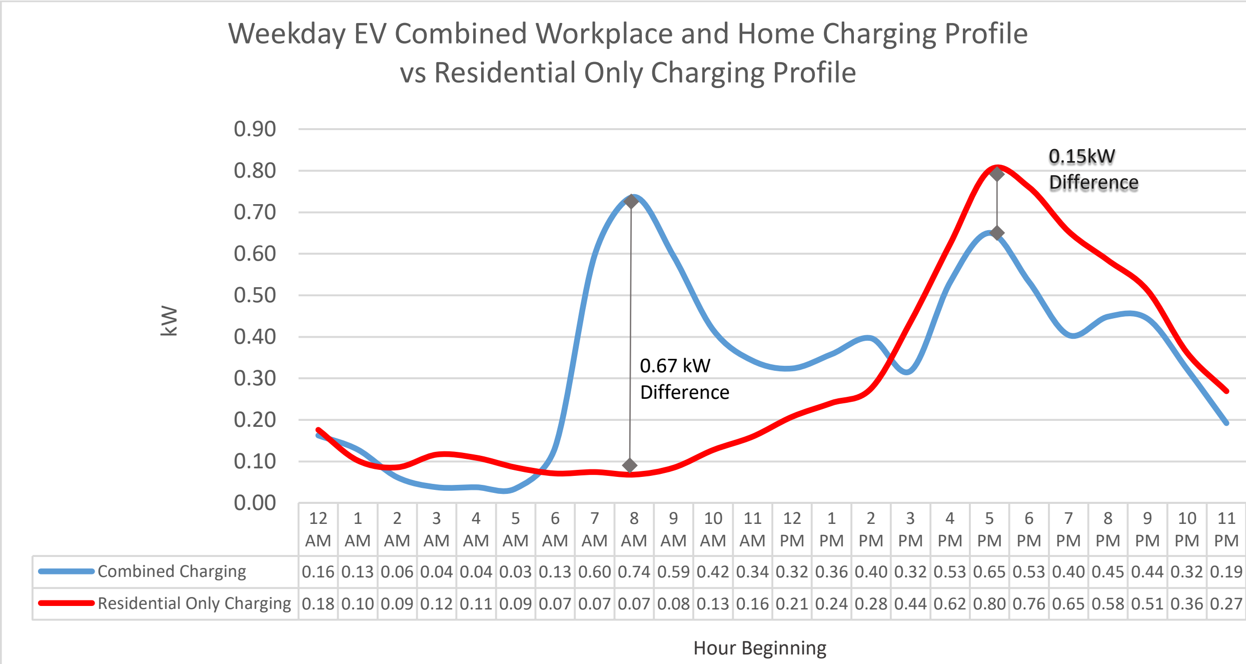
Commuters with workplace charging create two peaks during an average workday. The highest peak of 0.7 kW occurs at workplace chargers at 8 am, with a second smaller peak of 0.46 kW occurring at home, at 5 pm.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Home Charging	0.15	0.12	0.06	0.04	0.04	0.03	0.03	0.05	0.04	0.03	0.04	0.05	0.06	0.08	0.12	0.16	0.43	0.46	0.39	0.30	0.33	0.32	0.25	0.16
Workplace Charging	0.01	0.00	0.00	0.00	0.00	0.01	0.11	0.54	0.70	0.57	0.38	0.30	0.27	0.28	0.27	0.15	0.10	0.19	0.15	0.10	0.12	0.12	0.07	0.03

Figure 56. Workplace Charger Sample Group: Workplace and Residential Charging Profile

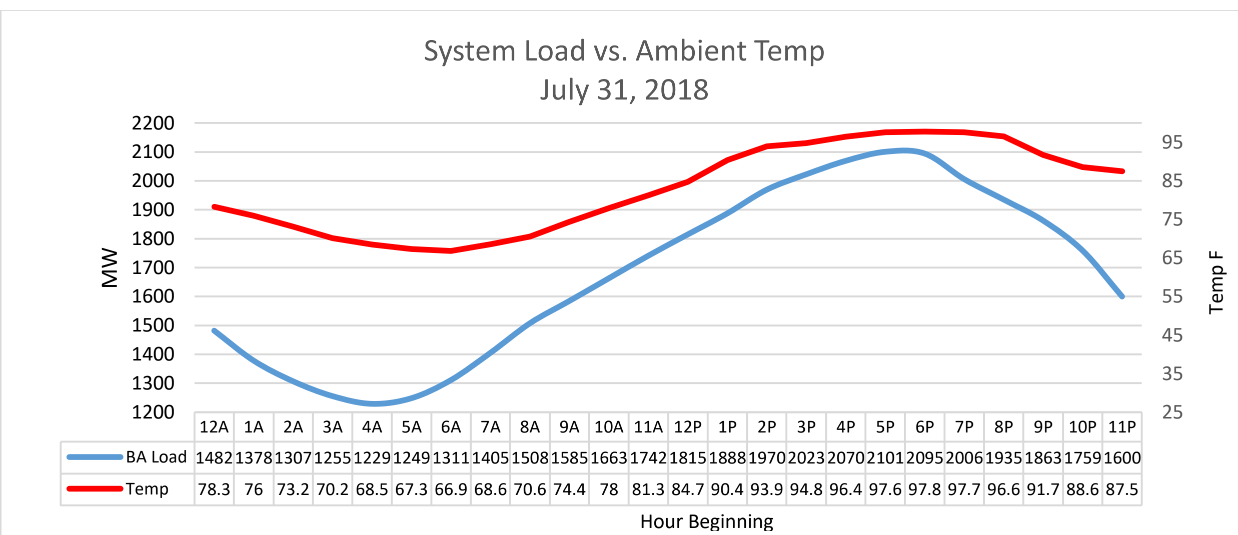
As a result, the availability and use of workplace chargers reduces the average residential peak demand by 0.15 kW in the evening, but also increases the morning peak by 0.63 kW.



	12 AM	1 AM	2 AM	3 AM	4 AM	5 AM	6 AM	7 AM	8 AM	9 AM	10 AM	11 AM	12 PM	1 PM	2 PM	3 PM	4 PM	5 PM	6 PM	7 PM	8 PM	9 PM	10 PM	11 PM
Combined Charging	0.16	0.13	0.06	0.04	0.04	0.03	0.13	0.60	0.74	0.59	0.42	0.34	0.32	0.36	0.40	0.32	0.53	0.65	0.53	0.40	0.45	0.44	0.32	0.19
Residential Only Charging	0.18	0.10	0.09	0.12	0.11	0.09	0.07	0.07	0.07	0.08	0.13	0.16	0.21	0.24	0.28	0.44	0.62	0.80	0.76	0.65	0.58	0.51	0.36	0.27

Figure 57: Workplace charging effect on residential charging

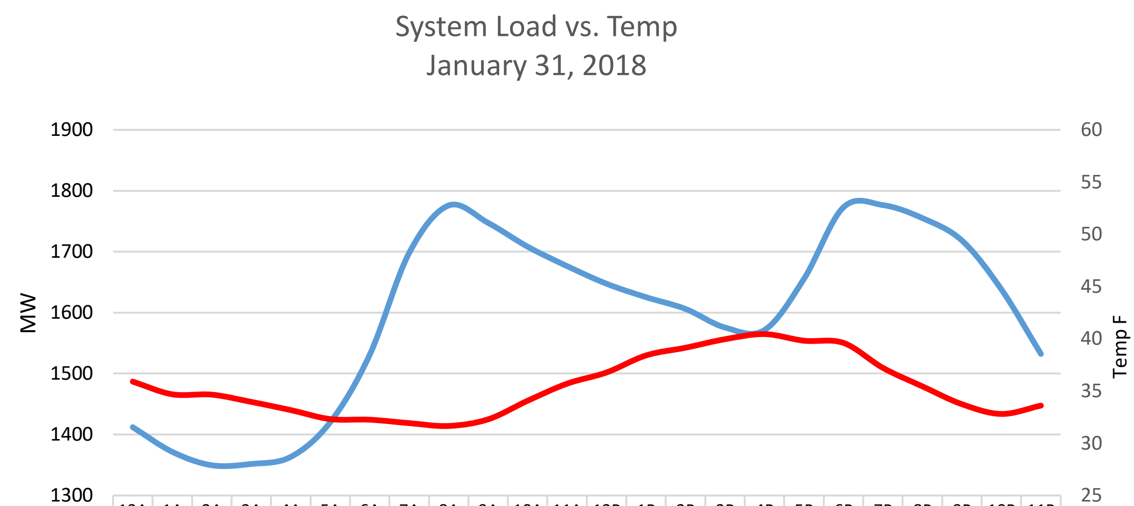
From spring through summer and fall, Avista's system peaks between the hours of 3pm to 7pm, while in the winter it peaks both in the morning between 7am and 10am, and in the evening between 5pm and 8pm. When compared to seasonal peak system demand it can be argued that workplace charging provides an automatic system benefit year-round in the evening, by reducing evening EV peak demand by 19%, even in the absence of networked EVSE and load management, TOU rates, or other methods to influence EV load.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
BA Load	1482	1378	1307	1255	1229	1249	1311	1405	1508	1585	1663	1742	1815	1888	1970	2023	2070	2101	2095	2006	1935	1863	1759	1600
Temp	78.3	76	73.2	70.2	68.5	67.3	66.9	68.6	70.6	74.4	78	81.3	84.7	90.4	93.9	94.8	96.4	97.6	97.8	97.7	96.6	91.7	88.6	87.5

Figure 58. System Load Vs Ambient Temperature, July 31, 2018

However, the use of workplace chargers also creates an average demand of 0.74 kW per EV at 8am, coinciding with the winter morning peak and 0.67 kW higher than the weekday residential load profile alone from customers without workplace charging. Workplace charging peaks could be reduced through load management and the use of EVSE with lower power output, e.g. using 3.3kW output instead of the 6.6kW used in the pilot would cut the peak load in half. Even without further peak reductions from the load profiles shown, modeling indicates that over the long term workplace charging in addition to residential charging provides net grid benefits greater than residential alone. This benefit increases over time with the expected increase in solar generation as WA moves toward 100% clean energy, as EVs can utilize additional solar power during the day if charging at workplace locations.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
BA Load	1412	1372	1350	1352	1363	1420	1531	1698	1776	1747	1708	1676	1647	1625	1606	1576	1571	1655	1773	1777	1755	1718	1638	1532
Temp	35.9	34.7	34.7	34	33.2	32.3	32.3	31.9	31.7	32.3	34.1	35.7	36.8	38.4	39.1	40	40.4	39.8	39.6	37.2	35.4	33.7	32.8	33.6

Hour Beginning

Figure 59. System Load vs. Ambient Temperature January 31, 2018

Fleet Analysis

Regionally, commercial fleet EVs are a relatively small component of the light-duty market. Participants utilizing a total of 14 fleet EVs included government, social services and healthcare organizations. Growth potential is apparent, as 74% of commercial applicants (28 of 38), indicated they would be interested in EVs for future fleet use.

Within the fleet program, five of the ten locations have networked EVSEs, providing insights on charging session characteristics, load profiles and cost savings. Daily energy demand for fleet EVs ranged from 1.5 kWh to 11.3 kWh per EV, corresponding to high variability in daily driving. Load profiles were similar to each other with demand peaking between 4pm – 8pm. The highest average daily demand occurred during the 6pm hour at 1.4 kW. Note that this is the average daily demand per EV at the location, as opposed to usage on a per EVSE port basis.

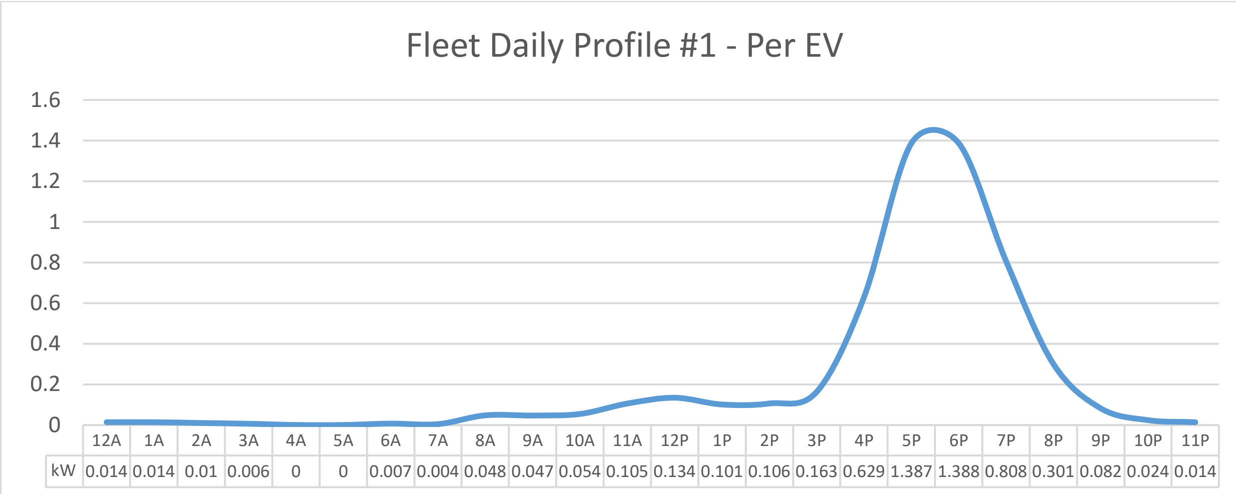


Figure 60. Daily fleet load profile at a single location

Based on load profiles, fleet EVs resulted in an avoided 68 to 524 gallons of fuel per EV, with fuel cost savings and reduced emissions. At $3.00 per gallon of gas and $0.115 per kWh, fleet vehicles driving approximately 3,250 to 13,600 miles annually saw fuel savings per EV of between $178 and $1,378. At the highest usage location, a fleet of four EVs saved over $5,512 per year in fuel costs, avoiding 2,472 gallons of gasoline consumption and 24 tons of CO_2 emissions.[38]

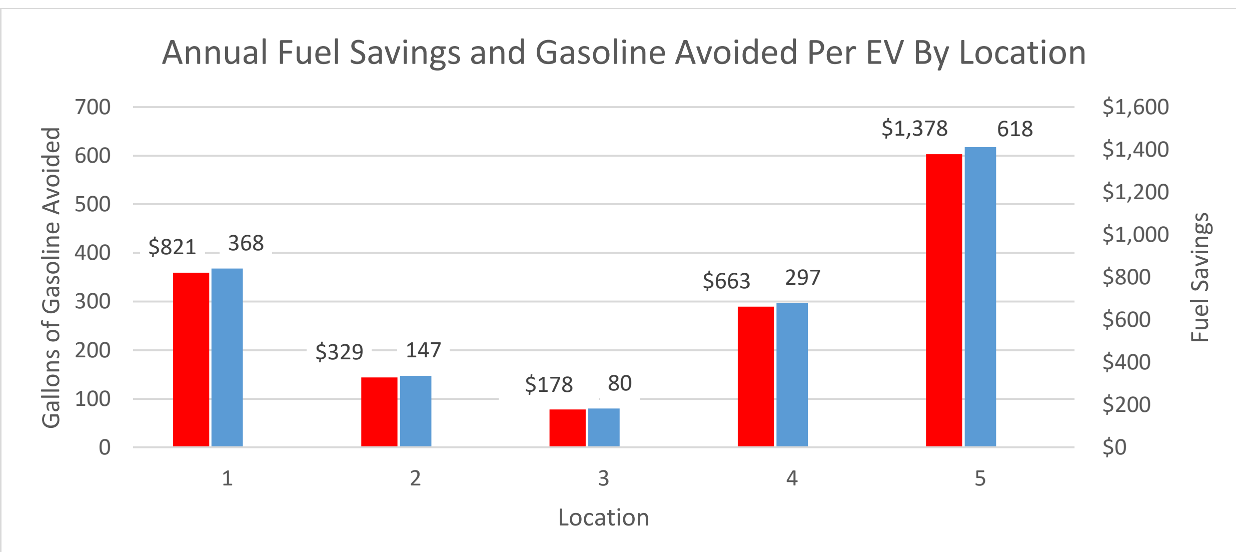
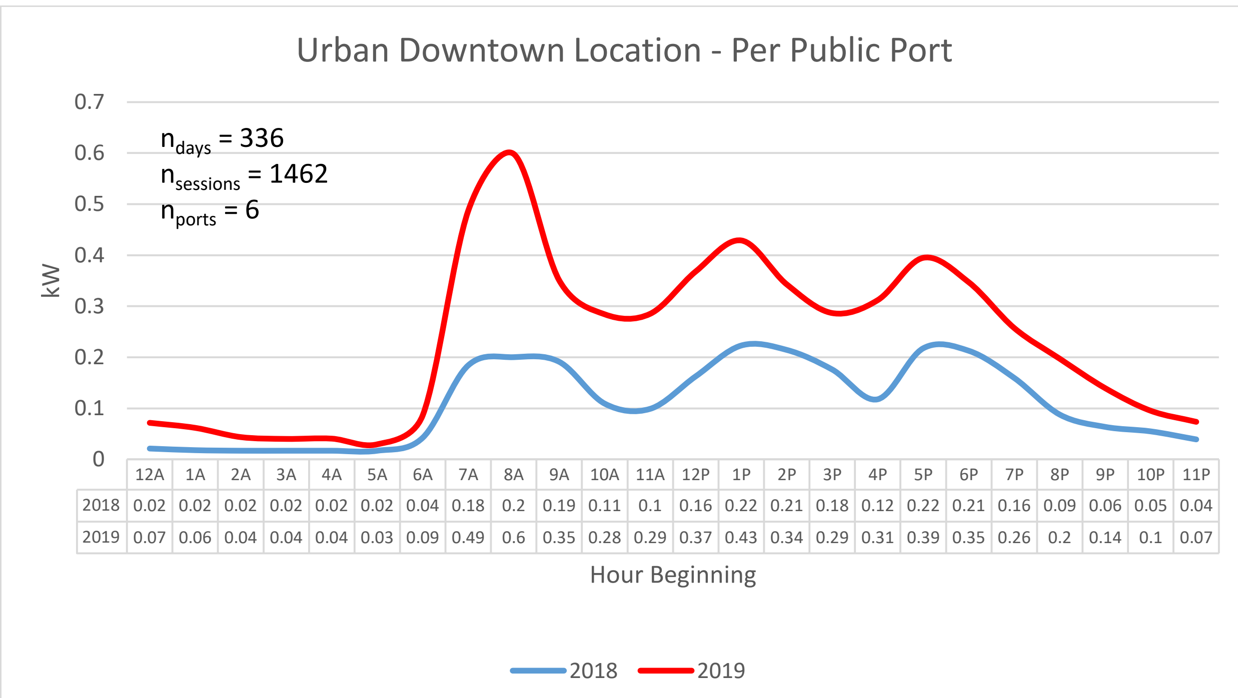


Figure 61. Fleet fuel savings and gasoline avoided per EV, at various locations

[38]At 19.4 pounds of CO2 per gas gallon * 2,472 gas gallons = 47,957 pounds of CO2 https://www.epa.gov/energy/greenhouse-gases-equivalencies-calculator-calculations-and-references

Public Analysis

Thus far, data shows low utilization of public EVSE in terms of both charging frequency and dispensed energy. Nevertheless, it is clear that public EVSE have great value and importance in the minds of EV drivers. For example, driver surveys showed 78% dissatisfaction with the availability of public charging and suggested more public installations are needed near shopping centers and along highways in outlying areas. Avista installed 24 public ports at 14 stations in rural areas near regional highways, and 16 ports in six higher traffic retail locations in Spokane. Public EVSE outside the Avista network has grown very slowly, with only three locations outside Spokane. Utilization and loads will vary substantially by location and can be expected to grow over time with higher EV adoption, as illustrated by the various load profiles in Appendix D. The high traffic downtown location shown below provides an example of this growth, more than doubling in one year.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
2018	0.02	0.02	0.02	0.02	0.02	0.02	0.04	0.18	0.2	0.19	0.11	0.1	0.16	0.22	0.21	0.18	0.12	0.22	0.21	0.16	0.09	0.06	0.05	0.04
2019	0.07	0.06	0.04	0.04	0.04	0.03	0.09	0.49	0.6	0.35	0.28	0.29	0.37	0.43	0.34	0.29	0.31	0.39	0.35	0.26	0.2	0.14	0.1	0.07

Figure 62. Load growth at downtown public location

At this public location, increased morning use is actually correlated with “workplace” charging for two employees that park during the day, in addition to an over 50% increase in the number of discrete drivers and frequency of “public” charging events lasting less than three hours.

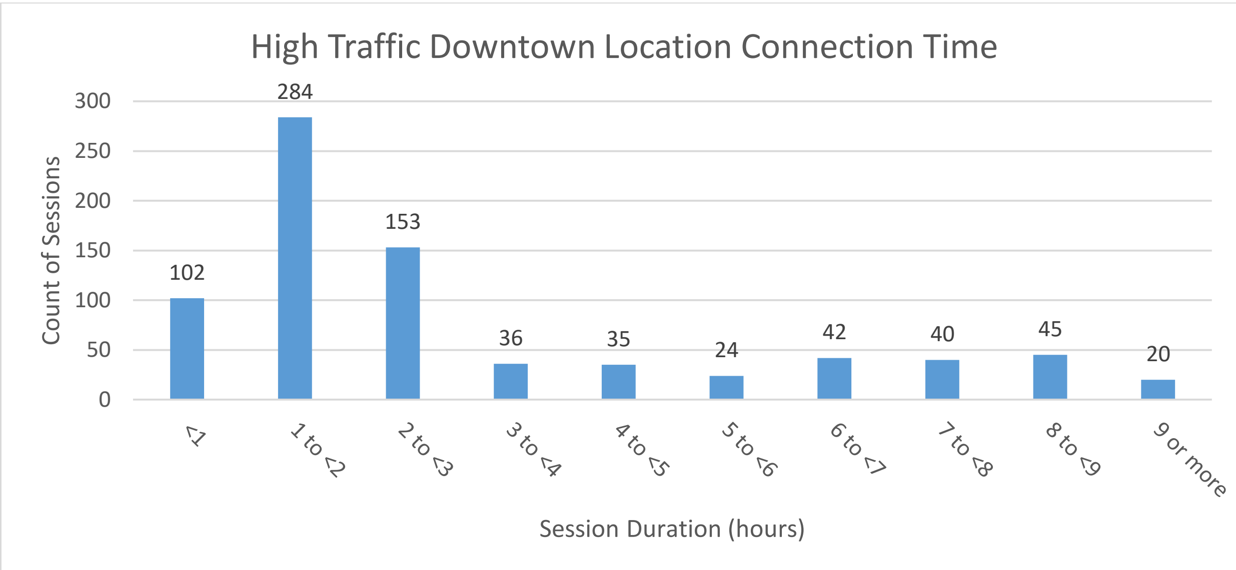


Figure 63. Public station dwell time at downtown location

At public locations, there has been a steady increase of charge sessions completed by individuals not participating in the EVSE Pilot Program. Of the 53,356 sessions recorded during the pilot program, 14,218 or 26% of all sessions were logged by visitors.

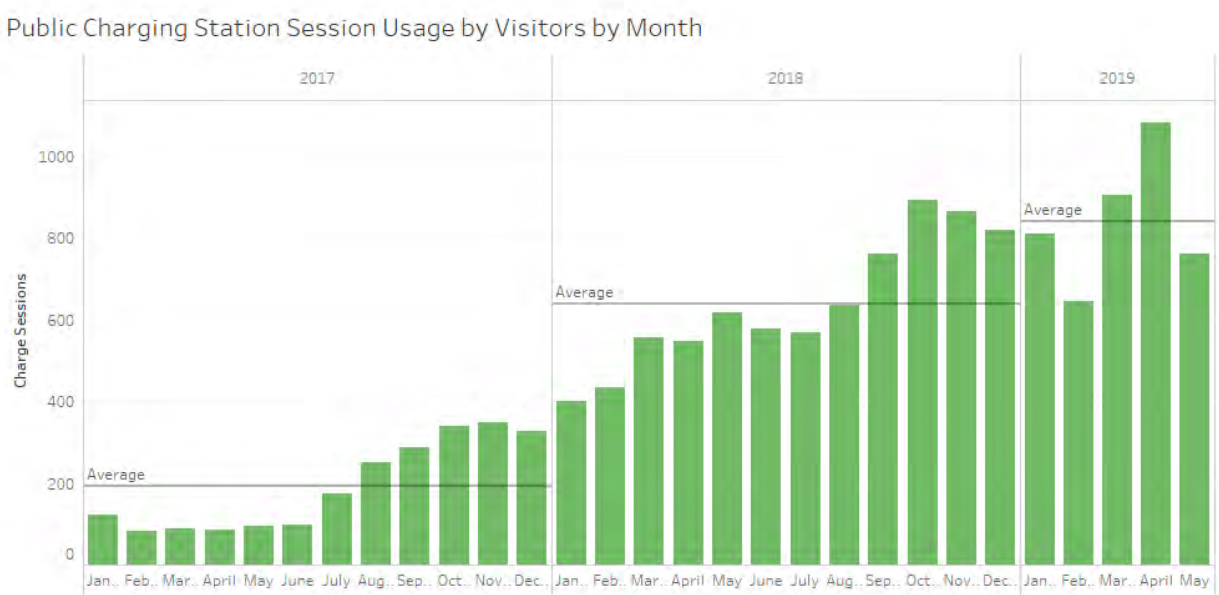
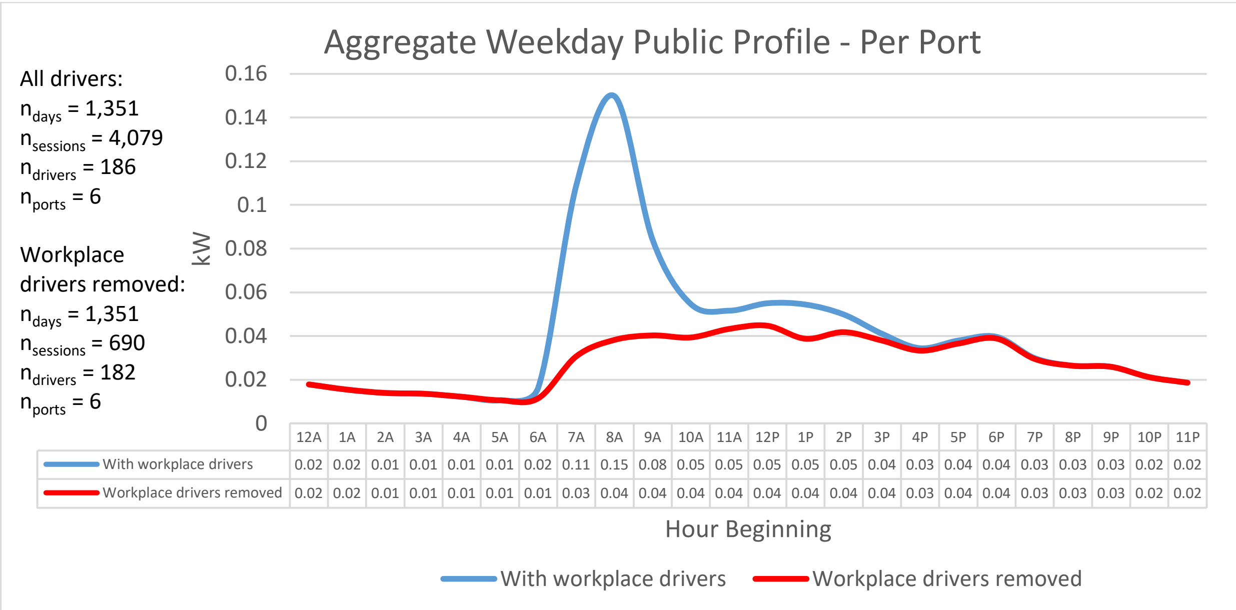


Figure 64. Public Charging Station Usage by Visitors by Month

Due to relatively low impact of station operating expenses resulting from low electricity costs and regional EV adoption, site hosts have almost entirely opted to free use of public charging, which may be expected to change in the future as utilization increases.

Looking more closely at three public stations in the Spokane area located near businesses with EV commuters, just four EV commuters out of a total of 186 visitors to these locations caused morning peak demand to increase 375% to 0.15 kW, compared to 0.04 kW without the commuters. Depending on site host objectives, a networked EVSE may be used to require an energy fee, time-based fees and limit penalties, and permission controls.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
With workplace drivers	0.02	0.02	0.01	0.01	0.01	0.01	0.02	0.11	0.15	0.08	0.05	0.05	0.05	0.05	0.05	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.02	0.02
Workplace drivers removed	0.02	0.02	0.01	0.01	0.01	0.01	0.01	0.03	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.03	0.04	0.04	0.03	0.03	0.03	0.02	0.02

Figure 65. Workplace driver charging implact at public station

DC Fast Charging

DCFC utilization varies significantly from site to site. Kendall Yards remains the most utilized, due to its location in the urban core of Spokane and along main East/West and North/South travel corridors. Other sites such as Rosalia are less utilized due to their distance from population centers, however they are of great value in enabling longer distance EV driving due to their strategic locations along inter-city travel corridors. The table below shows monthly DCFC charging sessions at each site, which grew by 19% in the last year. Increasing utilization is expected in the future, commensurate with greater EV adoption in the area. Note that downtime issues resulted in lower utilization in early 2019 for the West Plains, Pullman and Wandermere sites.

Table 14: Monthly DCFC sessions

Month	Rosalia	Kendall Yards	Pullman	Liberty Lake	Wander-mere	West Plains	U-District / GU
Commissioned	1/18/2017	9/14/2017	12/15/2017	1/12/2018	9/14/2018	9/18/2018	7/12/2019
Jan-Dec 2017	64	38	2	-	-	-	-
Jan-Dec 2018	55	179	86	99	61	14	-
Jan-2019	4	23	9	7	23	0	-
Feb	10	12	3	12	6	1	-
March	4	34	1	6	2	5	-
April	8	29	7	2	9	2	-
May	3	25	3	3	22	21	-
June	9	32	9	15	8	11	-
July	2	24	10	9	3	10	-
Total	157	396	130	153	134	64	-

Analysis of DCFC charging sessions using one-minute interval data shows a rapid ramp-up period to the maximum power level where it plateaus, between 20kW and 50 kW, followed by a longer ramp-down period that reduces the power level as the battery nears full capacity. DCFC connection and charging times are often the same, as the driver unplugs the vehicle when satisfied with the charge level rather than wait for a much longer period through the ramp-down phase to 100% state-of-charge. These observations are illustrated below, for one week of charging sessions at the Kendall Yards DCFC site.

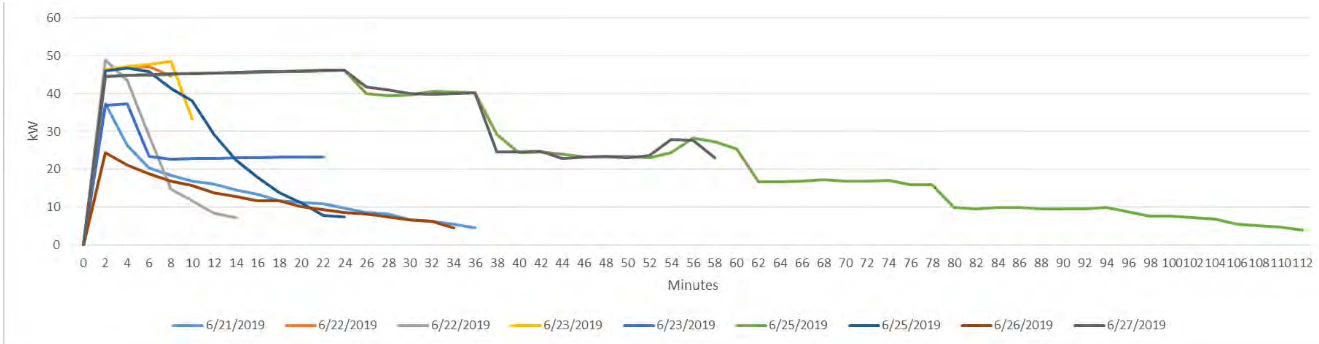


Figure 66: DCFC charging session load profiles

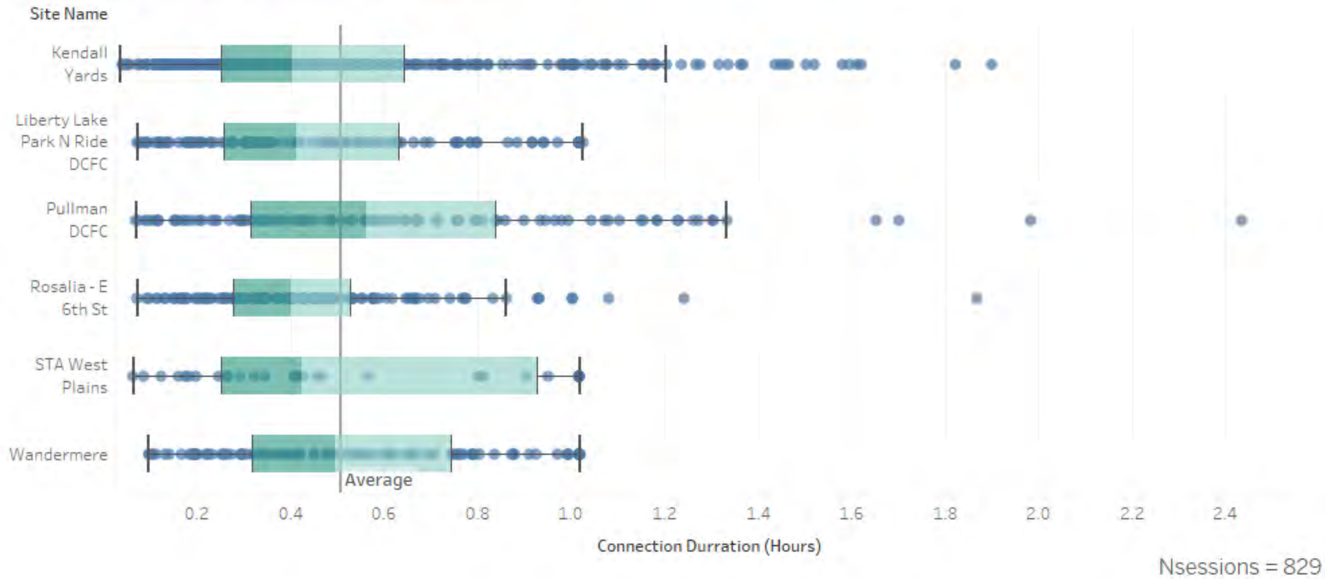
DCFC charging power may be limited by the EV and its battery state-of-charge, such that the delivered power level is often much less than the DCFC rating of 50kW. Accordingly, DCFC user fees should be applied on a per kWh basis, at least until the battery is well into its ramp-down period. Otherwise drivers that unavoidably draw lower power levels may pay unacceptably high rates, if charged on a per minute basis. With the extension of the pilot program in early 2018, DCFC fees were changed from $0.30/minute to $0.35/kWh, which is roughly equivalent to the cost of gasoline in terms of fuel cost per mile of driving range. This change received positive feedback from EV drivers and correlated with higher DCFC utilization thereafter. Beyond the ramp down period however, fees applied on a time basis and/or penalties for time beyond certain thresholds – at 60 minutes for example – may be necessary to free up the DCFC and avoid unnecessary wait times for other drivers.

Average energy consumption of 13.6 kWh per DCFC charging session was higher than all ACL2 types. The majority of charging times were between 15 and 45 minutes, averaging just over 30 minutes. Box plots of the DCFC session data show a fair amount of variability between the different DCFC sites, in terms of connection time and energy consumption.

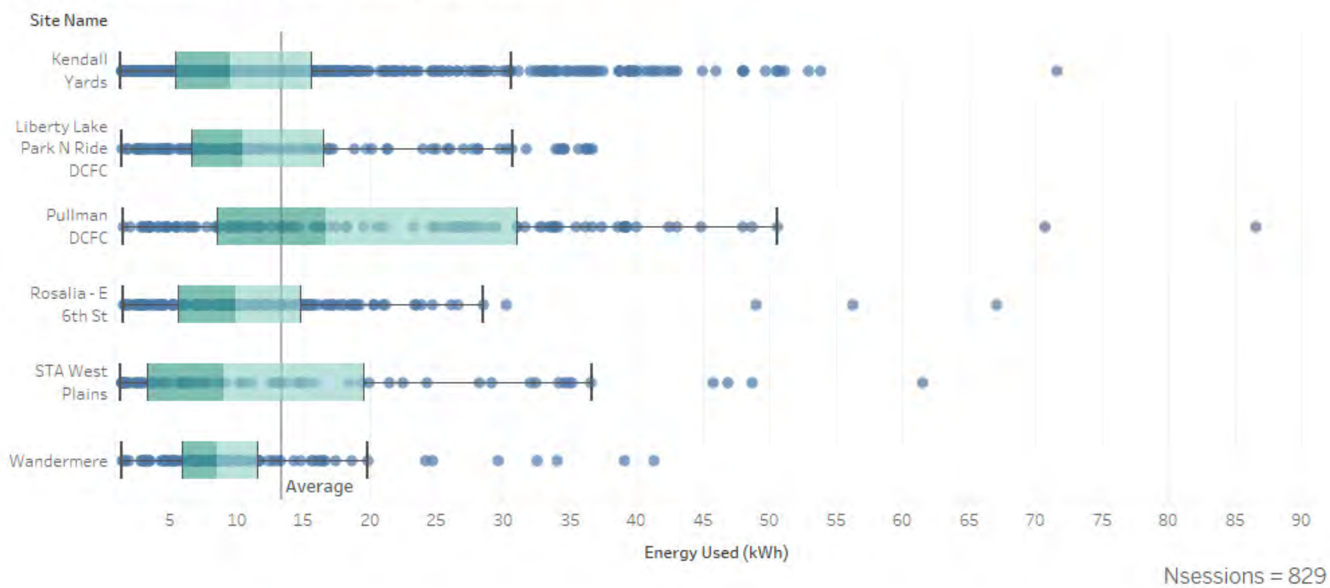
average kWh per session	13.6
average minutes per session	30.2
average revenue per session	$5.05

Table 15: DCFC session statistics, Jan2017 - May2019

DCFC Session Connection Time Duration



Energy Use (kWh) for DCFC Charge Session



By intent, three DCFC were installed with credit card readers, and four were installed without them to test customer use and preferences. To date, no customer complaints or suggestions have been received regarding the lack of credit cards on the four without them. At these stations, charging is initiated by either the EVSP smartphone app or an RFID card loaded with the customer's credit card information. For the three DCFC with credit card readers, 57% of charging sessions were initiated by the smartphone app or RFID, and 43% by credit card swipe. Note that unique customer ID cannot be captured in the network dataset when initiating by credit card, limiting the ability to understand individual charging patterns across the network.

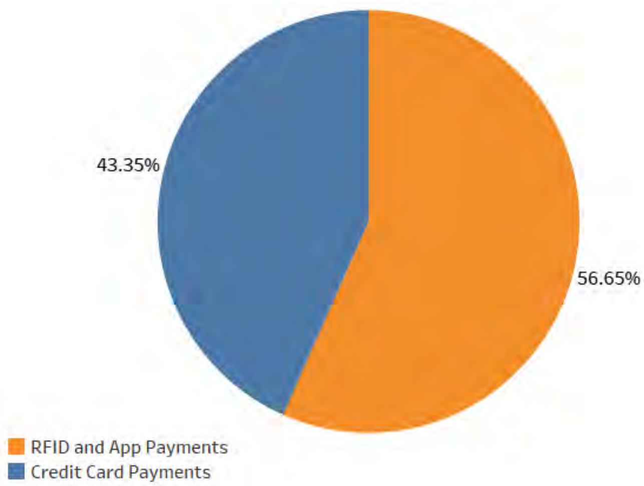


Figure 67: Credit card vs. RFID and Smartphone app payments at DCFC

Telematics Data and Analysis

To better understand driver behaviors and validate Greenlots' EVSE data, several customers participating in Avista's EVSE program agreed to installation of Fleetcarma telematics devices (C2 devices) in their EVs. The telematics device captures charging data, battery state of charge, battery efficiency, trip distance and speed, as well as energy losses from rectification and auxiliary loads.

Telematics devices were installed on 9 different vehicles. The use of these vehicles ranged from regular commuters, non-commuters, and fleet vehicles. Total trip break downs for these vehicles are as follows:

Table 16: Number of Trips per Vehicle Type and Make/Model

	Chevy Bolt	Nissan Leaf	Tesla Model S	Mitsubishi Outlander	Hyundai Sonata	Chevy Volt	Total Trips by Vehicle Type
PHEV Commuter	0	0	0		0	1259	1259
PHEV Non-Commuter	0	0	0	0	2335	0	2335
BEV Commuter	2461	834	4963	0	0	0	8258
BEV Non-Commuter	0	0	0	0	0	0	0
Fleet Vehicles	1358	0	0	1234	0	0	2592
Total Trips per Vehicle	3819	834	4963	1234	2335	1259	14444

Individuals with telematics devices in their vehicles also participated in the EVSE pilot program, providing a set of overlapping session data. 610 sessions were compared between the Greenlots and FleetCarma data sources, showing an average difference in power consumption of 1.6%, and the largest percent difference at 4.2%. A more thorough explanation of the telematics validation is available in Appendix B.

In total, FleetCarma telematics devices recorded 6,437 charge sessions, capturing data on charge duration, energy provided, state of charge at the beginning and end of each session, losses from rectifiers and auxiliary loads, and vehicle location in latitude and longitude coordinates.

Telematics Data: Charge Duration

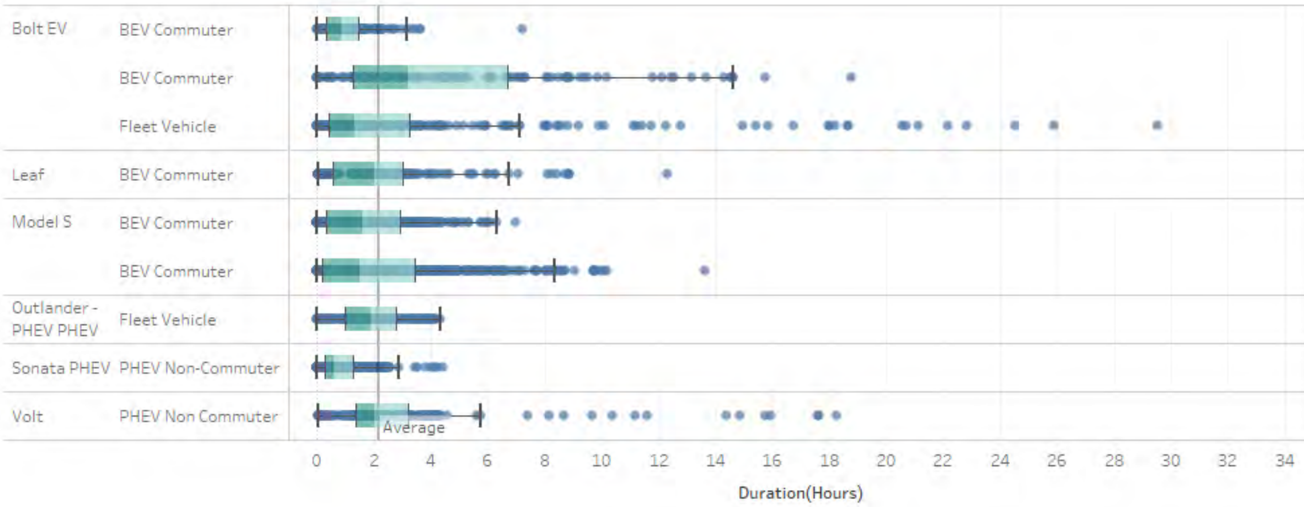


Figure 68. Telematics Data: EVSE Charge Duration

Data from the C2 telematics data shows that the average charge duration is 2.2 hours.

Telematics Data: State of Charge at Beginning of Charge Session

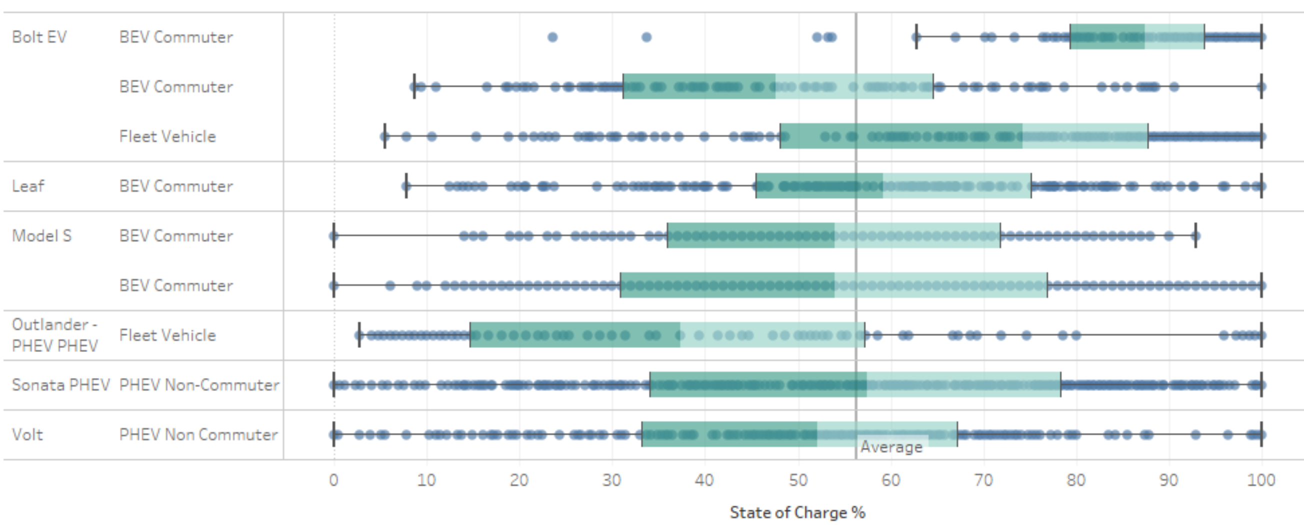


Figure 69. Telematics Data: State of Charge at the Beginning of Charge Session

The state of charge measures the percent of remaining battery power from a 100% full state. The above graph illustrates the different levels of remaining charge when a charging session was initiated. On average, batteries were at 56% state of charge when a session started.

Telematics Data: Energy Provided per Charge Session

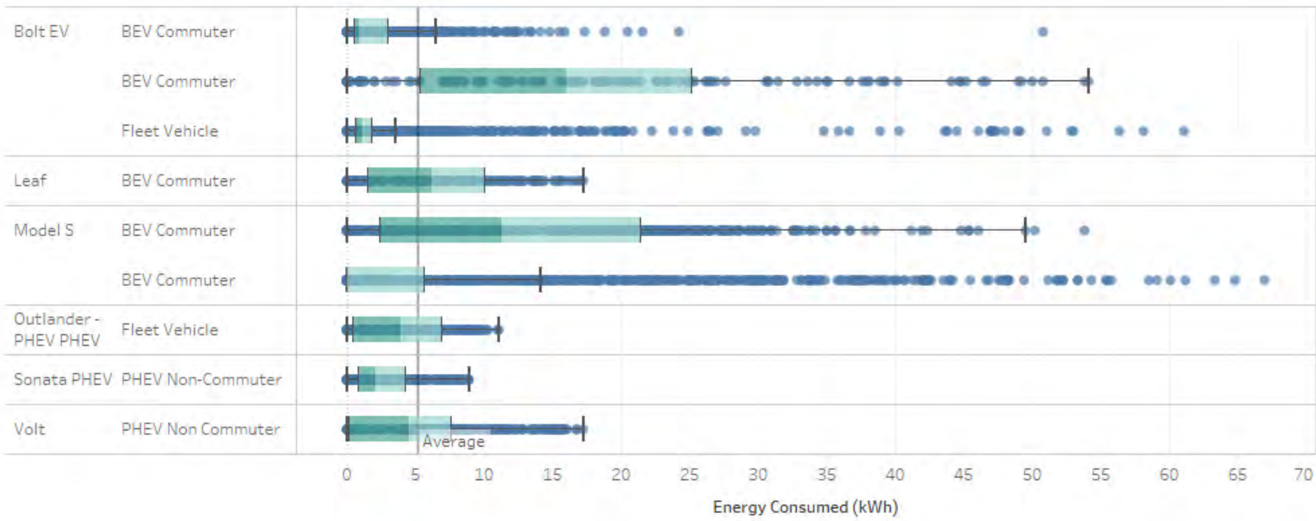


Figure 70. Telematics Data: Energy Provided per Charge Session

The average energy provided per charge session was 9.8 kWh.

Telematics Data: Rectifier Loss per Charge Session

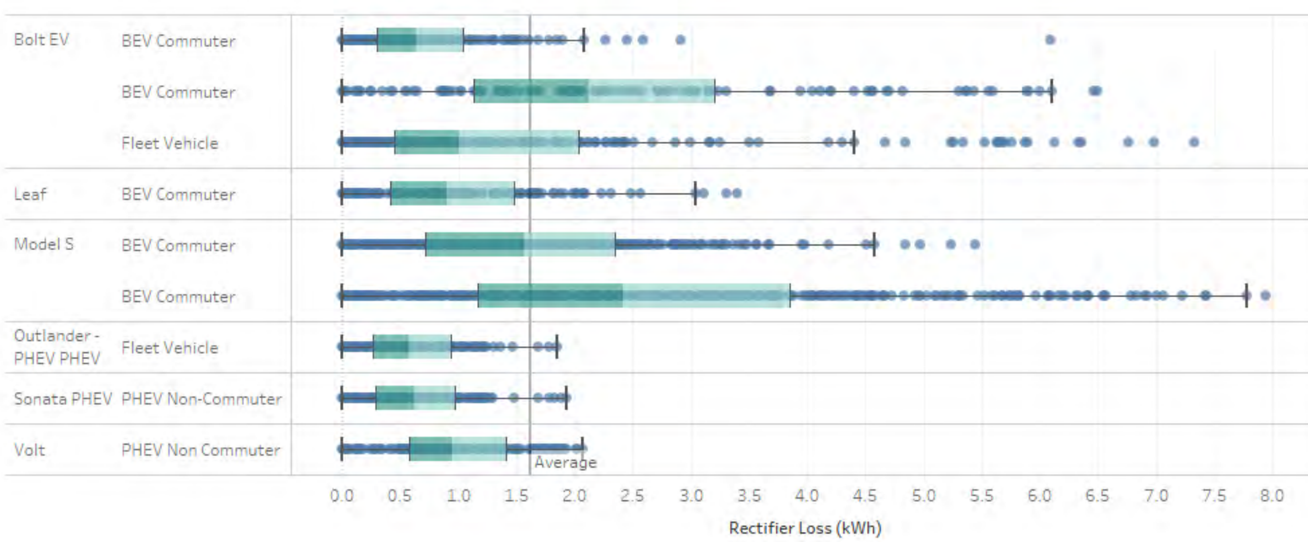


Figure 71. Telematics Data: Rectifier Loss per Charge Session

Finally, telematics provided the energy lost during each charging session. Charge loss is the difference between energy entering the EV charging port and the energy provided to the battery after current rectification, as well as losses resulting from other sources such as accessory electronics, cabin environment controls, and/or battery conditioning when available. According to the C2 data, on average each charging session lost 1.7 kWh, or 13.7% of total energy delivered by the EVSE to rectification and other auxiliary loads.

The C2 devices also recorded location of charging sessions with latitude and longitude coordinates. Location data allowed for the identification of charge sessions that did not occur within the Avista network, which made up 9% of total sessions.

Telematics data allowed for an analysis of battery efficiency in BEVs, with data from 9,406 trips collected. Trip lengths ranged from less than one mile to approximately 196 miles. As shown in the chart below, at shorter trip distances there is a wide range of battery efficiency. This could be due to a combination of regenerative braking, more variability in motor speed, greater idle times, and/or auxiliary components operating at non-steady states. As trip length increases and vehicle functions become less variable, battery efficiency converges between 3 and 4 miles per kWh. When filtering trip distances over 25 miles (264 data points), the average efficiency is 3.35 miles per kWh with a standard deviation of 0.6, which includes the rectifier and EVSE losses. This is an important parameter to use in modeling average EV energy consumption and resulting grid impacts, given assumptions of EVs on the system and annual driving distance per EV.

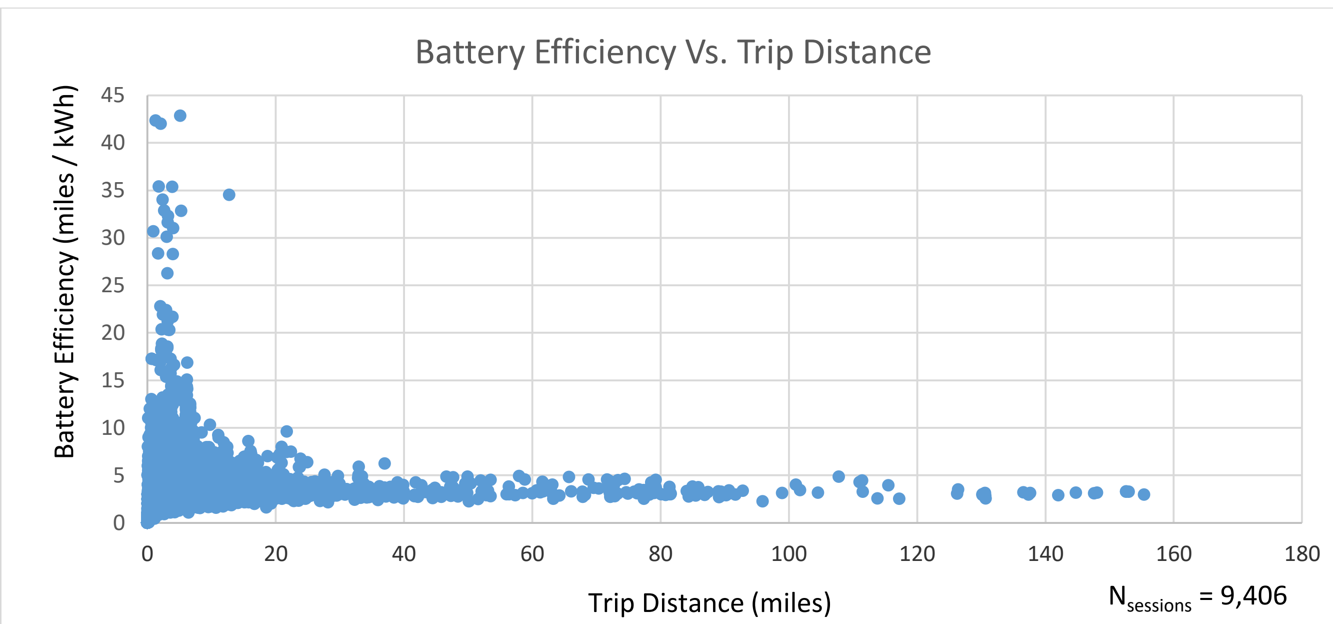


Figure 72. BEV Battery Efficiency Vs Trip Distance

Ambient temperature also has a major effect on battery efficiency. The table below shows battery efficiency versus temperature roughly corresponding with winter, spring/fall, and summer temperatures. Average trip efficiency increases from 2.6 miles per kWh during winter temperatures to 3.7 miles per kWh during summer temperatures.

Table 17. BEV Battery Efficiency VS. Ambient Temperature

Outdoor Temperature		
Temperature Range (°F)	**Average Efficiency (miles / kWh)**	**Trip Count**
less than 45	2.6	3,705
Between 45 and 65	3.5	2,921
greater than 65	3.7	2,783

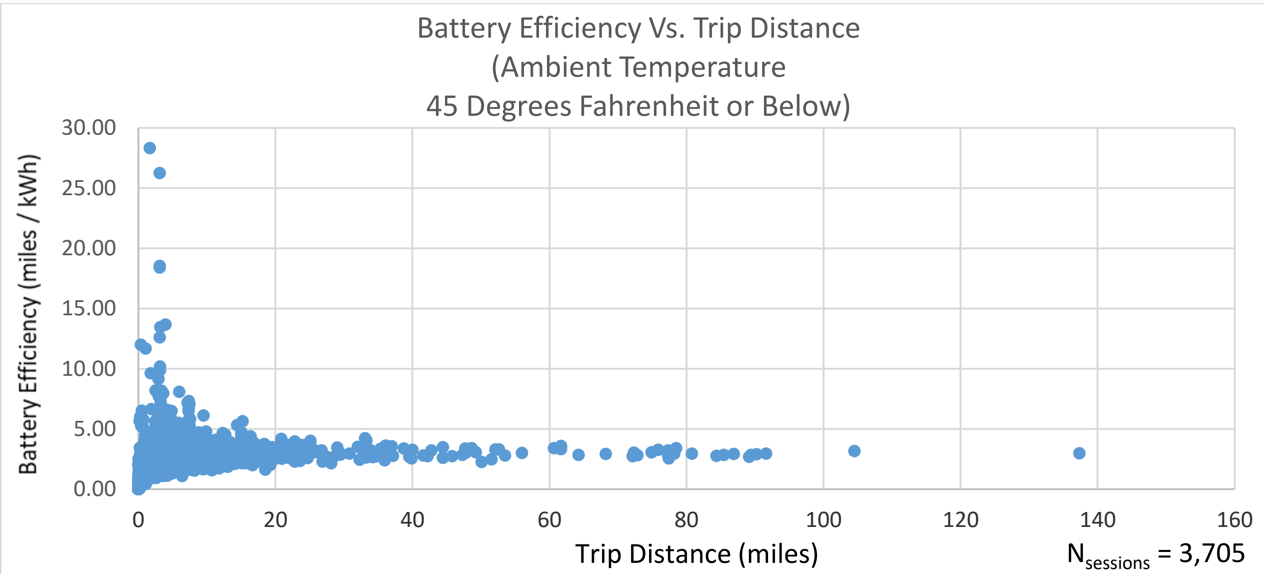


Figure 73. BEV Battery Efficiency Vs Trip Distance (Ambient Temperature 45 Degrees or Below)

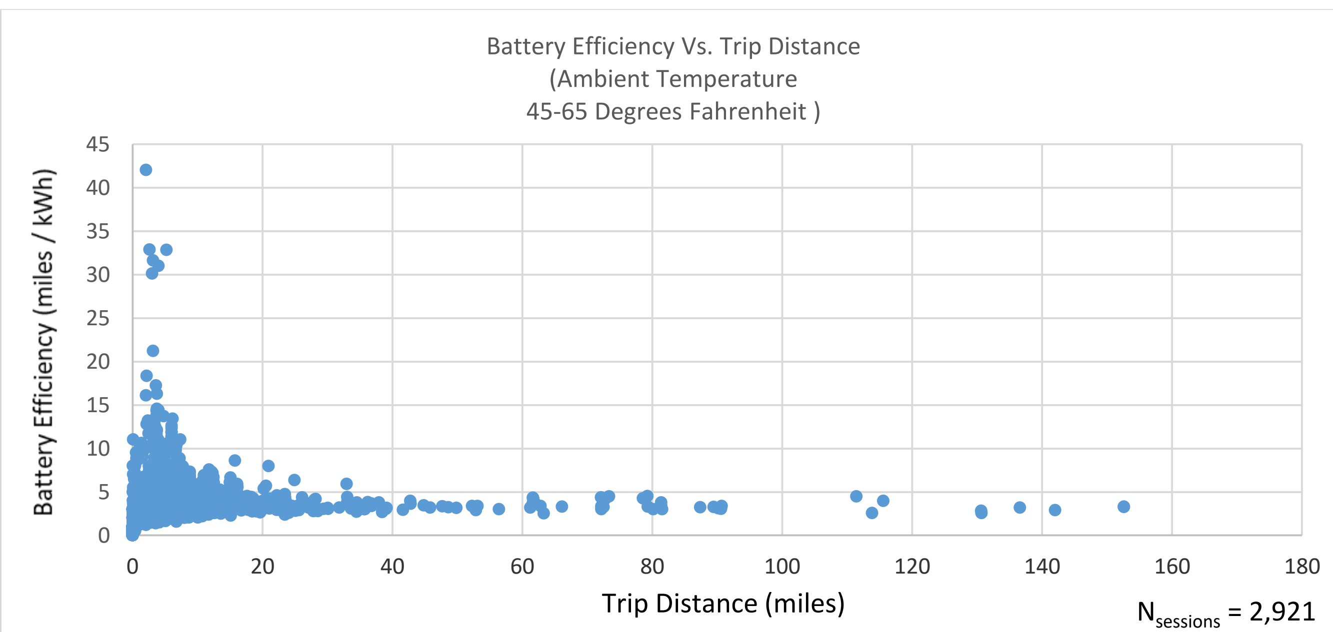


Figure 74. BEV Battery Efficiency Vs. Trip Distance (Ambient Temperature 45-65 Degrees)

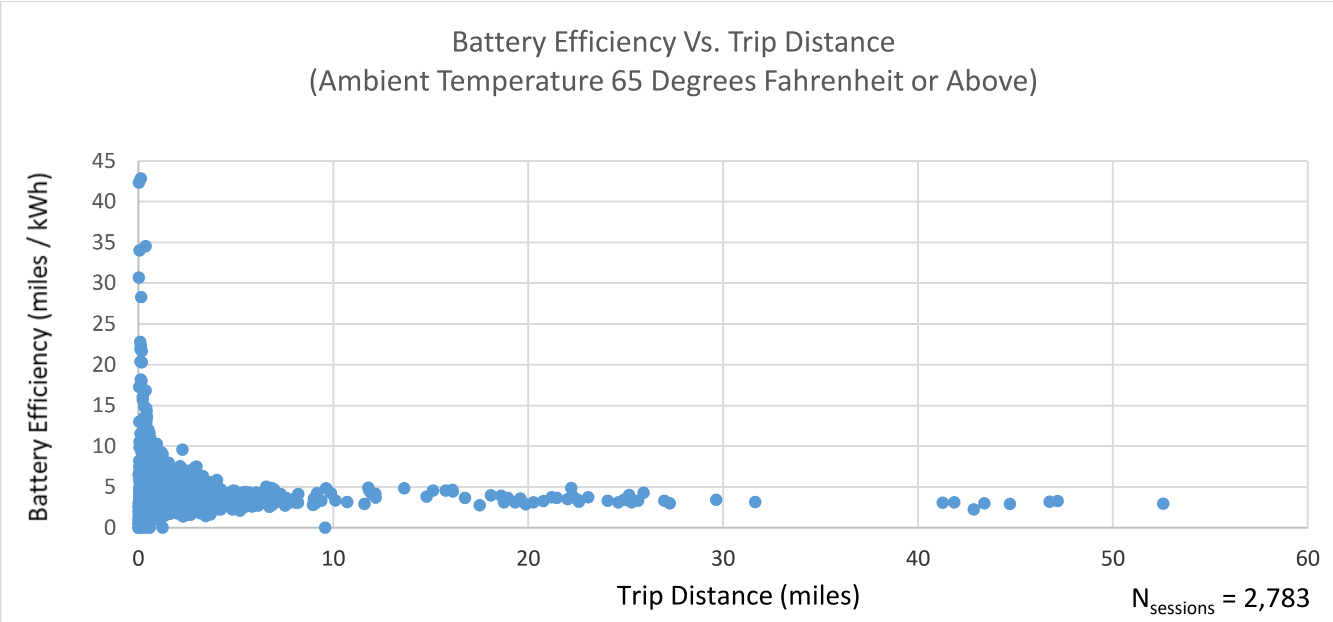


Figure 75. BEV Battery Efficiency Vs. Trip Distance (Ambient Temperature 65 Degrees or Above

Efficiencies in the above table and graphs represent power consumed from the battery, upstream of the rectifier. In addition, EVSE losses typically vary between 0.1% to 1.5%, depending on current.[39]

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[39] Apostolaki, Codani, Kempton. "Measurement of power loss during electric vehicle charging and discharging." https://www.sciencedirect.com/science/article/pii/S0360544217303730

Load Management

Residential Demand Response (DR)

Avista began DR experimentation in September 2018 with a small test group, expanding to all customers with networked residential EVSE by May 2019. The initial goal was to test if 75% of evening peak loads could be shifted to off-peak while maintaining high customer satisfaction. The new load profiles were then used in economic modeling to determine grid benefits from DR. Initially, DR events were set to 75% curtailment to maximum 1.8 kW output between 4pm and 8pm.

Special attention was given to frequent and open customer communications during the DR program. The rollout occurred over six phases, with the fourth and fifth phases experiencing delays due to software bugs eventually corrected by the EVSP. Note that while 92 stations are sent daily DR commands, due to connectivity issues between the EVSE and the server only 51 stations reliably receive them. More recently, EVSE from a different manufacturer have been used in several residential locations have demonstrated greatly improved connectivity, but are still in the early stages of testing.

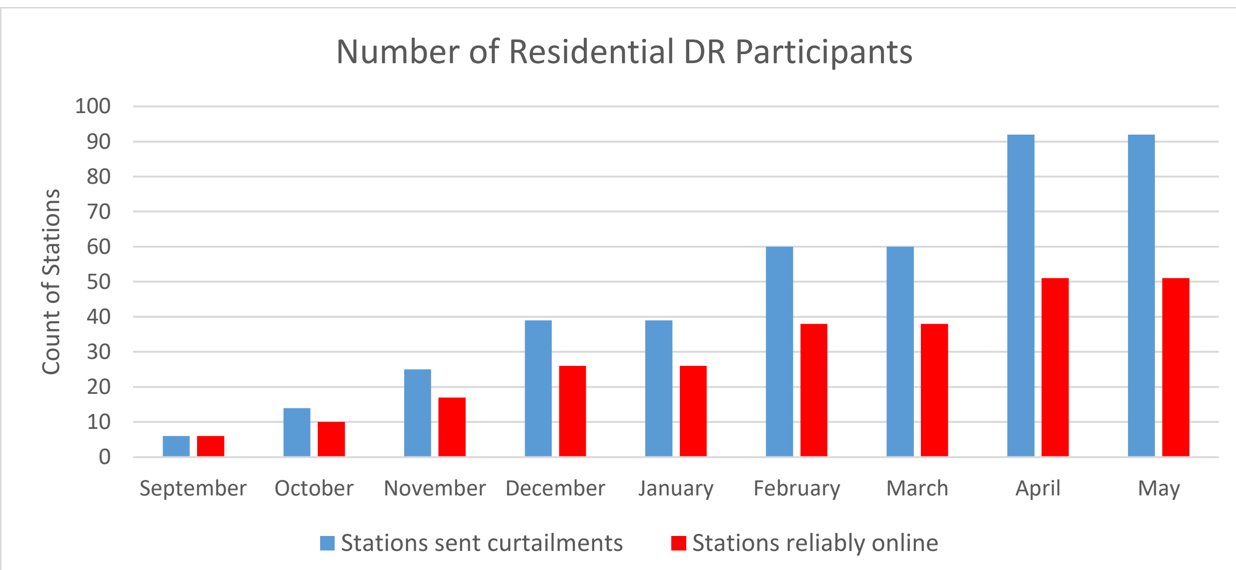


Figure 76. Implementation of residential DR program

Customers were given the ability to opt out of events through a "DR Event" feature on the EVSP phone app. When an event is initiated, the customer is sent a message a day ahead of time through their phone notifications, which they may choose to accept or reject. Customers also have the ability to set DR default preferences in the app. From September 2018 to July 2019, customers accepted or "opted in" to 85% of DR events. When surveyed about the impact of DR on daily driving, all customers stated that DR events had no effect on when or how they used their EV, and overall levels of satisfaction with the EVSE remained high. Session data backs up these surveys, showing that prior to DR, EVs would fully charge their battery in 59.6% of sessions, compared to 61.4% after DR. Customer feedback to improve the opt-out process included the ability to opt-out through email, change opt-in or opt-out status after the initial selection, and a physical button on the EVSE to opt-out at any time.

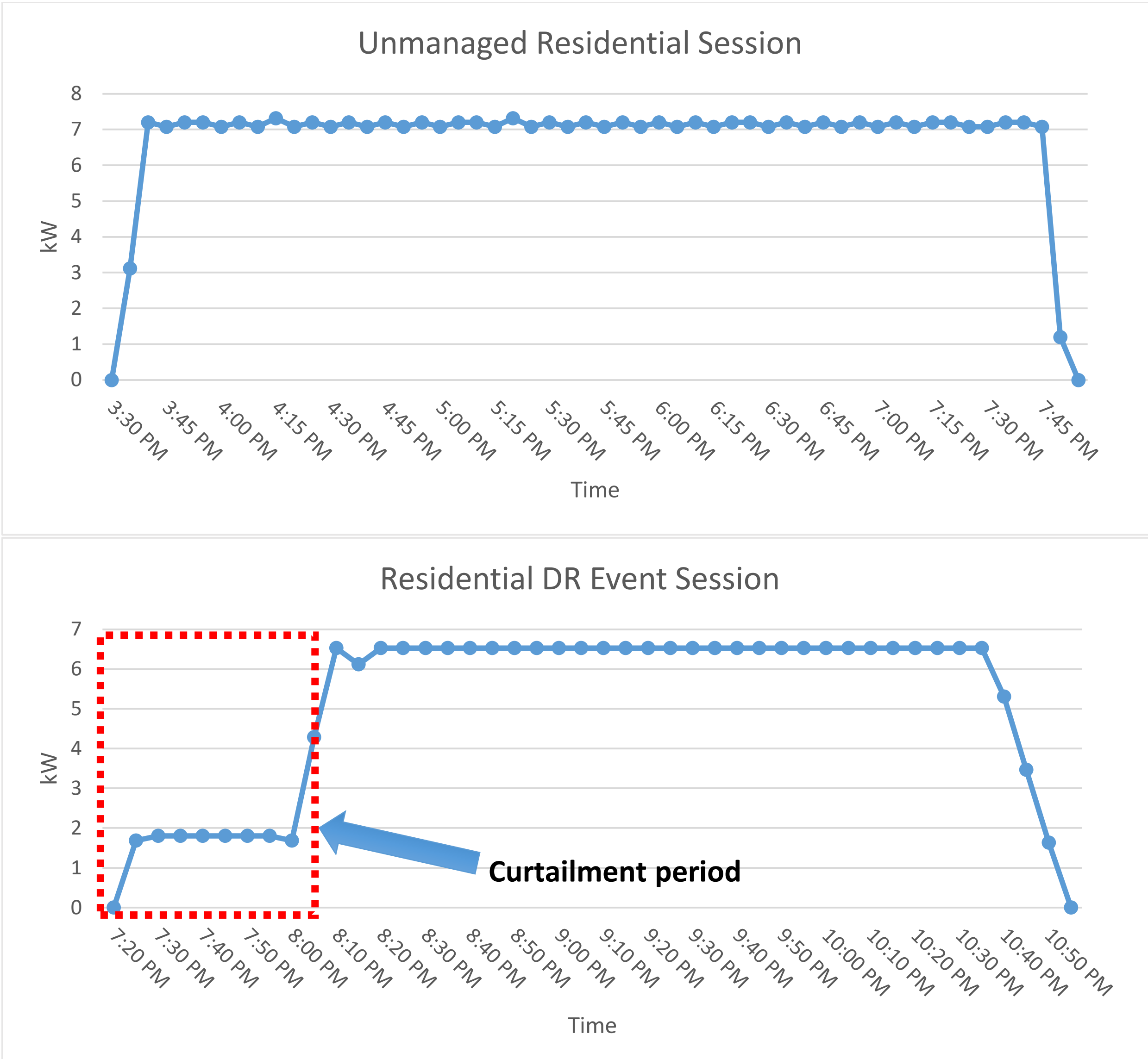


Figure 77. Example residential sessions before and after DR

As shown above, 75% curtailment of EVSE output results in 1.8kW delivered from 4pm to 8pm. When aggregated, the average load profile from 1,876 DR sessions demonstrated a 49% drop in peak demand compared to the uninfluenced load profile. Note that over a longer period of time, the accumulation of more DR sessions would further reduce the aggregated load profile's peak demand, to a limit governed by the output curtailment and the rate of DR opt-outs. After 8pm the DR event is concluded and a demand spike occurs, due to EVSE output rising back to the 6.6kW level. This effect is similar to what can occur at the beginning of a time of use (TOU) rate time window, as a large number of EVs begin charging at the same time to take advantage of the lower rate. Such spikes could adversely affect distribution infrastructure in high EV adoption scenarios, even during off-peak periods. Possible solutions to minimize such demand spikes include “randomizing” features when applying DR, or in the case of TOU utilizing dynamic rates.

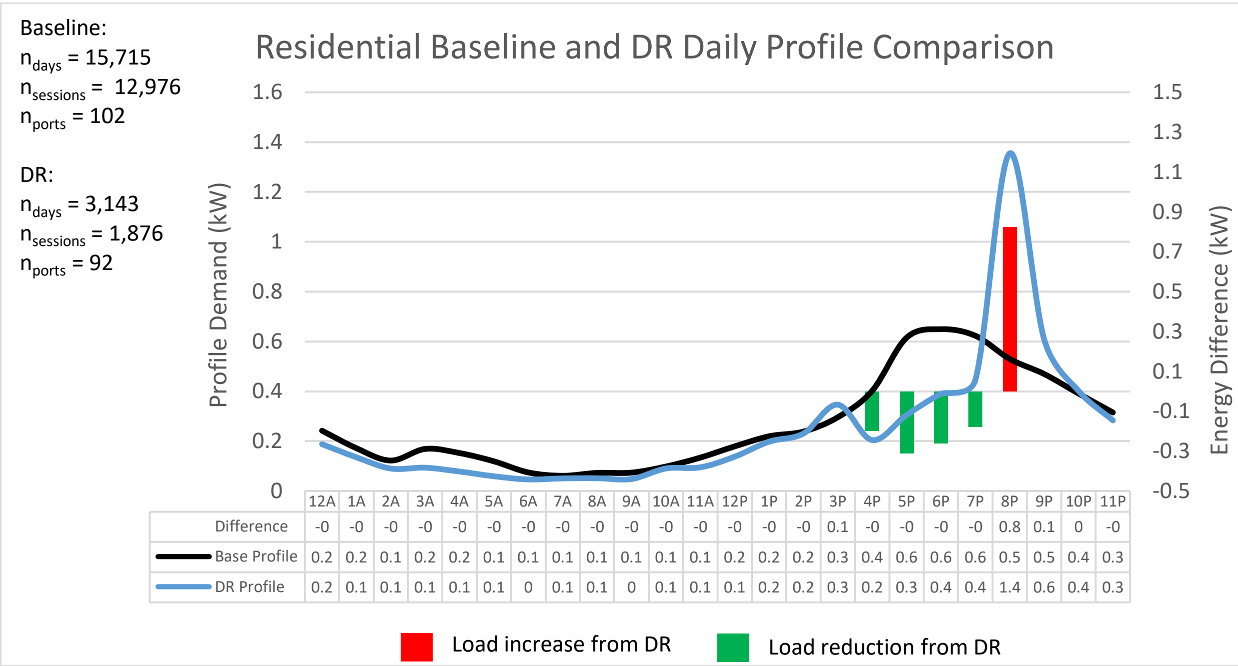


Figure 78. Residential aggregated load profiles before and after DR implementation with load change

The Company intends to pursue ongoing DR experiments, eventually with 100% curtailments and over longer time periods, to further determine the effects and practical limits of shifting EV loads utilizing DR, including the rate of customer opt-outs and satisfaction levels. Experiments to date demonstrate the acceptability of 75% peak load shifts for 85% of residential charging sessions, from a customer perspective. The practicality of utilizing networked EVSE for DR at scale, however, in a reliable and economically beneficial way will depend on much lower EVSE and networking capital and O&M costs, high uptime and online performance, and high customer participation rates. Integration with utility AMI systems could help reduce communication costs and improve reliability, however this will require industry technology and product development, as no commercially available systems currently exist that Avista may implement. In spite of these challenges, the Company feels that the effort to understand and effectively manage EV loads, consistent with the UTC Policy Statement, is important and should continue. This may involve the development and experimentation in a variety of methods and technologies, as it will become ever more important to integrate and optimize growing EV loads in the future as a flexible grid resource. In this regard, the inherent benefits of utilizing workplace charging to effectively minimize peak loads as well as support beneficial EV adoption, stand out as a focus area with excellent potential.

Residential DR Comparison with other TOU studies

A 2014 study completed by DTE and EPRI[40] compared the charging habits of customers given the choice of a flat rate for $40 per month, and a TOU rate of $0.18 on peak from 9am to 11pm on weekdays, and $0.07 off peak from 11pm to 9am on weekdays and all-day on weekends. Results showed a shift from 22% of EV charging energy consumed off peak in the flat rate, up to 62% off-peak with the TOU rate, comparable to Avista's DR group with 64% consumed off-peak.

A 2015 study completed by the utility Pepco also in conjunction with EPRI,[41] examined residential load profiles of EVs with a TOU rate in effect. Customers were given the option of TOU rates applied to the entire home, or just the EV. The on-peak period applied from noon to 8pm and all other hours were off-peak, with a rate differential between $0.10 and $0.11. Customers choosing the EVSE-only TOU rate consumed 93.7% of charging kWh during off-peak hours, significantly higher than the 77% of energy consumed off-peak in Avista's DR program, and the 62% consumed off peak in DTE's TOU program. This appears to be most likely due to individual education about the TOU rate and its benefits with participants, demonstrating the potential results of effective customer outreach and education.

	Time period	% of total energy consumption
DTE flat rate	On-peak (9am - 11pm weekdays)	78%
	Off-peak (11pm – 9am & weekends)	22%
DTE TOU rate	On-peak (9am - 11pm weekdays)	38%
	Off-peak (11pm – 9am & weekends)	62%
Pepco TOU rate	On-peak (12am -8pm)	6%
	Off-peak (8pm – 12pm)	94%
Avista no DR	On-peak (4pm – 8pm)	36%
	Off-peak (8pm – 4pm)	64%
Avista DR /V1G	On-peak (4pm – 8pm)	23%
	Off-peak (8pm – 4pm)	77%

Table 18: Comparison of On-Peak and Off-Peak Charging in DTE, Pepco, and Avista studies

With more time and expanded experimentation, it is expected that Avista's DR/V1G could approach 90% off-peak consumption, comparable to Pepco's study. Overall, these results represent a preliminary comparison between the effectiveness of TOU compared to DR/V1G in shifting peak loads, from a customer behavior and acceptance perspective.[42] Cost effectiveness must take into account other factors, such as the reliability and costs to implement each method, e.g. separate metering, EVSP support and communication fees, etc.

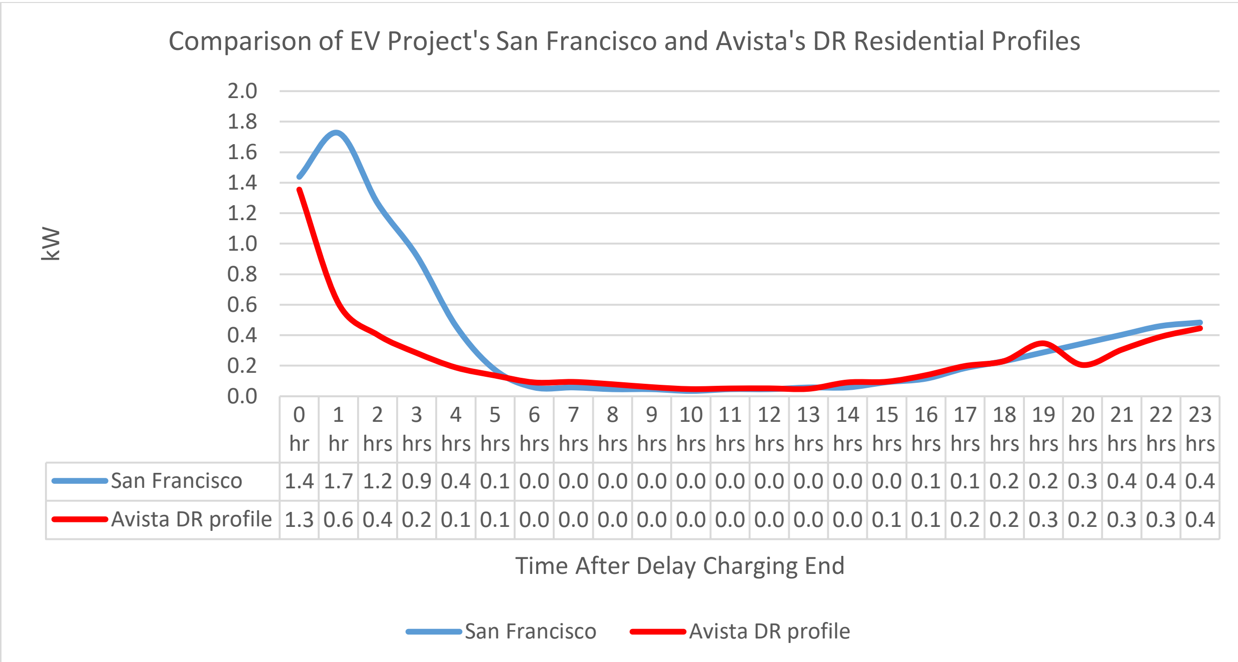
The 2015 EV Project (EVP) collected data from 869 EVSE in San Francisco, with an off-peak TOU rate available starting at midnight. As a proxy for DR, the EVP's San Francisco residential weekday charging profile is compared to Avista's residential DR profile, where Avista's 8pm conclusion of DR coincides with

[40] EPRI, DTE. "DTE Energy: Driving the Motor City Toward PEV Readiness" (2013)

[41] EPRI, Pepco. "Pepco Demand Management Pilot for Plug-In Vehicle Charging in Maryland" (2015)

[42] Pepco's study had a sample size of 35 participants enrolled in the EVSE-only TOU rate, compared to 51 participants in Avista's DR study after accounting for connectivity issues. In contrast, the much larger DTE study was carried out with 2,500 participants.

the EVP 12am TOU start time. One similarity between the two profiles is the demand spike that occurs immediately after the delayed charging event, at 1.3 kW for Avista's profile compared to 1.4 kW for EVP's profile.



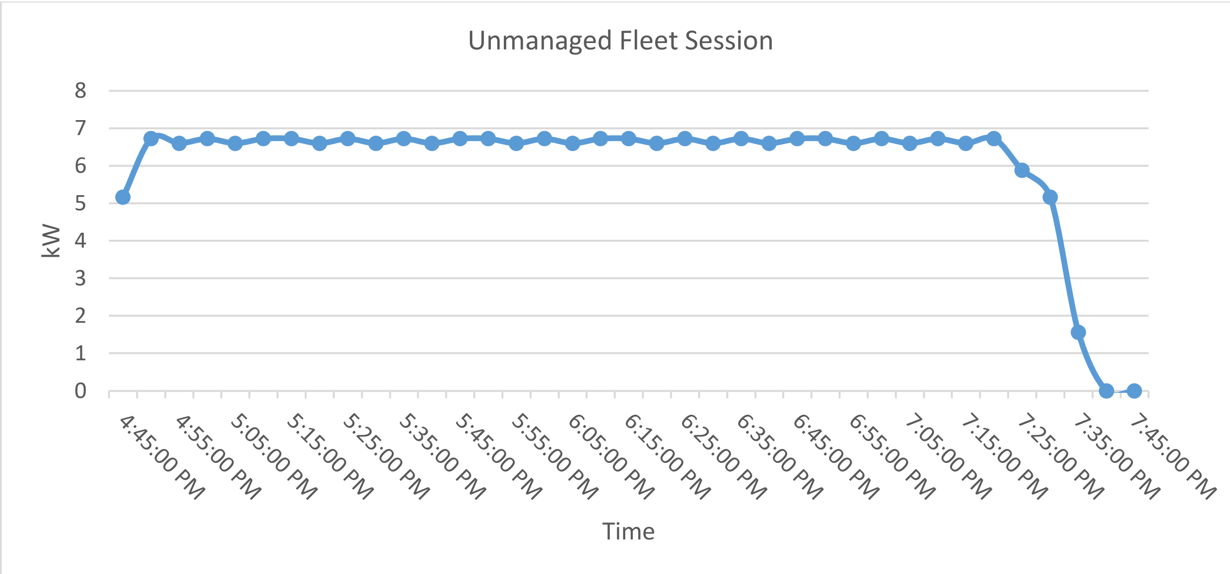
	0 hr	1 hr	2 hrs	3 hrs	4 hrs	5 hrs	6 hrs	7 hrs	8 hrs	9 hrs	10 hrs	11 hrs	12 hrs	13 hrs	14 hrs	15 hrs	16 hrs	17 hrs	18 hrs	19 hrs	20 hrs	21 hrs	22 hrs	23 hrs
San Francisco	1.4	1.7	1.2	0.9	0.4	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.4	0.4	0.4
Avista DR profile	1.3	0.6	0.4	0.2	0.1	0.1	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.1	0.1	0.2	0.2	0.3	0.2	0.3	0.3	0.4

Figure 79. Comparison of Avista and the EV Project's Profiles with Delayed Charging

One difference is that Avista's load drops by 55% over the first hour, while the EVP profile increases by 21%. This could be due to an increasing number of drivers nearing full battery capacity in the Avista study, while EVP drivers could conceivably start EV charging sessions sometime after the TOU rate starts at midnight. Also noteworthy is that the EVP study showed higher energy consumption averaging 9.0 kWh per day for the San Francisco group, compared to 6.0 kWh daily residential consumption for Avista's DR group.

Commercial DR

Avista implemented its commercial DR program at eight charging ports starting in the fall of 2017 at two different locations, one fleet with four fleet BEVs, and the other a workplace location with four regular EV commuters. A curtailment of 75% to 1.8kW output was applied to a large time window from 5:30am to 10:30pm. Similar to the residential DR experiments, once outside the curtailment window the EVSE could charge up to the maximum rate of 6.6kW until charging was complete. Examples of actual unmanaged and managed sessions are shown below.



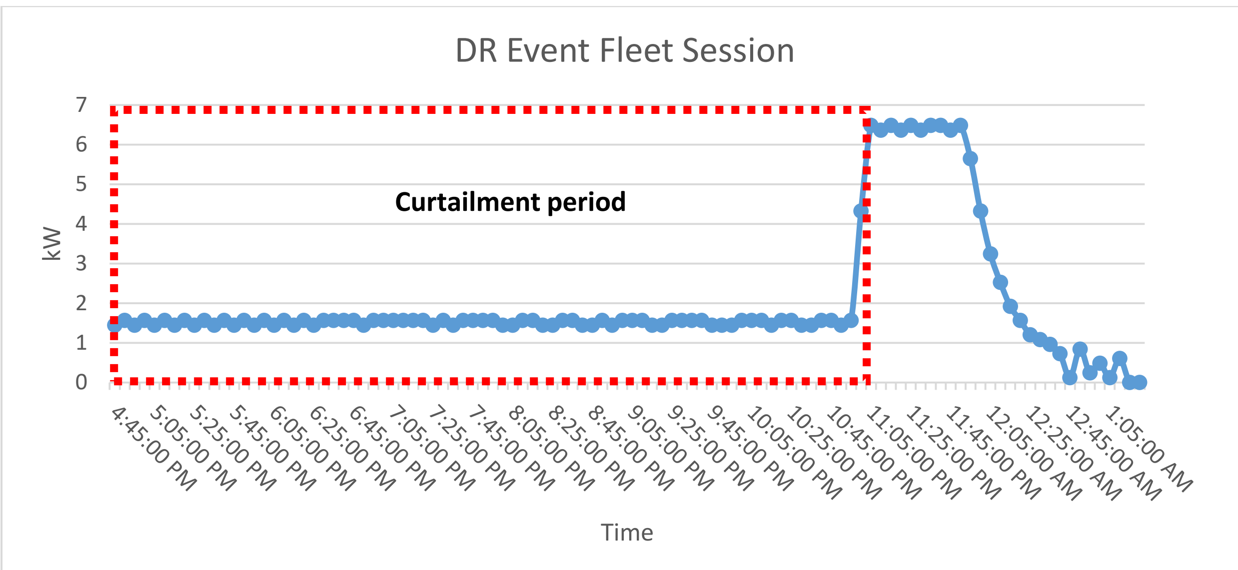
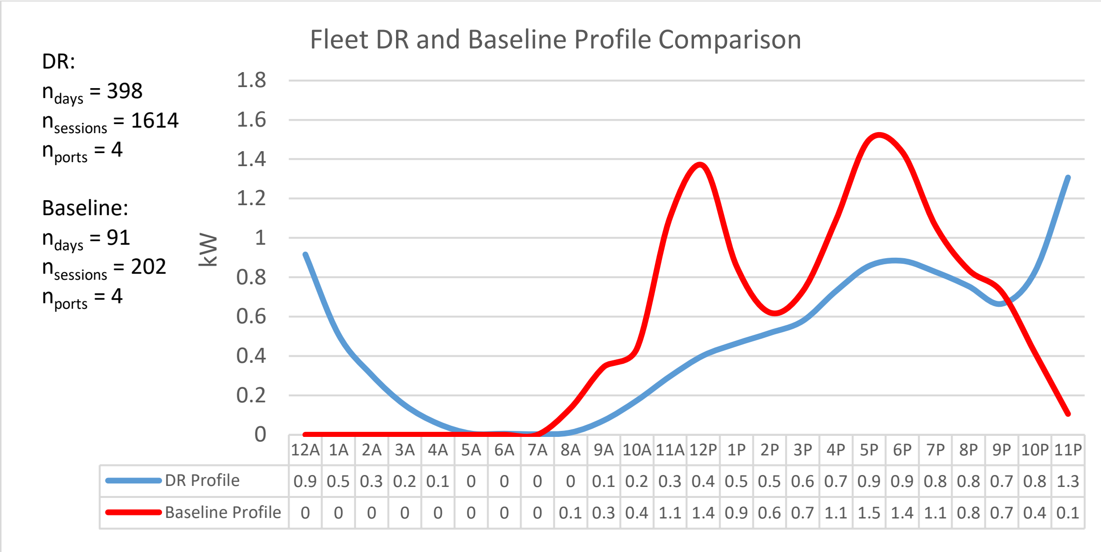


Figure 80. Example fleet sessions before and after DR

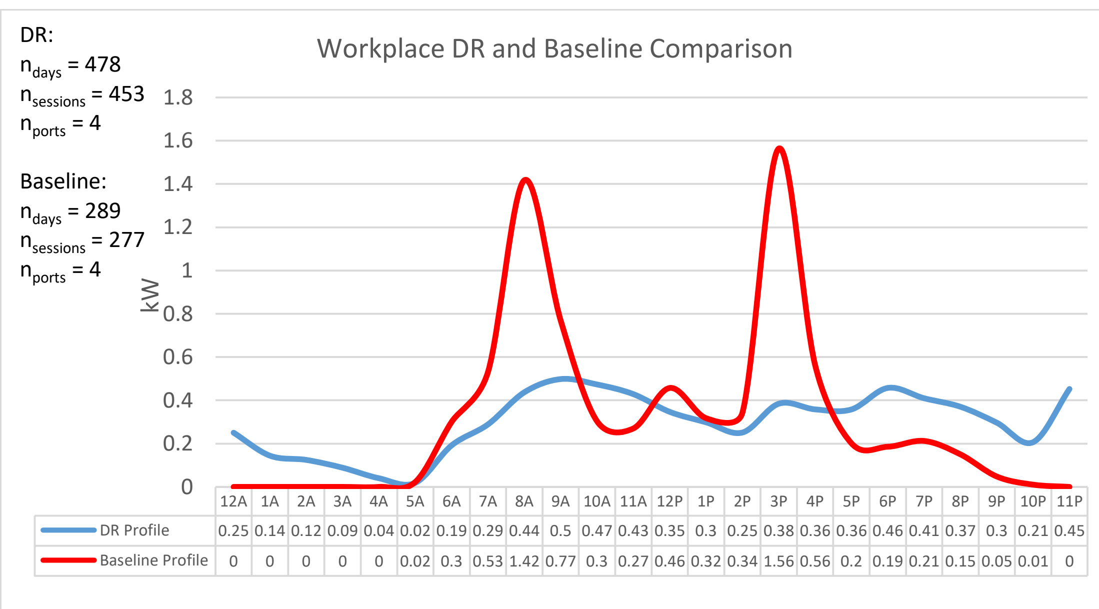
The chart below shows the aggregate load profile for the fleet site with four EVSE ports and four long range BEVs that regularly utilized the charging ports. Initially the baseline profile had two peaks consisting of a peak of 1.4 kW at 12pm and a second, larger peak of 1.5 kW at 5pm. Average daily energy usage totaled 11.3 kWh. At 12pm, DR lowered demand by 71% compared to baseline, and at 5pm demand dropped by 43%. DR was successful in shifting the peak load to off-peak overnight hours, with demand at the 11pm hour peaking at 1.3 kW. Baseline consumption between 11pm to 5am averaged 0.1 kWh, compared to DR consumption at 3.2 kWh.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
DR Profile	0.9	0.5	0.3	0.2	0.1	0	0	0	0	0.1	0.2	0.3	0.4	0.5	0.5	0.6	0.7	0.9	0.9	0.8	0.8	0.7	0.8	1.3
Baseline Profile	0	0	0	0	0	0	0	0	0.1	0.3	0.4	1.1	1.4	0.9	0.6	0.7	1.1	1.5	1.4	1.1	0.8	0.7	0.4	0.1

Figure 81. Aggregated fleet daily load profiles before and after DR

The workplace location is a large medical center open 24 hours with staff and visitors charging throughout the day and night. Initially the baseline profile showed two peaks at 8am and 3pm. After implementing DR, the station's profile flattened out significantly, and similar to the fleet DR results, energy consumption was dramatically shifted to the offpeak period from 11pm to 5am. Note that the workplace baseline profile was collected before October 2017 when there were four drivers consistently charging, and the DR profile that followed had at least seven drivers consistently charging.



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
DR Profile	0.25	0.14	0.12	0.09	0.04	0.02	0.19	0.29	0.44	0.5	0.47	0.43	0.35	0.3	0.25	0.38	0.36	0.36	0.46	0.41	0.37	0.3	0.21	0.45
Baseline Profile	0	0	0	0	0	0.02	0.3	0.53	1.42	0.77	0.3	0.27	0.46	0.32	0.34	1.56	0.56	0.2	0.19	0.21	0.15	0.05	0.01	0

Figure 82. Aggregated workplace daily load profiles before and after DR

While both of these locations were successful in reducing peaks and increasing off-peak demand, one major difference was the impact of DR on fully charging EV batteries. Before DR, EVs would be fully charged by the end of the session 78% and 84% of the time for fleet and workplace locations, respectively. After implementation of DR events, the workplace location saw the proportion of sessions where the EV was fully charged drop to 42%, and the fleet location saw a reduction to 72%. This difference could be caused by the more limited dwell time of the workplace location compared to the fleet location, i.e. fleet stations have EVs that are fixed at their locations and capable of charging overnight for a larger proportion of sessions, allowing EVs to fully recharge more often. Note that the data only represents individual charging sessions, i.e. an EV that is charged in the morning, leaves during the lunch hour and returns to complete charging for the day in a second session, would indicate one session that did not fully recharge, and a second that did. In any case, the significant drop at the workplace location warrants further investigation to verify information, determine causes, the effect on customer satisfaction, and if warranted, possible remedies.

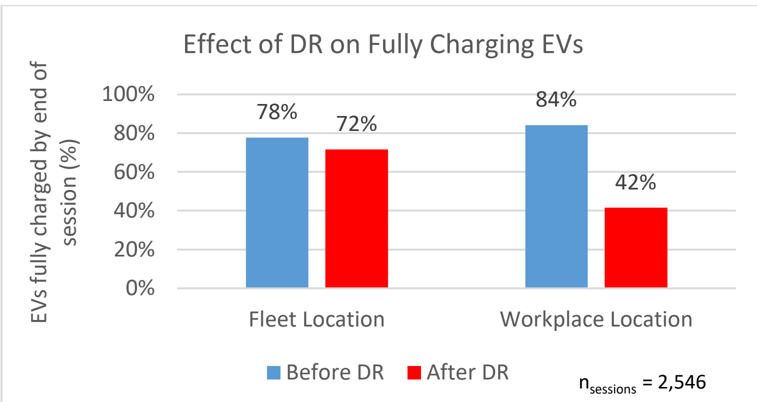


Figure 83. Comparison of fully charged batteries before and after DR at workplace and fleet locations

Grid and Economic Impacts

The utility grid is delineated by three major systems – generation, transmission, and distribution. On Avista's grid, generation power is stepped up to high AC voltages of 115kV or more, traveling long distances on the transmission system before the voltage is stepped down in distribution substations, typically to 13.5kV using 30MVA transformers. Each substation commonly has one to three feeder distribution lines that each usually run 3 to 5 miles in urban areas and 15 to 20 miles in rural areas. Power is distributed on these feeders from the substation to service transformers that step down voltage again and supply one or more service points, which are defined as the connection point at the customer meter. Most service transformers on Avista's system serve one to ten service points in residential neighborhoods, with an average of four.

Figure 84: Utility grid - generation, transmission, and distribution systems (source: USDOE)

Peak Native Load	1,716 MW
Total Generation Capability	1,858 MW
Circuit miles of Transmission Lines	2,770
# of Distribution Substations	170
Circuit Miles of Distribution Feeders	5,429
# of Service Transformers	88,783
# of Retail Electric Meters	384,838
Annual kWh per Residential Customer	10,658

Table 19: Avista's Electric Grid - Quick Facts

Modeling by E3 for the Pacific Northwest region and independently by Avista for its service territory indicates that light-duty EV adoption at baseline or higher levels over the next 20 years will provide net benefits over costs, in terms of both regional economic and utility ratepayer perspectives. Regional economic benefits are mostly due to major fuel savings of EVs. Both regional and ratepayer costs are dominated by the additional generation capacity required to serve new EV loads, with a small contribution from distribution costs, and no transmission costs. The analysis that follows includes details of distribution grid impacts, the results of E3s Pacific Northwest economic modeling, and comparisons with Avista's independent economic modeling. However, these are the results of 1st-order analysis that do not take into account important 2nd-order effects such as distribution feeder "backfeeding", and depend on system loading and cost assumptions contained in the Company's current IRP, which could change – perhaps dramatically – in the future. As such, this should be viewed as a good first step in the Company's ongoing effort to understand how EV loads may be optimally integrated and managed, in an evolving system that brings the most benefit to all customers.

Distribution Grid Impacts

A first order analysis of light-duty EV loads on distribution transformers was conducted for three different scenarios. The first scenario assumed a single EV load of 6.6kW serviced by each transformer in addition to existing loads, which equates to a roughly 25% EV adoption rate. The second scenario assumed 50% of service points with an added EV load of 6.6kW, and the third with 100%.

The electrical power demand on a service transformer from EVs is modeled as:

$$P_{EV\_aggregate} = n_{EV} * EV_{SE} * CF$$

Where:

$P_{EV\_aggregate}$ = Additional power demand created by simultaneous EV charging
n_{EV} = number of EVs downstream of a given service transformer
EV_{SE} = Power required to charge a single EV = 6.6 kW
CF = coincidence factor = 0 to 1

The CF is the percentage of simultaneous EV loads on a given transformer, compared to the sum of all potential loads. As more EVs are served by a single transformer, the maximum load on the transformer increases up to a limit governed by the CF. The CF curves used for transformer loading are based on industry and utility standards, and are directly related to the number of service points with EVs served by the transformer.

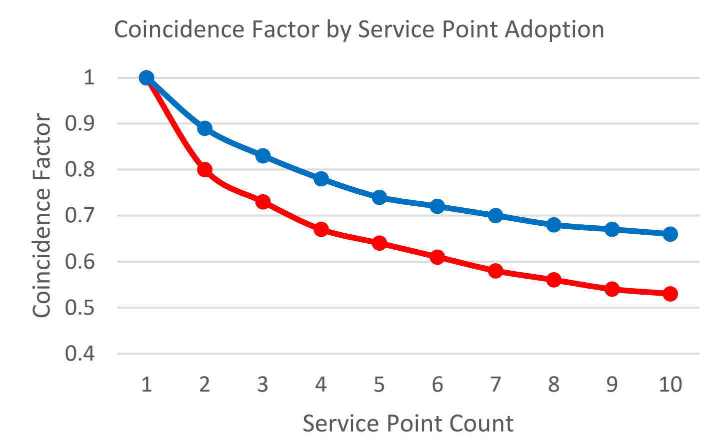


Figure 85: EV charging coincidence factor used in economic modeling

Estimated transformer replacement costs of \$3,516 for underground transformers and \$2,318 for overhead transformers include material and labor costs but do not include additional costs such as replacing or installing new pole arms, cutouts, arrestors, brackets or upsized distribution poles which may occur depending on the situation.

In the first scenario, a single EV load of 6.6 kW during peak hours was appended to each transformer's existing peak load, for 88,783 transformers sized between 15 to 100 kVA, each with 10 or fewer service points. A single EV served by each transformer is equivalent to an overall EV adoption rate of 23%. As a result of this load, 5.9% (5,280 of 88,783) of residential transformers exceeded their overloading limits as determined by IEEE Std C57.91.[43]

In the second and third scenarios, applying EV loads to 50% of service points on all transformers caused the peak load to exceed the failure threshold on 19.7% of transformers, compared to a 30% failure rate for the scenario with 100% EV service points. Upgrade costs for the 50% and 100% adoption scenarios were \$46.9 million and \$72.6 million, respectively.

[43] IEEE C57.91-2011 – Guide for Loading Transformers and Step-Voltage Regulators. *https://standards.ieee.org/standard/C57_91-2011.html*

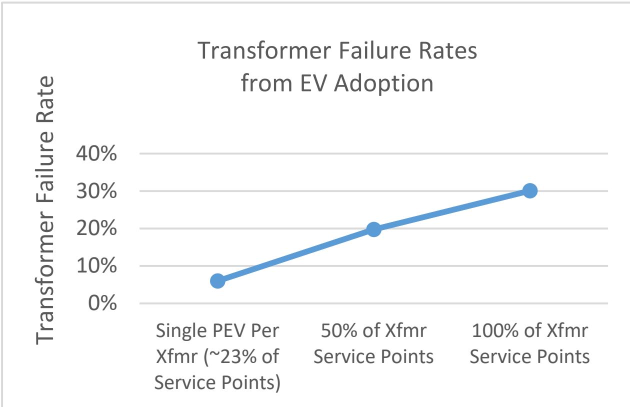


Figure 86: Failure rate of residential transformers from EV loads

Note that unusual situations that could alter charging behavior were not modeled. For example, a higher level of EV charging might occur before a major storm if customers felt there was a risk of pending power outages, which could cause additional transformer overloads and failures. Also, it was assumed that only one EV will charge at a time at a given residence, even though at high EV adoption rates many households would have more than one EV, and some of them may choose to install multiple EVSE so that both EVs could charge simultaneously.

Feeders are typically designed and built with 10 MVA capacity, ideally operating at 6 MVA with overload concerns at 8 MVA. This is done to allow for feeder "backfeeding", where a given feeder may take on some of the load from other feeders in the event of issues and repairs. Assuming uninfluenced EV load profiles, first-order analysis of a sample of Avista's feeders showed 33% reached the 8MVA threshold and were therefore considered "overloaded", assuming baseline EV adoption and all other existing loads held constant, rising to 47% overloaded with 50% EV adoption and 67% with 100% adoption. Reconductor costs for urban feeders average $400k per mile, compared to $300k per mile for rural feeders. In turn, impacts to feeders can result in impacts to substations, with the need to increase the number of feeders or in some cases build a new substation, at an average cost of $2.5M per substation. Note that detailed information at many points in the distribution system for existing loads and forecasts, and sophisticated modeling is required to take in to account important 2nd-order effects such as feeder backfeeds and cascading impacts to substations with more certainty.

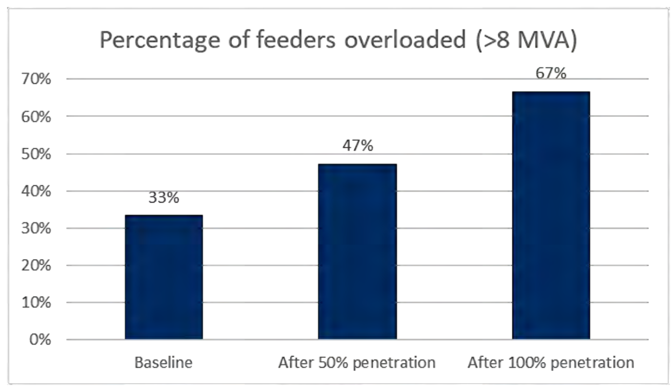


Figure 87: Distribution feeder overloads from EV loads, assuming all other loads held constant

Based on analysis of detailed feeder-level data for four utilities in the Pacific Northwest, E3's study showed an average distribution cost of $27 net present value (NPV) per EV over the 2017-2036 time period. In other words, an NPV of $27 represents the total additional costs to the distribution system over the 20-year time frame of the study, for each EV during that time. Avista's analysis indicates an average distribution cost of $38 NPV per EV over a similar 2019-2038 time period. In both studies, similar assumptions were used for baseline EV adoption, EV purchase costs, fuel costs, etc., as detailed in Appendix H. However, the model's calculation methods and algorithms were developed independently.

The relatively low EV impacts on the distribution grid as predicted by both models reflect the assumptions of modest baseline EV adoption, historically established system cost escalations, and reduced distribution peak loads over time as a result of energy conservation.[44,45] Higher levels of EV adoption and the sensitivity to cost and energy conservation assumptions must be further explored, as well as important second-order effects on the distribution system beyond a first-order analysis.

E3's Pacific Northwest EV Study (2017 – 2036)

In 2017, E3 completed a detailed study of EV grid and economic impacts in the Pacific Northwest, sponsored by six regional utilities. The study's objectives were to support an understanding of how EV adoption could result in costs and benefits from both a "regional" and a "ratepayer" perspective, sensitivity to assumptions, the value of managed charging, CO_2 reductions, and implications for utility planning. In the "regional" perspective, monetized EV costs and benefits that flow in and out of the region are considered, while in the "ratepayer" perspective the marginal EV costs and benefits are isolated to the effects on customer utility rates. Over the study's 20-year time horizon, calculated cash flows for each year are translated to an equivalent net present value (NPV) in 2017, using a discount rate of 4.9%. When the NPV of total costs is less than the NPV of total benefits for a given scenario, a net benefit results, and vice versa. For more detail including the analytical approach, input variables, and how they are applied in the regional and ratepayer perspectives, see the E3 study and Appendix H of this report.

From a regional perspective, E3 concluded that all regions in the Pacific Northwest showed a net benefit from EV adoption, calculated at $1,941 NPV per EV for the regional base case scenario. These net benefits were also shown to be most strongly influenced by assumptions of EV adoption, EV purchase costs relative to gasoline vehicles, and gasoline prices. These assumptions result in the largest cost component of incremental vehicle cost, and the largest benefit component of gasoline fuel savings. The analysis further showed that generation capacity cost was nearly equal to energy cost, and distribution costs

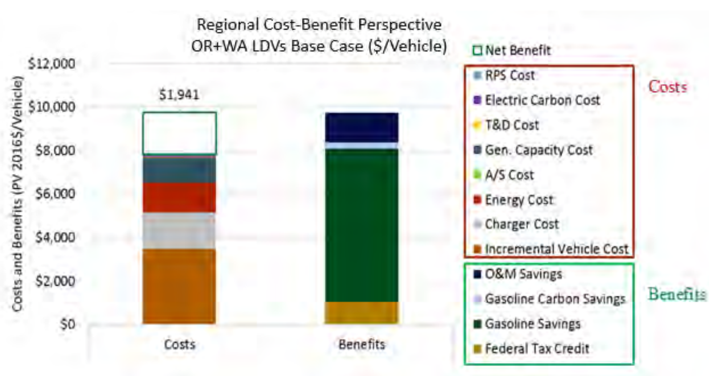


Figure 88: E3 Regional Cost-Benefit

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[44] E3 (p.54)
[45] Avista Electric Integrated Resource Plan (2017)

were not significant. When examining the benefits of managed charging, E3 estimated an additional $500 to $1,700 regional net benefit per EV, with 70% to 90% of the added value from reduced generation capacity costs, and the smaller remainder from energy cost savings. Note that the E3 model is linear and therefore does not include important "interactive" or dynamic effects between input variables, i.e. feedback loops. For example, lower EV purchase costs and higher gas prices would result in higher EV adoption, and vice versa, which greatly affects the cost-benefit result. In reality, these feedback loops are asymmetric in that negative effects such as utility energy and generation capacity costs are mitigated by lower EV adoption, while positive effects such as the benefits of gasoline fuel savings are amplified by higher adoption.

In the "ratepayer perspective", E3 showed that EV adoption would create ratepayer net benefits for the region as a whole, but that results could vary greatly from one utility service territory to the next depending on that utility's reserve generation capacity. Wholesale electricity prices were also found to have a significant influence on net results, as they impact generation capacity cost. Utility revenue from the additional metered billing of EVs results in a net benefit over total costs of $387 NPV per EV. When considering the potential value of managed charging, E3 calculated an additional NPV of $400 to $1,600 per EV, as a result of reducing EV loads that occur during "peak" hours, causing increased generation capacity costs. Distribution costs were not significant in either case, as modeled in the base case adoption scenario from 2017 through 2036.

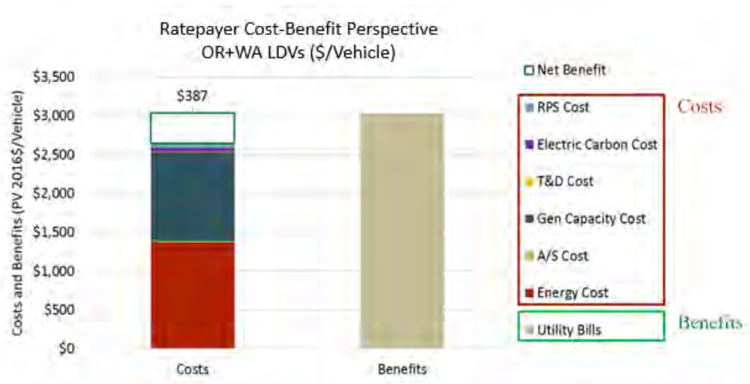

Figure 89: E3 Ratepayer Cost-Benefit

Avista's Study (2019 – 2038)

Following E3's study for the Pacific Northwest, Avista independently developed an economic model that would also calculate EV costs and benefits for the regional and ratepayer perspectives, but specific to Avista's grid and service territories, and with the flexibility to alter inputs such as the EV load profiles gathered from the EVSE pilot. E3 was consulted to confirm input variables over a 20-year time horizon for the Avista model, analogous with the baseline input variables used in E3's Pacific Northwest EV study where EVs reach 15% of light-duty vehicle sales in 2030 (see Appendix H). A discount rate of 6.58% was used to model Avista's weighted cost of capital.

In this way, Avista's results may be compared to E3's, using similar inputs and independent modeling methods. If the model outputs are reasonably matched, then a form of independent replication is achieved, establishing additional confidence in both E3's and Avista's modeling and results. In addition to the 20-year baseline scenario with and without managed charging, Avista's model was used to analyze a 50-year study of accelerated, very-high EV adoption, where light-duty EVs reach 90% of registered vehicles by 2050.

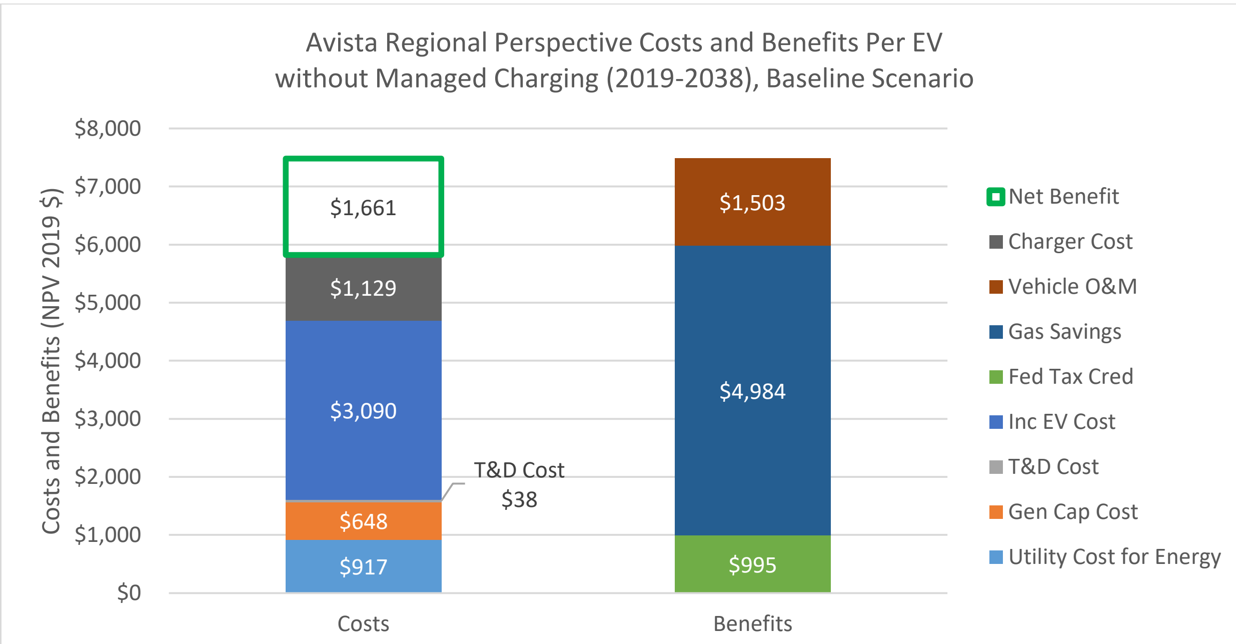

Figure 90. Regional perspective costs and benefits per EV without managed charging 2019-2038

In the regional perspective, Avista's model results in a net benefit of $1,661 per EV without managed charging, comparable to the E3 result of $1,941 per EV for the Pacific Northwest region. Note that in Avista's model, costs for renewable portfolio standards (RPS), electric carbon cost, and ancillary services (A/S) are not considered, as they were shown to be negligible in E3s results. Similar to the E3 study, Avista's regional costs are dominated by the incremental EV cost, and benefits from fuel savings. In addition to the embedded utility energy costs consistent with Avista's IRP assumptions, additional utility costs to serve the new EV loads come primarily from generation capacity costs at $648 per EV, with only $38 per EV from distribution costs. Note that while they are tangible and important benefits to the region, this study does not include a monetized value for societal and health benefits resulting from reduced GGE emissions and local air pollutants.

When managed charging is included, regional net benefits increase $464 per EV to a total benefit of $2,125 per EV. This assumed 75% of the residential load was shifted to off-peak from the hours of 4pm to 8pm year round, as was demonstrated in the EVSE pilot. Most of the additional benefit comes from reduced generation capacity costs. This is comparable but slightly below the range of E3's regional net benefit from managed charging, at $500 to $1,700 additional benefit per EV. Additional benefits in the Avista model could be realized with more peak load shifting, as may be possible. Nominally divided by an assumed 10 year life of an EV, these results mean that the cost to implement load management per EV must be less than $46 per year using Avista's result, or between $50 and $170 per year using E3's results, in order to achieve additional regional net benefits from managed charging.

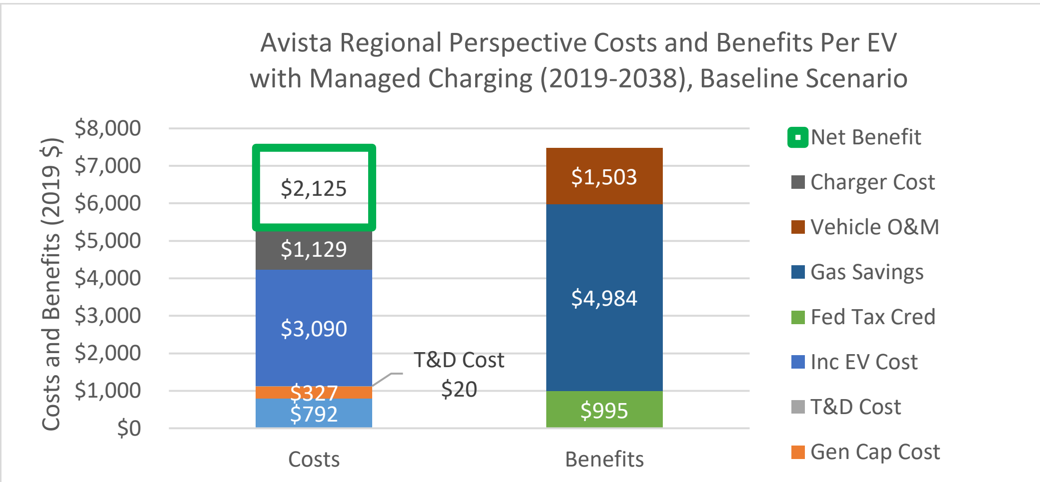

Figure 91: Regional perspective costs and benefits per EV with managed charging 2019-2038

Using Avista's model for the Ratepayer Perspective baseline scenario without managed charging, a net benefit of $1,206 per vehicle is realized, significantly higher than E3's result of $387 per vehicle. This is due mostly to the lower generation capacity costs in Avista's model, where Avista is long on generation capacity until 2027.

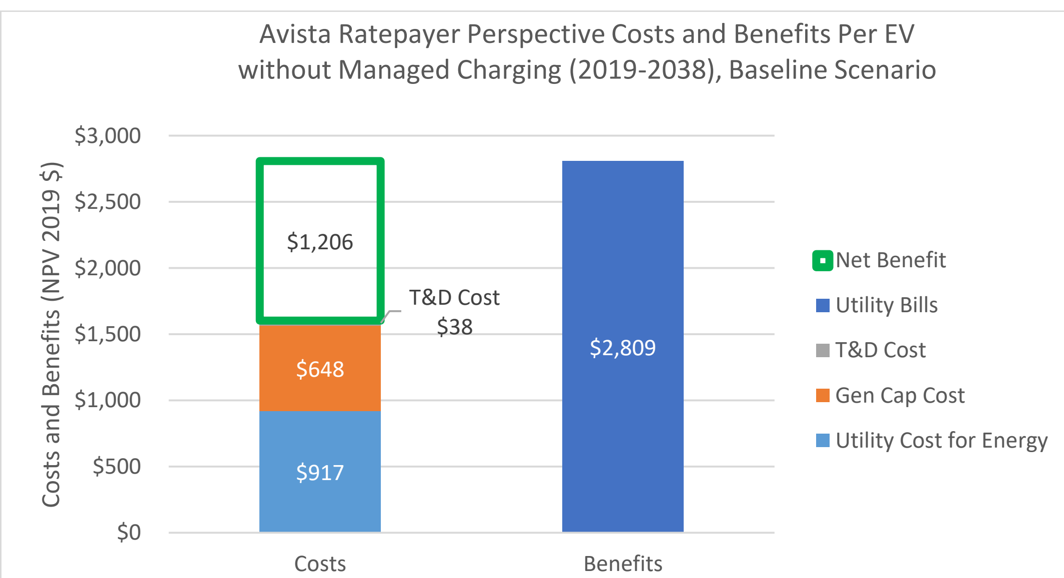

Figure 92: Ratepayer Perspective costs and benefits per EV, without managed charging 2019-2038

Considering the Ratepayer Perspective with managed charging, Avista's model results in additional net benefits of $463 per EV. Again, this is mostly due to reduced costs of generation capacity, assuming 75% reduction of residential peak loads from 4pm to 8pm. Given the assumed 10-year service life of EVs, actual costs to implement load management would reduce the net benefit, and would need to be less than $46 per EV per year, to result in a net benefit increase. Note that similar cost reductions that could result from implementing a TOU rate, would also have the effect of reducing benefits from utility billing revenue and corresponding net benefits.

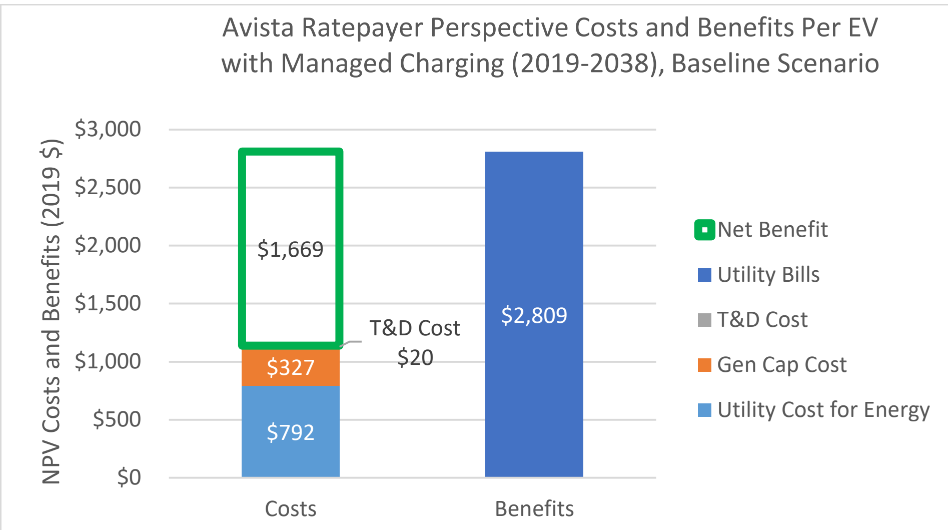

Figure 93. Ratepayer Perspective costs and benefits per EV, with managed charging 2019-2038

As the scenarios considered thus far represent relatively modest baseline adoption, the Avista model was used to consider a scenario of very high EV adoption over a longer timeframe, where EVs reach 90% of registered light duty vehicles by 2050, and 95% of light-duty vehicles by 2068, as shown below. E3 was consulted to develop an adoption curve and model input variables over this longer timeframe.

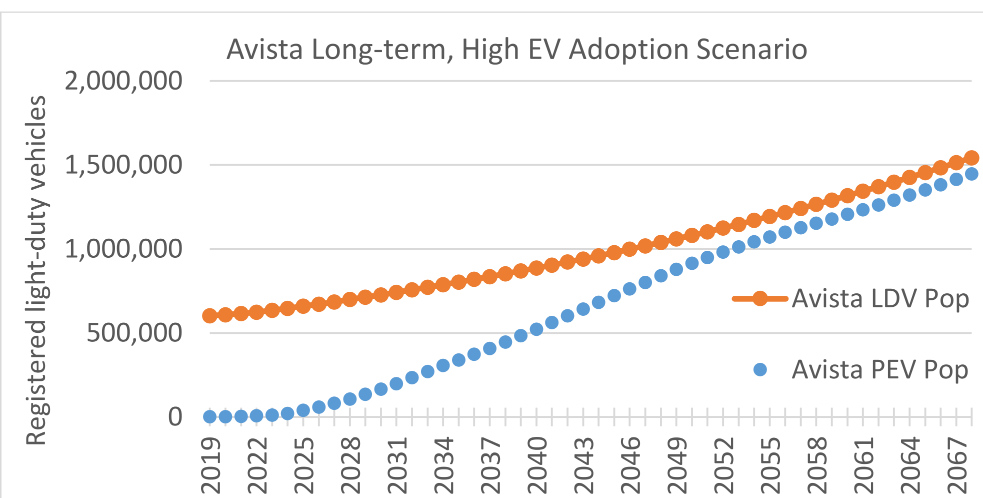

Figure 94: Long-term, High EV adoption scenario in Avista Washington service territory

In the long-term, very high adoption scenario, results for the Regional Perspective show a significant increase of 75% in net benefits compared to the baseline scenario, and a large but relatively smaller increase of 33% for the Ratepayer Perspective. This is due to the effect of lower EV purchase costs over time in the Regional Perspective, and higher utility revenue in the Ratepayer Perspective.

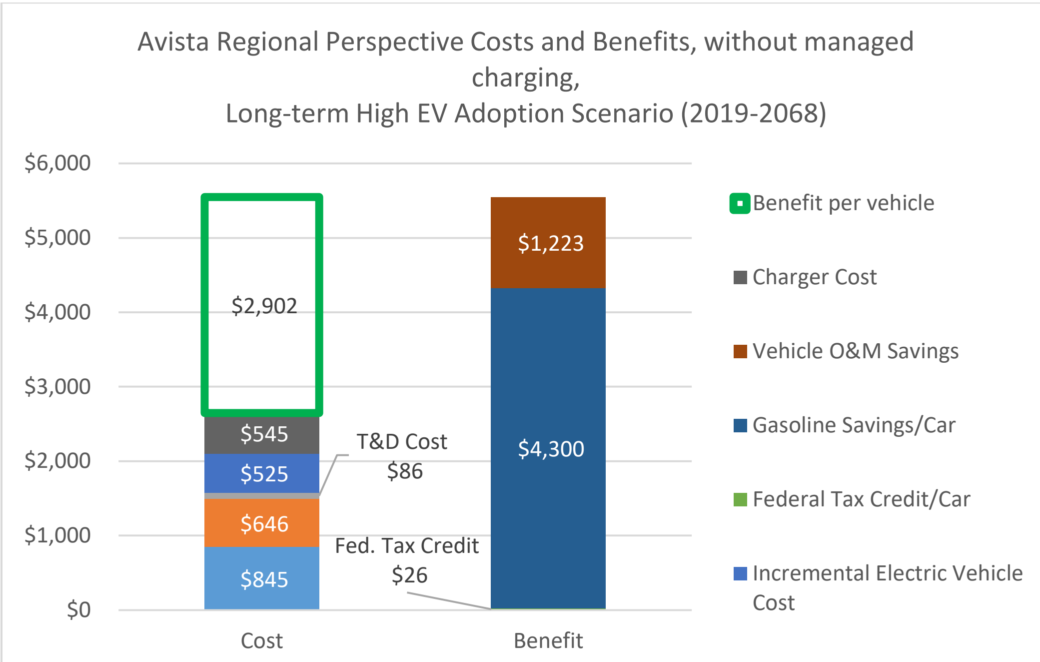

Figure 95. Avista Regional perspective NPV costs and benefits per EV for long term, high EV adoption scenario, 2019-2068

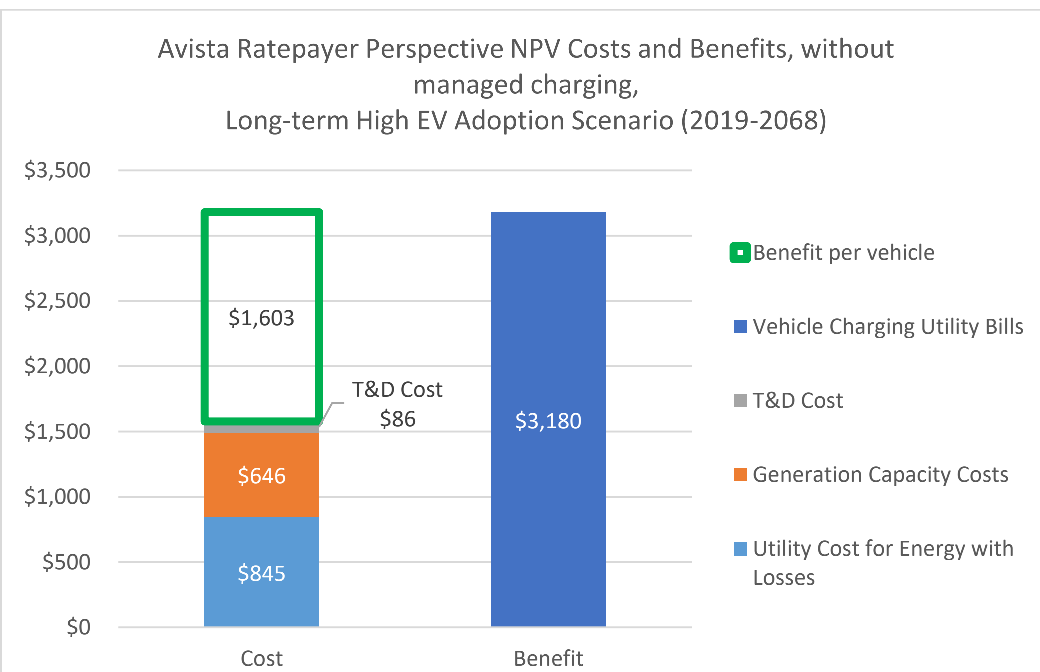

Figure 96. Avista Ratepayer perspective NPV costs and benefits per EV for long term, high EV adoption scenario, 2019-2068

Given the longer time horizon in this study, there is a larger uncertainty in model inputs and results, particularly as Distribution feeder and substation costs are assumed to be negligible as was the case for the baseline model. As was stated previously, the impact of other loads, second-order effects, and managed charging over this longer timeframe could conceivably have a significant negative or additional net-positive result. As such, this analysis and results should be viewed as a good starting point that must be further advanced and refined as EVs and the grid as whole evolves, rather than a definitive set of conclusions that will not change or are not subject to a number of uncertainties.

Expenses and Revenues

Expenditures from the beginning of the EVSE pilot (Schedule 077) on May 2, 2016, through September 15, 2019, totaled $3,851,124. Detailed expenses by category and type are as follows:

Expenditure Category / Type		Capital	O&M	Total	% of Total
Residential AC Level 2 EVSE	Design & Installation	$245,648	$0	$245,648	6.4%
	Hardware	$248,908	$0	$248,908	6.5%
	Maintenance & Repairs	$0	$13,586	$13,586	0.4%
	Premises Wiring Reimbursements	$0	$138,551	$138,551	3.6%
	Total	**$494,557**	**$152,137**	**$646,693**	**16.8%**
Workplace-Fleet-MUD AC Level 2 EVSE	Design & Installation	$347,791	$0	$347,791	9.0%
	Hardware	$413,270	$0	$413,270	10.7%
	Maintenance & Repairs	$0	$8,980	$8,980	0.2%
	Premises Wiring Reimbursements	$0	$193,471	$193,471	5.0%
	Total	**$761,061**	**$202,451**	**$963,512**	**25.0%**
Public AC Level 2 EVSE	Design & Installation	$259,805	$0	$259,805	6.7%
	Hardware	$212,075	$0	$212,075	5.5%
	Maintenance & Repairs	$0	$26,726	$26,726	0.7%
	Premises Wiring Reimbursements	$0	$57,934	$57,934	1.5%
	Total	**$471,880**	**$84,660**	**$556,540**	**14.5%**
DC Fast Charging Stations	Design & Installation	$613,852	$0	$613,852	15.9%
	Hardware	$282,738	$0	$282,738	7.3%
	Maintenance & Repairs	$0	$2,474	$2,474	0.1%
	Meter Billing	$0	$28,664	$28,664	0.7%
	Total	**$896,590**	**$31,138**	**$927,728**	**24.1%**
Other Project Expenses	Education & Outreach	$17,500	$31,114	$48,614	1.3%
	Community & Low-Income Programs	$0	$60,433	$60,433	1.6%
	EVSE Network & Data Management	$469,578	$0	$469,578	12.2%
	Misc General Expenses	$0	$16,537	$16,537	0.4%
	Auto Dealer Referrals	$0	$6,000	$6,000	0.2%
	Project Management & Analysis	$0	$155,490	$155,490	4.0%
	Total	**$487,078**	**$269,573**	**$756,651**	**19.6%**
Total		**$3,111,165**	**$739,959**	**$3,851,124**	

Table 20: EVSE Pilot Expenditure Details

Expenses were in-line with expectations, and under budget. New EVSE installations concluded on June 30, 2019. Ongoing operational expenses include network support, load management experiments

(V1G), and EVSE maintenance, estimated at $180,000 per year for the 419 AC Level 2 ports and 7 DCFC sites currently deployed.

Utility revenues from light-duty EVs include electric meter billing from residential and commercial EV customers, as well as DCFC user fees regulated by the UTC, currently set at $0.35/kWh for the seven DCFC on the area network. The table below provides estimated annual revenues from light duty EVs operated by Avista customers in Washington, based on average consumption data and billing rates, and DCFC session data.

Year	EVs	Annual Billing Revenue	DCFC User Fees	Total
2016	502	$121,581	$0	$121,581
2017	663	$160,494	$665	$161,159
2018	937	$226,706	$2,548	$229,254
2019 (projected)	1319	$319,246	$4,500	$323,746

Table 21: Annual utility revenue from Avista electric customers in Washington with EVs

Avista customers in Idaho as well as customers of other local utilities can contribute to utility revenue in Washington, from their potential use of AC Level 2 EVSE located in Washington at workplace and public locations, as well as public DCFC.

Conclusions and Recommendations

The Company gained valuable experience through the EVSE pilot, achieving its learning objectives while effectively supporting early EV adoption. Light-duty EV loads will be manageable from a grid perspective over at least the next decade, and EVs offer the potential to provide significant economic and environmental benefits for the long term. Customers were highly satisfied with Avista's pilot program that installed a variety of EVSE at both residential and commercial locations, which correlated with growing EV adoption in the region. Improvements and areas of focus were identified, including the need for more public charging, improved reliability of networked EVSE, strong education & outreach programs including dealer engagement, and workplace charging that provides grid benefits by mitigating evening peak loads on the system, while acting as a major catalyst for EV adoption.

Avista is now in an excellent position to propose a comprehensive Transportation Electrification Plan in both Washington and Idaho service territories, that includes major areas of education & outreach, dealer engagement, community & low-income, EVSE infrastructure, load management, commercial fleets, rate design, internal programs, planning, and grid integration. Through this long-term effort, the Company intends to innovate and serve our customers and communities in electrifying the transportation sector, building a better energy future for all in partnership with industry, customers, local governments and policymakers.

Key Takeaways from the EVSE pilot:

1. Empirical data collected from the EVSE pilot and economic modeling of light-duty EV load profiles show that grid impacts over at least the next decade are very manageable and that net economic benefits can extend to all customers – from both a regional and ratepayer perspective, not just to those driving EVs. In addition, significant reductions of GGE emissions and other harmful air pollutants may be achieved with EVs. These economic and environmental benefits may be further increased with effective load management that shifts more electric load to off-peak periods. However, grid impacts and costs resulting from EV peak loads could become significant over longer time horizons, with higher EV adoption, and as other loads and the grid change. The EVSE pilot represents a good start in the Company's ongoing effort to understand how EV loads may be optimally integrated and managed, in an evolving system that brings the most benefit to all customers.

2. Avista was able to cost-effectively install EVSE for a wide variety of uses and locations, resulting in high customer satisfaction for both residential and commercial customers. In addition, the EVSE pilot program and activities correlated with a significant increase in the rate of EV adoption in the area. This provides strong evidence that utility programs supporting EV adoption, including EVSE owned and maintained by the utility, are viable and effective in supporting and enabling beneficial EV

growth. Flexible and committed partnerships with industry providers, a focus on providing value for the customer, and installation contractor performance were keys to success in Avista's pilot.

3. Workplace charging stands out as a powerful catalyst for EV adoption, while simultaneously providing grid benefits from reduced EV charging at home coincident with evening peak demand, that occurs year-round. Workplace charging can also increase peak loads during cold winter mornings, which may be mitigated by utilizing EVSE with lower power output that is adequate and satisfactory for the customer, and other load management strategies.

4. Low dealer engagement, a lack of EV inventories, and persistent customer awareness and perception issues continue to be a major barrier to mainstream EV adoption in the region. With its strong customer and community relationships, the utility can help overcome these issues with robust education and outreach programs, including dealer engagement.

5. Avista successfully demonstrated the use of EVs to reduce operating costs for a local non-profit and government agency serving disadvantaged customers. The Company expects local stakeholder engagement to continue in the development and expansion of similar programs, as well as other innovative ways to serve communities and low-income customers, consistent with the UTC Policy Statement.

6. Customer survey responses and comments showed a widespread desire for more public AC Level 2 and DC fast charging sites, which may be supported in future utility programs and rate designs. EVSE operating costs are an important factor to address, in order to gain broader support and sustainable expansion that serves a growing EV fleet. In particular, analysis of DCFC utilization, monthly meter billing, and user fee revenue illustrates that operating expenses may not be recovered under existing rate schedules and the traditional application of demand charges, thereby posing a significant barrier to DCFC expansion and EV adoption. A new rate design should be developed to address these issues while reasonably recovering utility costs.

7. Networked EVSE reliability, uptime, costs, and customer experience are all important opportunities for improvement, and should be pursued by Avista in partnership with EVSE and EVSP providers. Experience gained from the EVSE pilot has reinforced the importance of utilizing interoperable networked EVSE, avoiding closed systems that can lead to stranded assets and low return on investment. In contrast, non-networked EVSE are extremely reliable and cost effective, and should be utilized wherever possible unless data collection, user fee transactions, remote monitoring, or other requirements necessitate the use of networked EVSE.

8. Load management experiments showed that residential customers remained satisfied while the utility curtailed peak EV loads by 75%, without additional compensation or incentives other than the installation of the EVSE owned and operated by the utility. More DR experimentation may show the feasibility to shift an even higher percentage of peak load. While load management utilizing DR and V1G technology and methods appears acceptable from a customer perspective, reliability and costs must be significantly improved to attain net grid benefits and enable practical application at scale.

9. Data and analysis were somewhat limited by the available pool of participants and EVSE sites, however results compared well with other studies using larger population samples, and EVSE data was satisfactorily verified by telematics data. As the industry evolves, a greater variety of light-duty EVs with larger battery packs may become the norm. In this respect, the EV load profiles developed and examined in this study may under-predict electric consumption and peak loads to some degree. The Company should monitor and stay abreast of industry developments and implications as they may affect the grid and the opportunity to best serve customers in the electrification of transportation.

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Appendix A: Glossary of Terms & Abbreviations

Sources: Altas HUB, Alliance for Transportation Electrification, Wikipedia, and from SEPA as adapted from the California Public Utilities Commission (CPUC) Vehicle Grid Integration Communications Protocol Working Group Glossary of Terms (http://www.cpuc.ca.gov/vgi/), 2017. These definitions are "working definitions" and are not meant to be formal or conclusive, with some editing by the authors.

AC, DC: alternating current, direct current. The U.S. electricity grid generally operates on AC. A typical household outlet is 110–120 VAC (volts alternating current). Larger home appliances use 240 VAC. Electric car batteries operate on DC.

AC Level 2 Charger: An AC Level 2 (L2) charger can be found in both commercial and residential locations. They provide power at 220V-240V and various amperages resulting in power output ranging from 3.3kW to 19.2kW.

AFDC: U.S. DOE Alternative Fuel Data Center website containing a wealth of information on alternative fuels and vehicles.

Aggregator: An aggregator is a third party intermediary linking electric vehicles to grid operators. Increasingly, aggregators are stepping into a role of facilitating interconnections to entities that provide electricity service. Broadly, aggregators serve two roles: downstream, they expand the size of charging networks that electric vehicle (EV) customers can access seamlessly, facilitating back-office transactions and billing across networks; upstream, they aggregate a number of EVs and Charging Station Operators (CSO) to provide useful grid services to Distribution Network Operators (DNO) and Transmission System Operators (TSO).

AV: Autonomous Vehicle is a vehicle that can guide itself without human input. There are various levels of autonomous technology as defined by SAE from level 0 (no driving automation) to level 5 (full driving automation).

BEV (Battery Electric Vehicle): Battery Electric Vehicle is a vehicle with a drivetrain that is only powered by an onboard battery and electric motor(s).

CAV: Connected Autonomous Vehicle is an autonomous vehicle that has vehicle-to-vehicle or vehicle-to-infrastructure capabilities.

C2 Device - a telematics hardware device, from FleetCarma, that is capable of logging driving and charging data from electric vehicles.

CCS: The Combined Charging System is a charging method for electric vehicles from the SAE J1772 connector. The plug contains a DC and AC option and is also referred to as a Combo connector. The automobile manufacturers supporting this standard include BMW, Daimler, FCA, Ford, General Motors, Hyundai, Jaguar, Tesla, and Volkswagen.

Charger: A layperson's term for the on-board or off-board device that interconnects the EV battery with the electricity grid and manages the flow of electrons to recharge the battery. Also known as Electric Vehicle Supply Equipment (EVSE).

Charge Session: A charge session is period of time an electric vehicle (EV) is actively charging its battery through the connection with a charger (EVSE).

Charging: Charging is the process of recharging the onboard battery of an electric vehicle.
Charging Level: The terms, AC Level 1, AC Level 2, and DC Fast describe how energy is transferred from the electrical supply to the car's battery. Level 1 is the slowest charging speed. DC Fast is the fastest. Charging rate varies within each charging level, depending on a variety of factors including the electrical supply and the car's capability.
Charging Station: The physical site where the Electric Vehicle Supply Equipment (EVSE) (also known as the charger) or inductive charging equipment is located. A charging station typically includes parking, one or more chargers, and any necessary "make-ready equipment" (i.e., conduit, wiring to the electrical panel, etc.) to connect the chargers to the electricity grid, and can include ancillary equipment such as a payment kiosk, battery storage, or onsite generation.
Charger: A layperson's term for on-board or off-board device that interconnects the EV battery with the electricity grid and manages the flow of electrons to recharge the battery. Also known as Electric Vehicle Supply Equipment (EVSE).
CHAdeMO: "CHArge de MOve" is the trade name of a quick charging method formed by Tokyo Electric Power Company, Nissan, Mitsubishi, Fuji Heavy Industries, and later joined by Toyota.
Connector: The plug that connects the electricity supply to charge the car's battery. J-1772 is the standard connector used for Level 1 and Level 2 charging. CCS or "Combo" connectors are used for DC Fast charging on most American and European cars. CHAde-MO is the connector used to DC Fast charge some Japanese model cars.
Demand Response (V1G, direct load management, controlled charging, intelligent charging, adaptive charging, or smart charging): Central or customer control of EV charging to provide vehicle grid integration (VGI) offerings, including wholesale market services. Includes ramping up and ramping down of charging for individual EVs or multiple EVs whether the control is done at the EVSE, the EV, the EV management system, the parking lot EV energy management system or the building management system, or elsewhere.
DER: Distributed Energy Resource
DERMS: Distributed Energy Resource Management System
Direct Current Fast Charger (DCFC): Direct Current Fast Charging equipment is designed to rapidly deliver direct current to a vehicle's onboard battery. DCFCs commonly have power ratings of 50kW or higher.
Direct Install Costs: Corresponding to the direct costs associated with the installation of an EVSE. These costs include labor and materials for mounting the EVSE, wiring connections, network connections, signage, EVSE testing, and work to complete required permitting and inspections.
DOE: Department of Energy is commonly used to refer to the U.S. energy agency or a State energy agency.
DOT: Department of Transportation is commonly used to refer to the U.S. Dept of Transportation or a State transportation agency.
DR: Demand Response (see Demand Response)
DRMS: Demand Response Management System
E&O: Education and Outreach

Electric Vehicle Service Provider (EVSP): Electric Vehicle Service Provider also known as a Network Service Provider (NSP), provides services related to chargers, such as data communications, billing, maintenance, reservations, and other non-grid information. The EVSP sends grid commands or messages to the EV or EVSE (e.g., rates information or grid information based on energy, capacity or ancillary services markets; this is sometimes called an electricity grid network services provider). The EVSP may send non-grid commands (e.g., reservations, billing, maintenance checks), and may receive data or grid commands from other entities, as well as send data back to other entities.

Electric Vehicle Supply Equipment (EVSE): Electric Vehicle Supply Equipment, also often called an EV charger, is standalone equipment used to deliver power to the input port connection on an EV. This device includes the ungrounded, grounded, and equipment grounding conductors, the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets or apparatus associated with the device, but does not include Premises Wiring.

ENERGY STAR for EVSE: Compliance standards for electric vehicle supply equipment to receive ENERGY STAR certification.

EPA: Environmental Protection Agency is commonly used to refer to the U.S. environmental protection agency or a State environmental protection agency

EPRI: Electric Power Research Institute conducts research, development, and demonstration projects to benefit the public in the United States and internationally.

EV: Electric Vehicle is the commonly used name for vehicles with the capability to propel the vehicle fully or partially with onboard battery power and contains a mechanism to recharge the battery from an external power source. EVs can include full battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

EVSE: see Electric Vehicle Supply Equipment

EVSP: see Electric Vehicle Service Provider

Fleet EVSE: EVSE for use by business owned vehicles.

GGE: Greenhouse Gas Emissions

GHG: Greenhouse Gas

GMS: Grid Management System is based on an architecture and guiding principles to proactively support changing requirements while minimizing disruption to existing operations, consumer commitments, and regulatory requirements.

GSE: Ground Support Equipment is equipment used in airports such as belt loaders, luggage tags, and water trucks.

HDV: Heavy-Duty Vehicles have a gross vehicle weight above 26,000 pounds.

ICE (Internal Combustion Engine): ICE is an acronym for Internal Combustion Engine. ICE vehicles typify the majority of gasoline/diesel/natural gas vehicles that make up the majority of automotive fleet.

ICCT: International Council on Clean Transportation. ICCT is a research group and has published several reports transportation electrification

IEEE: Institute of Electrical and Electronics Engineers is a professional association whose objectives are the educational and technical advancement of electrical and electronic engineering, telecommunications, computer engineering and allied disciplines.

IEEE 2030.5: IEEE 2030.5 is a standard for communications between the smart grid and consumers. The standard is built using Internet of Things (IoT) concepts and gives consumers a variety of means to manage their energy usage and generation.

IEEE P2690: This standard defines communications between Electric Vehicle Charging Systems and a device, network, and services management system, which is typically based "in the cloud" but could also include interfaces to site-specific components or systems (e.g., building energy management systems).

IGP: Integrated Grid Planning

Interoperability: The ability of devices, systems, or software provided by one vendor or service provider to exchange and make use of information, including payment information, between devices, systems, or software provided by a different vendor or service provider.

IOU: Investor-Owned Utility

ISO 15118-1:2013: ISO 15118 specifies the communication between EV and the EVSE.

J1772: also known as a "J plug", is a North American standard for electrical connectors for electric vehicles maintained by the Society of Automotive Engineers (SAE) International, and has the formal title "SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler". It covers the general physical, electrical, communication protocol, and performance requirements for the electric vehicle conductive charge system and coupler.

L2 Station: See AC Level 2 Charger.

LBEV (Long Range Battery Electric Vehicles): LBEVs are BEVs (see BEV) that have an average driving range greater than 200 miles for a full battery charge.

LDV: Light-Duty Vehicles have a gross vehicle weight at or below 14,000 pounds

Level 1: Level 1 is part of the charging standard defined by the SAE for charging equipment using standard 120V household electricity.

Level 2: Level 2 is part of the charging standard defined by the SAE for charging equipment using 208V or 240V electricity, similar to the power level used for ovens and clothes dryers.

Load Curves: A load curve or load profile is a graph of electrical load over time. This is useful for utilities to determine how much electricity will need to be available at a given time for efficiency and reliability of power transmission.

Make-ready: Make-ready describes the installation and supply infrastructure up to, but not including the charging equipment. The customer procures and pays for the charging equipment, which could be funded by a separate rebate or other incentive by the electric company or other entity.

Managed Charging: Managed charging allows an electric utility or a third-party to control the charging of an EV remotely. This entity could enable or disable charging, or could control the power level for charging.

MDV: Medium-Duty Vehicles have a gross vehicle weight more than 14,000 and less than 26,001 pounds.

MUD: Multi-Unit Dwellings are a type of residence in which multiple housing units are located within a single building or building complex (e.g., an apartment complex, duplex, condos, etc). This is synonymous with a multi dwelling unit (MDU). EVSE at MUDs are intended for use by MUD residents. EVSE located on hotel or motel properties are also included within MUD session data in this report.

NEMA: National Electric Manufacturers Association

Networked EVSE: These devices are connected to the Internet via a cable or wireless technology and can communicate with the computer system that manages a charging network or other software systems, such as a utility demand response management system (DRMS) or system that provides charging data to EV drivers on smartphones. This connection to a network allows EVSE owners or site hosts to manage who can access EVSE and how much it costs drivers to charge.

NGO: Non-Governmental Organization

Non-networked EVSE: These devices are not connected to the internet and provide basic charging functionality without remote communications capabilities. For example, most Level 1 EVSE are designed to simply charge a vehicle; they are not networked and do not have additional software features that track energy use, process payment for a charging session, or determine which drivers are authorized to use the EVSE. Secondary systems that provide these features can be installed to supplement non-networked EVSE.

NREL: National Renewable Energy Laboratory

NPV: Net Present Value is the sum of future cash flows using a discount rate, such that it takes into the account of the time value of money.

OATI: Open Access Technology International, Inc.

OEM: Original Equipment Manufacturer, commonly used to refer to automobile manufacturers.

OpenADR 2.0b: Open Automated Demand Response (OpenADR) is an open and standardized way for electricity providers and system operators to communicate DR signals with each other and with their customers using a common language over any existing IP-based communications network, such as the Internet.

OCPP: The goal for the Open Charge Point Protocol (OCPP) is to offer a uniform solution for the method of communication between charge point and central system.

PEV (Plug-in Electric Vehicle or PEV): see EV

PHEV (Plug-in Hybrid Electric Vehicle): Plug-in Hybrid Electric Vehicle is a plug-in electric vehicle that can be powered by either or both a gasoline/diesel engine or an onboard battery.

Platform: The base hardware and software upon which software applications run.

Port: see Connector

Premises Wiring: electrical supply panel and dedicated 208/240VAC circuits that suppy electricity directly to EVSE. This includes the protective breaker at the supply panel, wiring, final junction box, receptacle and all attachments and connections.

Proprietary Protocol: A protocol that is owned and used by a single organization or individual company.

Protocol: Set of rules and requirements that specify the business process and data interactions between communicating entities, devices, or systems. Most protocols are voluntary in the sense that they are offered for adoption by people or industry without being mandated in law. Some protocols become mandatory when they are adopted by regulators as legal requirements. A standard method of exchanging data that is used between two communicating layers.

Public EVSE: Public EVSE can be found in multiple types of locations including but not limited to business parking lots, public buildings, or adjacent to public right-of-way. Public AC Level 2 EVSE have a standard J1772 connector, while DCFC have a CHAdeMO and/or CCS connectors. Tesla vehicles may utilize public EVSE with an adapter, however other EVs cannot use Tesla EVSE, as no adapters are available.

Residential EVSE: located within a person's home, most often in a garage, residential EVSE are usually used by 1 or 2 EVs intended only for use by the home owner.

Ride and Drive: Event where individuals are given the opportunity to look at EVs, talk with EV drivers, and ride in or drive an EV.

RPS: Renewable Portfolio Standard

OCPP (Open Charge Point Protocol): An application protocol for communication between EVSEs and EVSP servers.

Standard: An agreed upon method or approach of implementing a technology that is developed in an open and transparent process by a neutral, non-profit party. Standards can apply to many types of equipment (e.g., charging connectors, charging equipment, batteries, communications, signage), data formats, communications protocols, technical or business processes (e.g., measurement, charging access), cybersecurity requirements, and so on. Most standards are voluntary in the sense that they are offered for adoption by people or industry without being mandated in law. Some standards become mandatory when they are adopted by regulators as legal requirements.

Standardization: Process where a standard achieves a dominant position in the market due to public acceptance, market forces, or a regulatory mandate.

State of Charge (SOC): The level of charge of an electric battery relative to its capacity.

TCO: Total Cost of Ownership is a financial estimate that accounts for both purchase price and continued, variable operating costs of an asset.

TE: Transportation Electrification

Telematics: In the context of EV charging, including managed charging, telematics refers to the communication of data between a data center (or "cloud") and an EV, including sending control commands and retrieving charging session data.

TNC: Transportation Network Company is a company that connects passengers with drivers via a mobile app or website. Example companies include Uber and Lyft.

TOU (Time of Use) Rate: Time-of-use often refers to electricity rates that can vary by the time of day. TOU rates can also be structured to vary by season.

TRU: Truck Refrigeration Unit is a device that is installed in a truck to refrigerate a truck's storage compartment.

Use Case: Defines a problem or need that can be resolved with one or more solutions (technical and/or non-technical) and describes the solutions. The use case is a characterization of a list of actions or event steps, typically defining the interactions, describing the value provided and identifying the cost.

Uptime: Defines the amount of time an EVSE is functionally able to provide a charge when requested, as opposed to a faulted state where no charge may occur. Depending on configuration settings, networked EVSE may still be able to provide a charge and maintain uptime status when offline from the network connection.

Workplace EVSE: Workplace EVSE are located on business property, primarily intended for use by employees. However, often the business owner will allow use by visitors or the public, if it is located in an accessible location.

V1G: V1G refers to vehicles only capable of receiving power from the electrical grid to the onboard battery. This can also commonly be referred to as demand response for EVs

V2B: Vehicle-to-Building refers to vehicles capable of sending power from the onboard battery to a building.

V2G: Vehicle-to-Grid refers to vehicles capable of receiving power to the onboard battery from the electrical grid and vice-versa.

V2H: Vehicle-to-Home refers to vehicles capable of sending power from the onboard battery to a home.

VMT: Vehicle Miles Traveled

VPP: Virtual Power Plant (VPP) is a cloud-based distributed power plant that aggregates the capacities of heterogeneous energy resources for the purposes of enhancing power generation, as well as trading or selling power on the open market.

ZEV: Zero Emission Vehicle is a vehicle with no tailpipe emissions and includes battery electric vehicles and hydrogen fuel cell electric vehicles.

Appendix B: Data Validation

The primary dataset used for analysis includes 64,574 charging sessions logged by networked EVSE from January 1, 2017 through May 24, 2019. Of the 64,578 sessions, approximately 10,391 recorded less than 1 kWh of consumed energy and were removed from the study. Additionally, 827 logged connection times greater than 70 days were removed from the data set. The remaining 53,356 sessions were utilized for analysis of various load profiles across networked residential, workplace, public, fleet, and multi-unit dwelling EVSE. High confidence in the accuracy and validity of EVSE session data was established by close comparison with a separate dataset of identical sessions obtained from a smaller number of vehicle telematics devices, as detailed below

Greenlots Data

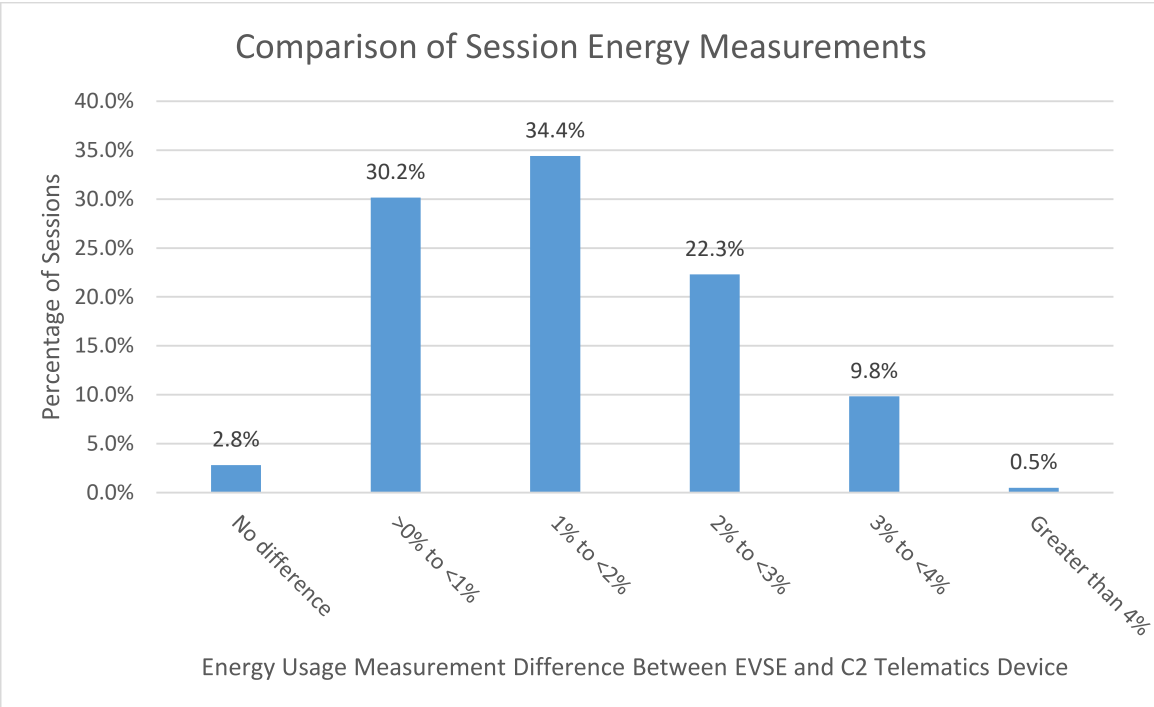
Charging session data from EVSE networked to the Greenlots SKY server included user ID, EV make and model, station ID, station location, session start/stop time, station type, power level, consumed energy, collected fees, payment method, DR event start/stop time, and DR opt-out. Unregistered users such as visitors that did not participate as residential customers in the pilot program or those that used credit cards at DCFC, were recorded as "anonymous" user IDs with unknown EV make/model.

Actual charging time differs from connection time especially in the case of AC Level 2 sessions where the vehicle is parked for long periods of time and often charges to full battery capacity, such as at home and at work. Rather than using detailed interval data for charging time analysis, the charging time for AC Level 2 sessions were calculated by using the recorded energy consumed in the session, distributed by hour using the charge rate of the EV. For example, a charge duration of 2 hours is calculated from a reported 13.2 kWh consumption and an EV rectified at 6.6 kWh. Time remainders are rounded up to the nearest hour, approximating the typical ramp-down period of 45 to 60 minutes as the battery nears a full state of charge. Note that consumed energy data from the networked EVSE does not include EVSE energy losses, conservatively estimated at 1.5%.

Validation of EVSE Data

To better understand driver behaviors and validate data from Greenlots, several customers participating in Avista's EVSE program agreed to install a FleetCarma telematics device in their EV. The telematics device captures charging data as well as battery state of charge, battery efficiency, trip distance and speed, and energy losses from rectification and auxiliary loads.

Comparison and analysis of identical session data from four drivers in over 610 charging sessions, an average, absolute difference of 1.6% was calculated between the FleetCarma and Greenlots EVSE dataset, with a median absolute difference of 1.5%. The histogram below clarifies the distribution of the difference seen in these 643 sessions, with 99.5% of sessions showing an energy measurement difference of less than 4%, and three of the 610 charging sessions as outliers with a 4% or greater difference.



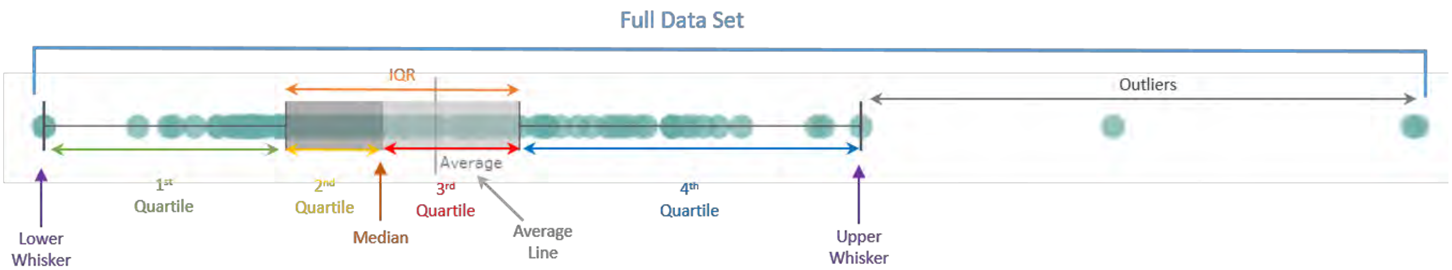
Ambient conditions, EVSE losses, and some uncertainty in rectification losses contribute to the observed differences. For some vehicles, FleetCarma estimates rectification losses as a percentage of energy measured entering the battery. Since rectification losses vary based on speed of charging and other factors, this would account for some of the observed differences seen in the measurements. While both the EVSE and C2 devices measure power by taking periodic measurements of voltage and amperage, the C2 does so by reading signals from the EV's controllers while the EVSE uses its internal metrology equipment. Therefore, some loss differences between the EVSE's metrology equipment and the EVs accounts for some difference in energy measured between the two devices, typically between 0.1% to 1.5%.[46] These differences also vary based on ambient temperature, voltage and amperage, state of the EVSE connector and cable, internal EV systems, and other factors.

Overall, the relatively small average difference of less than 2%, and relatively narrow distribution over 610 sessions provides high confidence in the accuracy and validity of session data and derivative analyses provided in this report.

[46] Apostolaki-Iosifidou, Codani and Kempton. "Measurement of power loss during electric vehicle charging and discharging." Energy 127 (2017) 730-742.

Appendix C: Explanation of Box Plots

Many box plots are utilized in this report to help illustrate distribution of data. They are a statistical visualization tool that separates the data set into 4 quartile groups of “non-outlier” data, and outlier data below the 1st quartile and above the 4th quartile limits.



Interquartile Range (IQR): Represented by the shaded boxes near the middle of the data set. The IQR is the middle 50% of the recorded values in the entire data set, and by definition includes the 2nd and 3rd quartiles of non-outlier data. This range also contains the median value, and usually the average. Mathematically, the IQR is defined as $IQR = Q_{3MAX} – Q_{2MIN}$

Median: The median value is defined as the value separating the lower and upper 50% of the data values. Also considered to be the ‘middle value’ or the value that separates the 2nd and 3rd quartiles.

Average Line: The average line represents the calculated average of all the values within the full data set including the outliers. The average is calculated by taking the sum of all the data values within the data set and dividing by the number of data values, and is usually within the IQR.

Whiskers: Visually represented by a horizontal line ending at an intersection with a vertical line, the whiskers represent the boundary between the “outlier” and “non-outlier” data coinciding with the limits of the 1st and 4th quartiles. The two values are calculated as:

Upper Whisker (UW) = $Q3_{MAX} + (IQR * 1.5)$

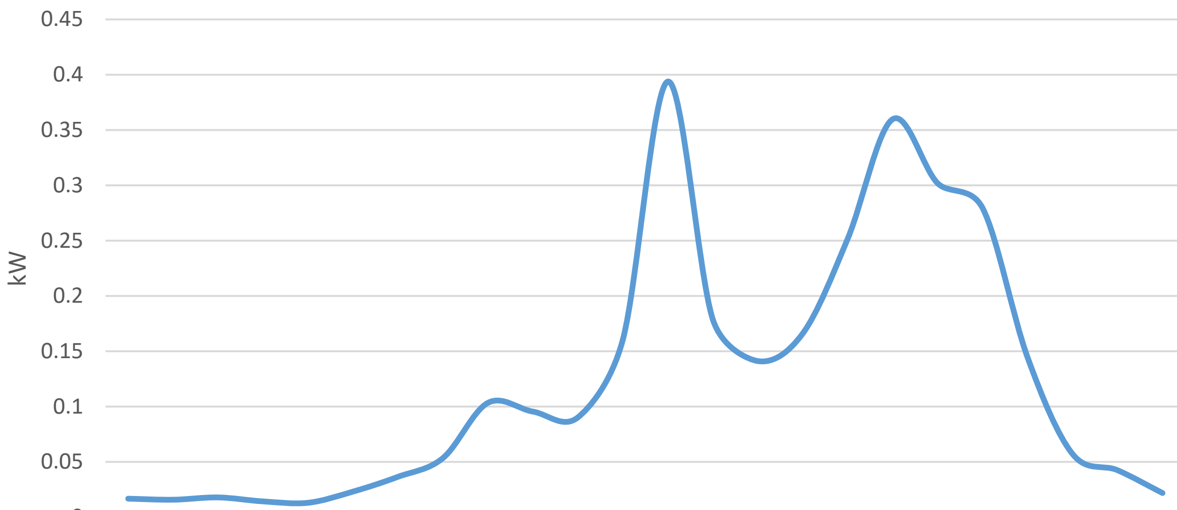
Lower Whisker (LW) = $Q2_{MIN} – (IQR * 1.5)$

(the Lower Whisker defaults to 0 if the calculated value is less than 0 and there are no values in the sample less than 0)

Outliers: Outliers are values beyond the minimum and maximum established by the 1st and 4th quartiles. Outlier data may provide clues into unusual circumstances within the dataset that need additional attention, or the possible existence of invalid or “bad data” which should be investigated and eliminated from the data set, as appropriate.

Appendix D: Assorted Charging Profiles

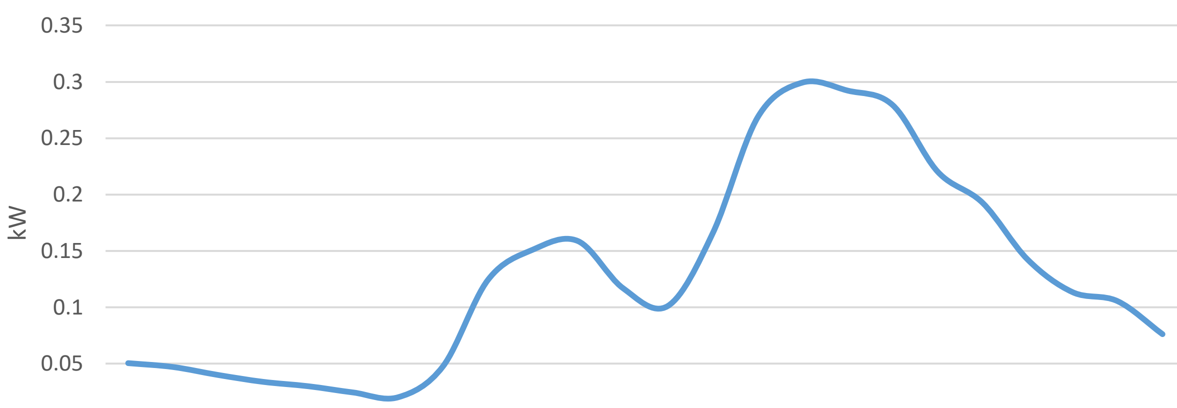
Strip Mall Location - Per Port



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
kW	0.02	0.02	0.02	0.01	0.01	0.02	0.04	0.05	0.1	0.1	0.09	0.16	0.39	0.18	0.14	0.17	0.25	0.36	0.3	0.28	0.14	0.06	0.04	0.02

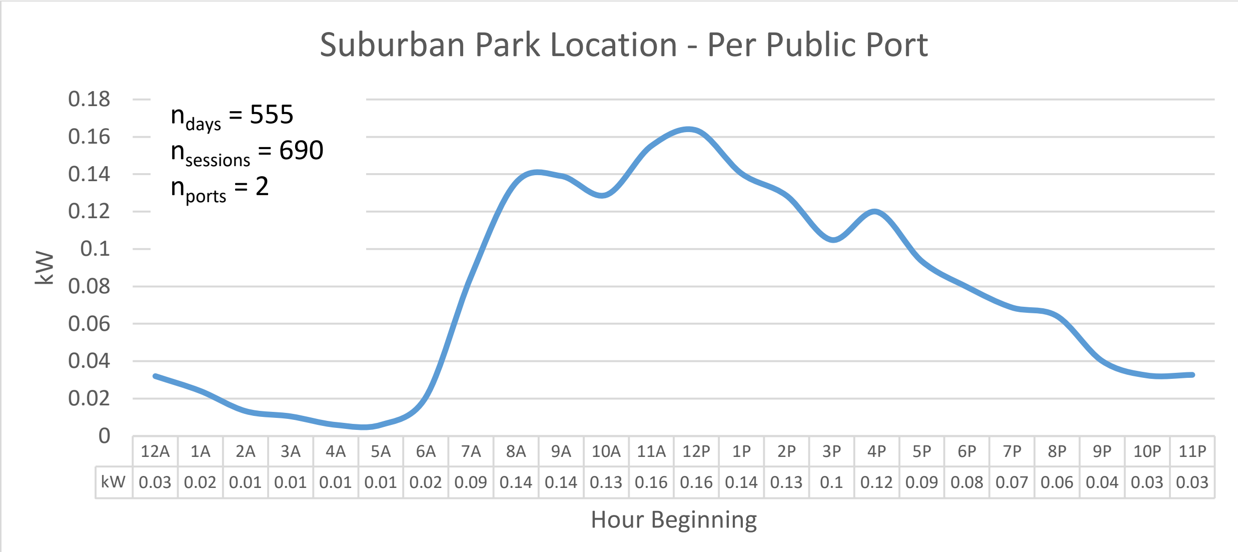
Hour Beginning

Suburban Grocer - Per Port

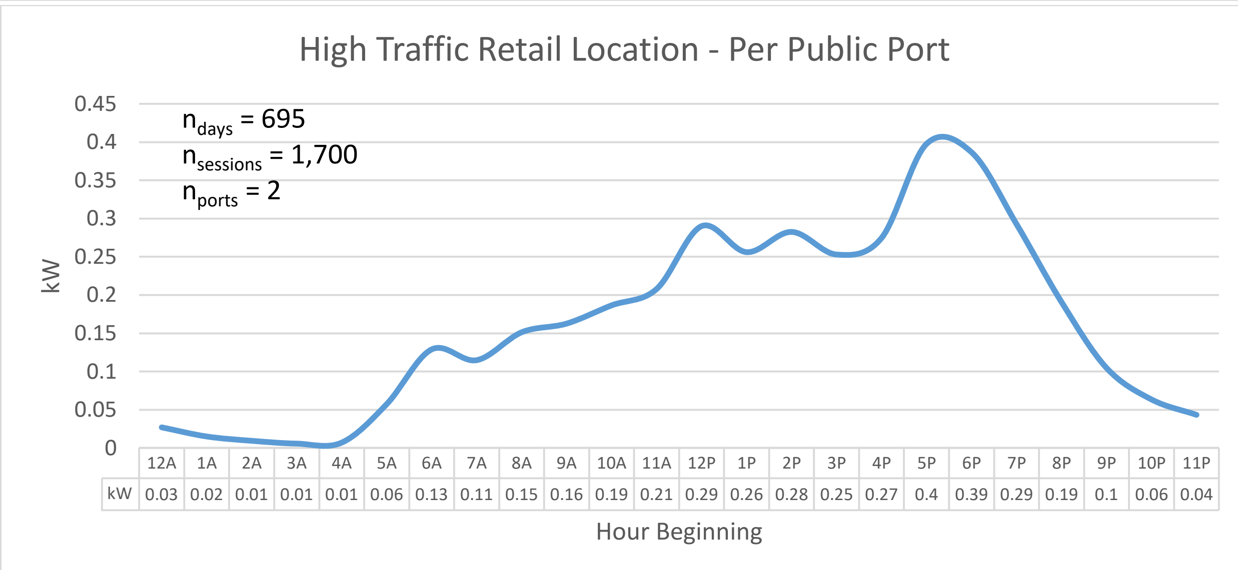


	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
kW	0.05	0.05	0.04	0.03	0.03	0.02	0.02	0.05	0.12	0.15	0.16	0.12	0.1	0.17	0.27	0.3	0.29	0.28	0.22	0.19	0.14	0.11	0.11	0.08

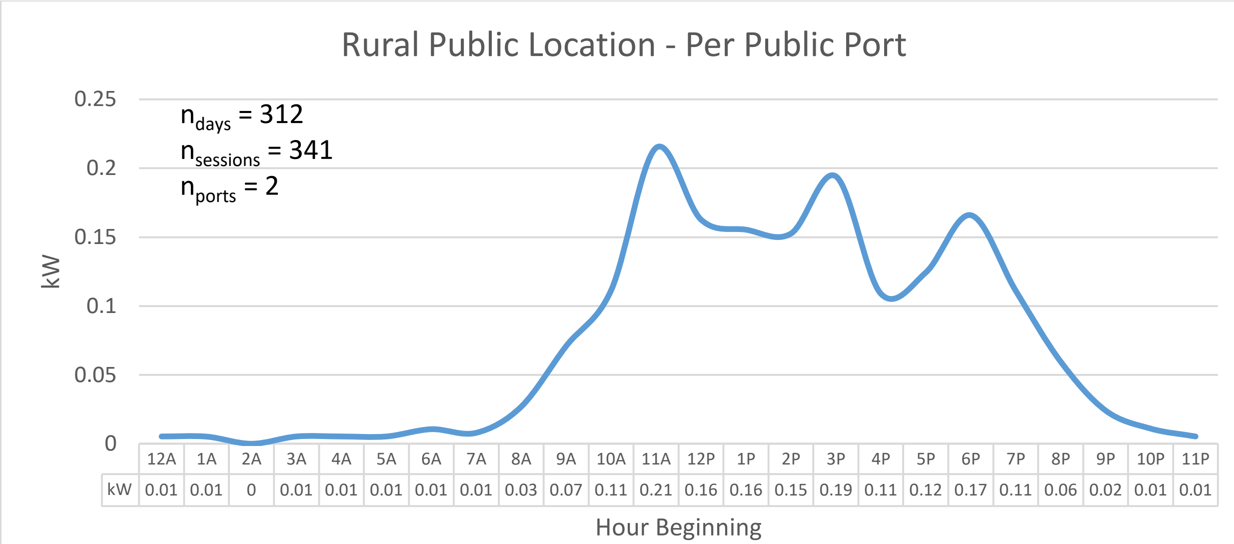
Hour Beginning



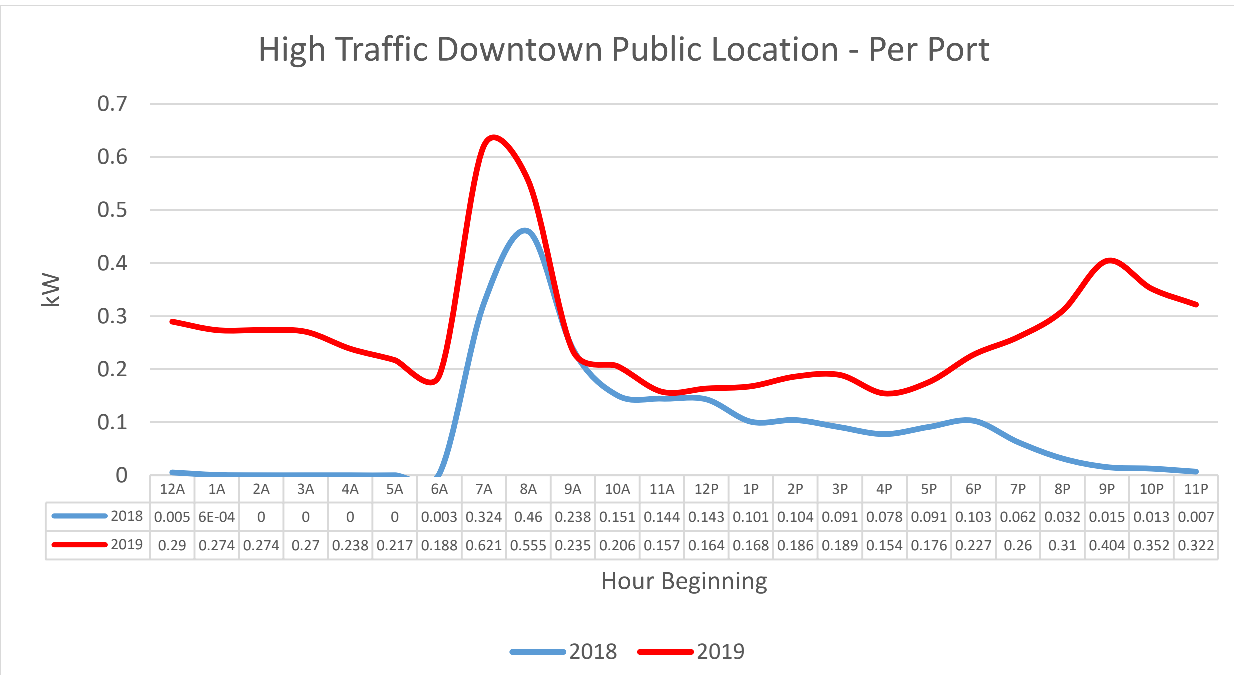
	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
kW	0.03	0.02	0.01	0.01	0.01	0.01	0.02	0.09	0.14	0.14	0.13	0.16	0.16	0.14	0.13	0.1	0.12	0.09	0.08	0.07	0.06	0.04	0.03	0.03



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
kW	0.03	0.02	0.01	0.01	0.01	0.06	0.13	0.11	0.15	0.16	0.19	0.21	0.29	0.26	0.28	0.25	0.27	0.4	0.39	0.29	0.19	0.1	0.06	0.04



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
kW	0.01	0.01	0	0.01	0.01	0.01	0.01	0.01	0.03	0.07	0.11	0.21	0.16	0.16	0.15	0.19	0.11	0.12	0.17	0.11	0.06	0.02	0.01	0.01



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
2018	0.005	6E-04	0	0	0	0	0.003	0.324	0.46	0.238	0.151	0.144	0.143	0.101	0.104	0.091	0.078	0.091	0.103	0.062	0.032	0.015	0.013	0.007
2019	0.29	0.274	0.274	0.27	0.238	0.217	0.188	0.621	0.555	0.235	0.206	0.157	0.164	0.168	0.186	0.189	0.154	0.176	0.227	0.26	0.31	0.404	0.352	0.322

Appendix E: Charge Session Box Plots for Workplace Charging sample Group

Appendix E provides session data for the 12 networked EV drivers within the sample workplace charging group who regularly charged at their workplaces. Drivers within this sample group initiated charge sessions at designated workplace EVSE approximately 2.3 times per week. Data from workplace charging sessions show an average connection time of 3.8 hours, with substantial variation from driver to driver.

Workplace EVSE Session Connection Duration

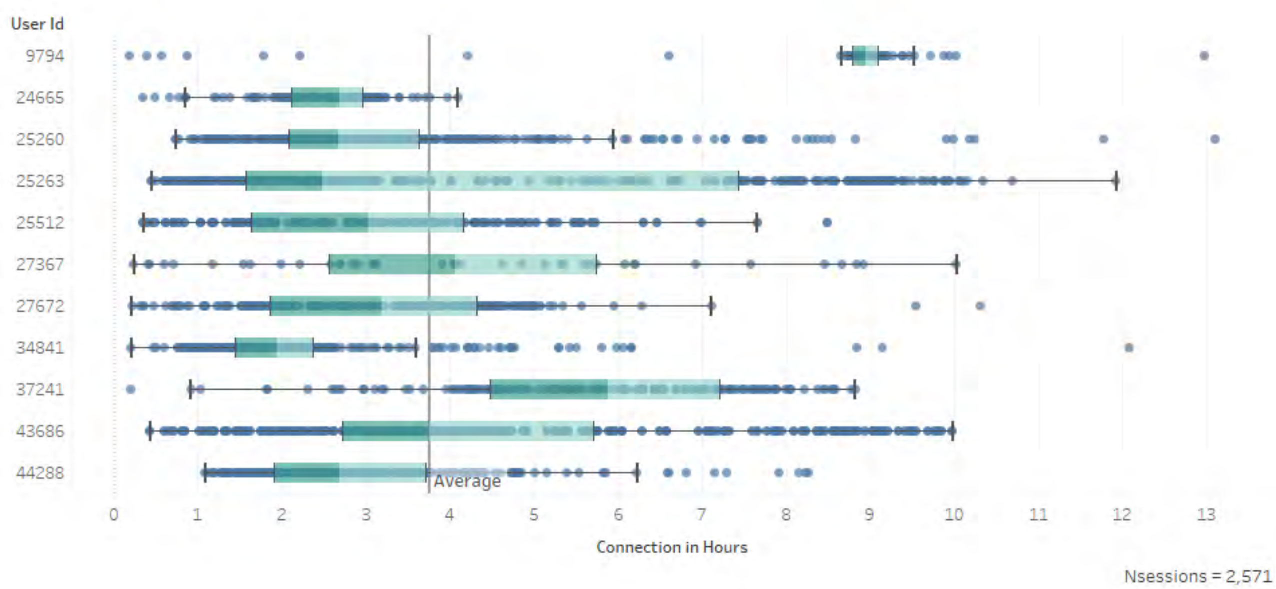


Figure 97. Workplace EVSE Sesssion Connection Duration

Workplace Charge Duration

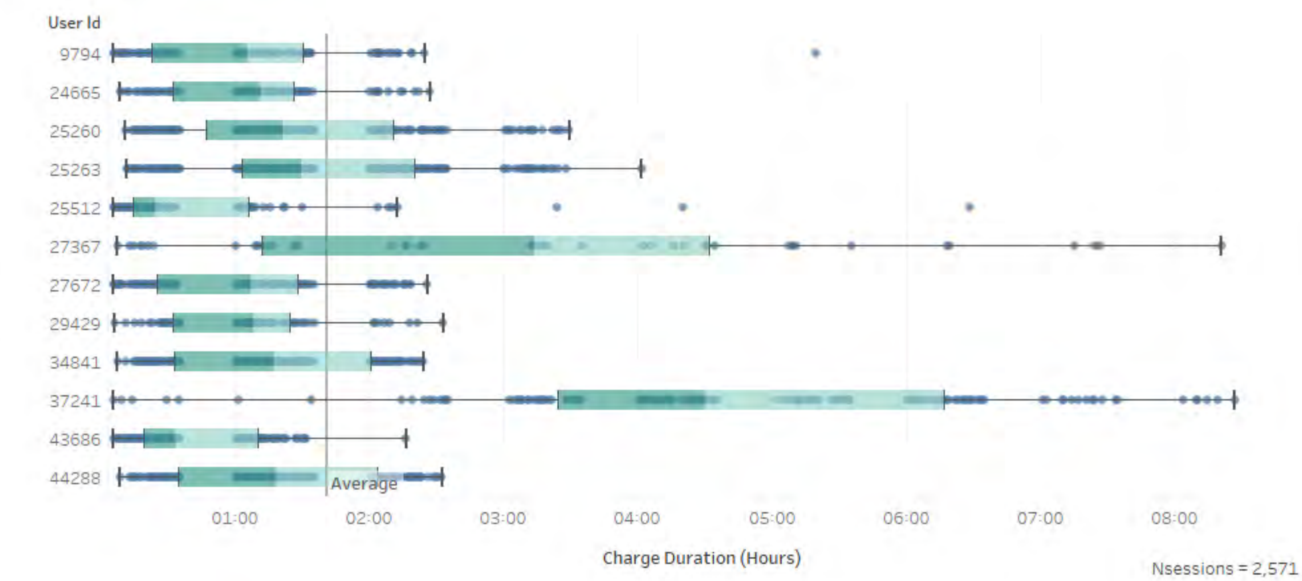


Figure 98. Workplace EVSE Charge Duration

Average energy consumption for the sample group was 8.1 kWh per workplace charging session, again with the two drivers showing significantly different characteristics.

Workplace Energy Usage (kWh) per Charging Session

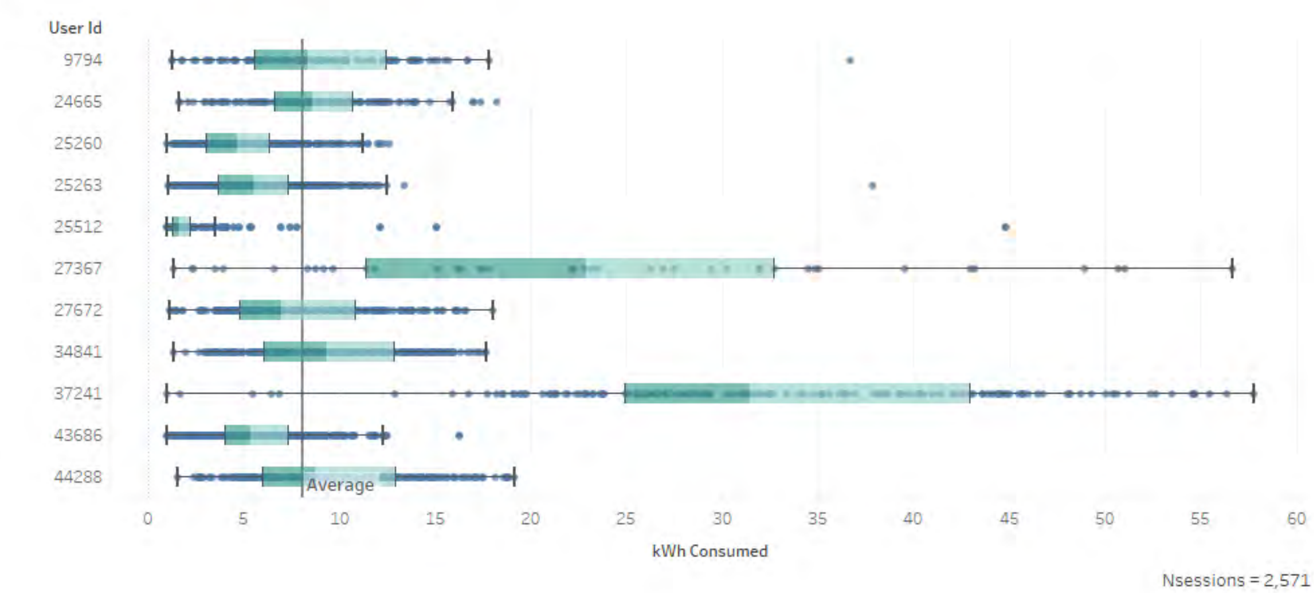


Figure 99. Workplace EVSE Energy Usage per Charge Session

In addition to the workplace charge sessions, the sample group also logged 4,013 charge sessions with their networked residential AC2 charger over 6,169 days.

Workplace Chargers: Residential EVSE Session Connection Duration

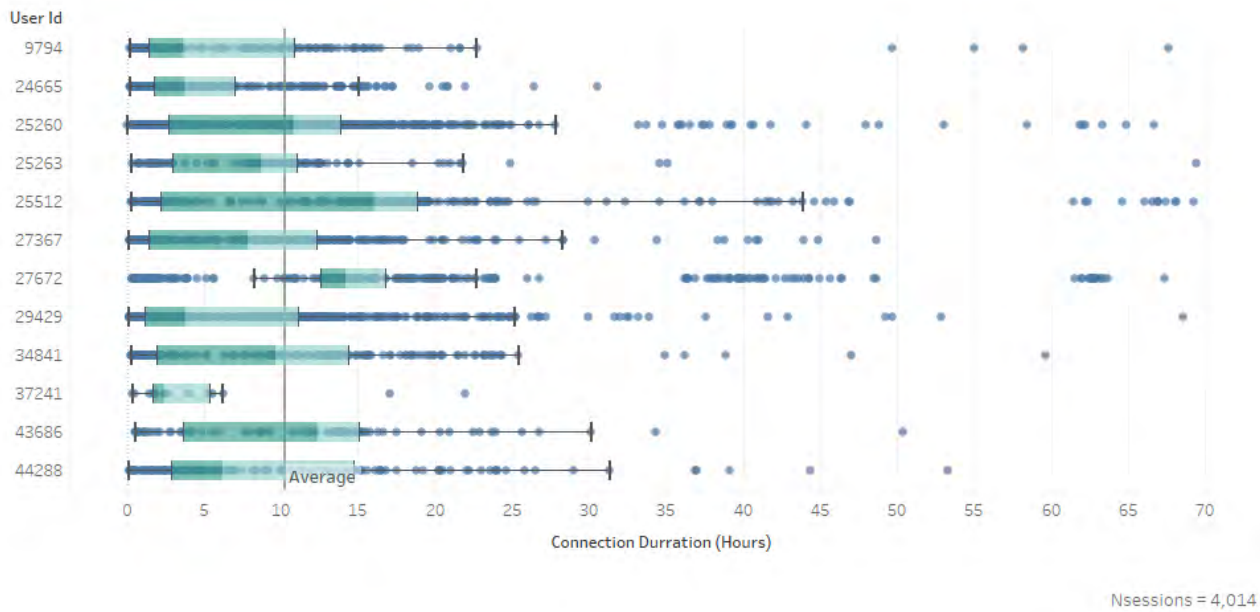


Figure 100. Workplace Charger Sample Group: Residential EVSE Connection Duration

Workplace Chargers: Residential Charge Duration

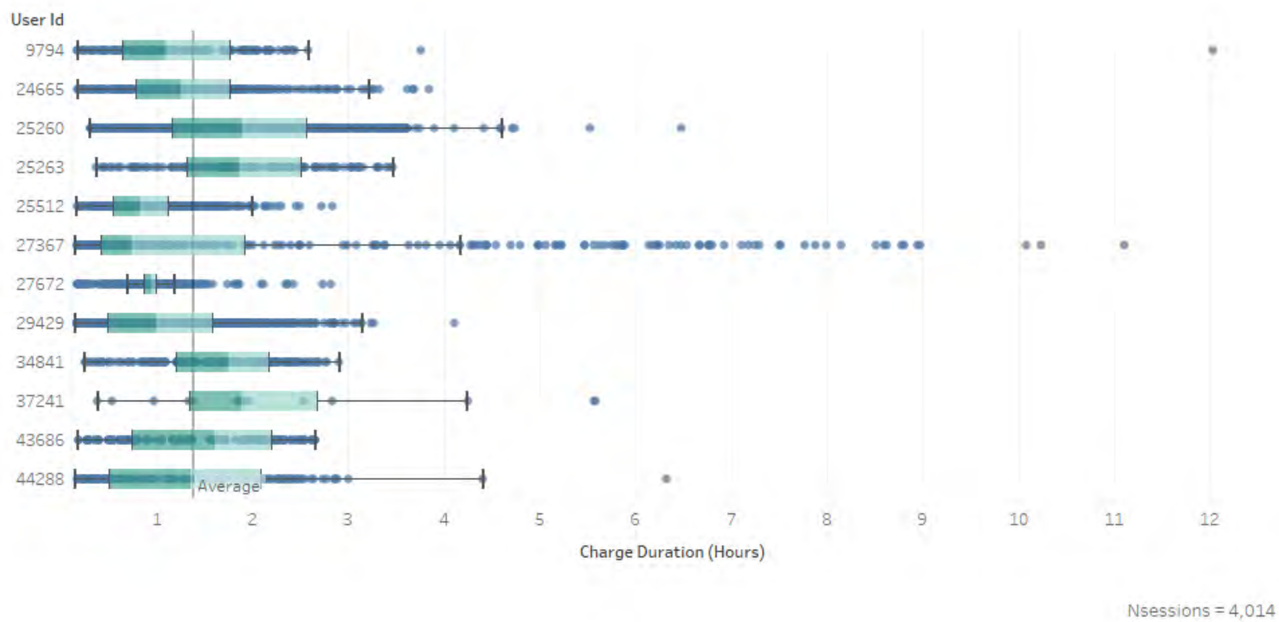


Figure 101. Workplace Charger Sample Group: Residential EVSE Session Charge Duration

Workplace Chargers: Energy Usage (kWh) per Residential Charging Session

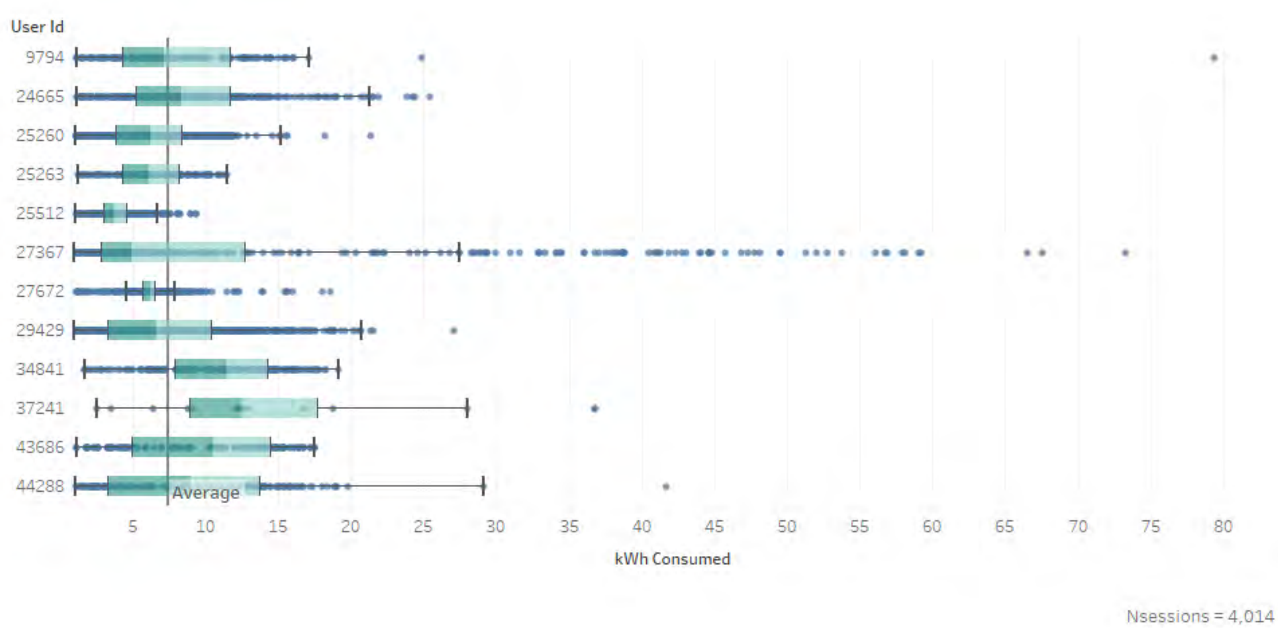
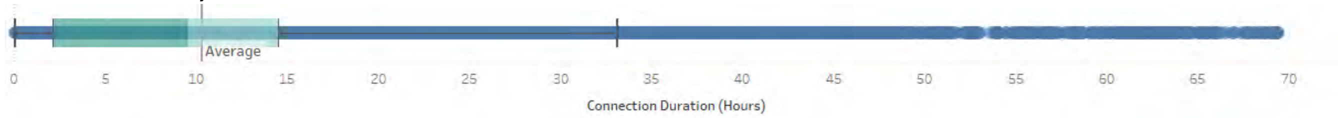
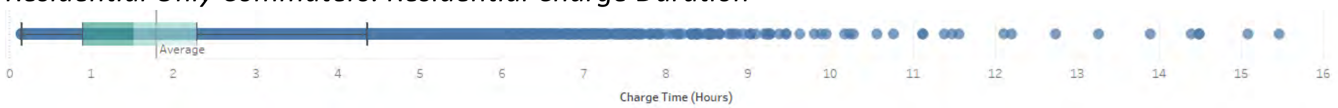


Figure 102. Workplace Charger Sample Group: Residential EVSE Session Energy Usage

Residential Only Commuters: Residential EVSE Session Connection Time Duration



Residential Only Commuters: Residential Charge Duration



Residential Only Commuters: Residential Energy Use

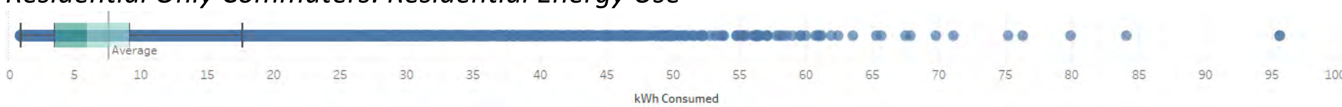


Figure 103. Residential Only Commuters: EVSE Charge Session Characteristics

The average time the sample group remained connected to their residential AC2 unit was 10.6 hours, with an average charge duration of 1.4 hours, and average energy consumption of 7.4 kWh per session. In comparison, session data from the BEV and PHEV commuters without workplace charging had an average residential session connection time of 10.3 hours, a charge duration of 1.8 hours, and energy use of 7.6 kWh.

Appendix F: Avista EVSE Network Energy Usage

	Avista Average Daily Hourly Energy Consumption (kWh)				
Hour Beginning	**Public L2: 35 Ports**	**Workplace L2: 58 Ports**	**Fleet L2: 10 Ports**	**Public DCFC: 6 Ports**	**Residential L2: 102 Ports**
12:00 AM	2.1	0.9	0.9	0.5	22.6
1:00 AM	1.6	0.6	0.7	0.4	14.3
2:00 AM	1.3	0.6	0.7	0.3	11.1
3:00 AM	1.1	0.4	0.6	0.2	13.4
4:00 AM	1.0	0.8	0.6	0.1	11.6
5:00 AM	1.1	1.5	0.5	0.1	9.0
6:00 AM	1.7	3.3	0.4	0.1	7.3
7:00 AM	8.1	15.1	0.5	0.2	7.9
8:00 AM	10.4	21.8	0.7	0.4	7.8
9:00 AM	8.7	20.8	1.2	0.5	10.6
10:00 AM	8.3	15.1	1.7	0.8	15.6
11:00 AM	8.8	11.5	2.6	1.2	20.5
12:00 PM	10.6	10.8	2.7	1.4	25.2
1:00 PM	10.4	12.6	3.0	1.8	29.0
2:00 PM	10.1	12.3	4.1	1.9	33.0
3:00 PM	9.3	8.8	4.7	1.8	44.0
4:00 PM	9.2	6.9	6.1	1.7	58.5
5:00 PM	10.4	6.7	6.1	1.7	77.2
6:00 PM	10.0	5.7	5.0	1.6	76.4
7:00 PM	8.4	4.5	3.8	1.5	69.1
8:00 PM	6.5	5.6	2.8	1.2	60.6
9:00 PM	4.8	3.5	2.0	1.0	53.3
10:00 PM	3.5	1.8	1.5	0.8	39.7
11:00 PM	2.6	1.2	1.1	0.6	31.3

	E3 Approximate Daily Energy Consumption (MWh)				
Hour Beginning	Home L1	Home L2	Work L2	Public L2	Public DCFC
12:00:00 AM	7	30	0	0	0
1:00:00 AM	5	21	0	0	0
2:00:00 AM	4	14	0	0	0
3:00:00 AM	2	8	0	0	0
4:00:00 AM	1	7	0	0	0

5:00:00 AM	1	6	0	0	0
6:00:00 AM	0.5	7	2	0	0
7:00:00 AM	0.5	7	6	0.5	0
8:00:00 AM	0.5	7	13	1	0
9:00:00 AM	0.5	7	17	3	0.1
10:00:00 AM	0.5	7	18	4	0.1
11:00:00 AM	1	8	17	4	0.2
12:00:00 PM	2	9	15	3	0.1
1:00:00 PM	2	9	14	3	0.1
2:00:00 PM	2	10	13	2	0.1
3:00:00 PM	3	14	10	2	0.1
4:00:00 PM	4	21	9	1	0.2
5:00:00 PM	7	32	8	1	0.2
6:00:00 PM	10	42	7	0.5	0.3
7:00:00 PM	12	48	7	1	0.3
8:00:00 PM	12	47	5	0.5	0.2
9:00:00 PM	12	47	3	0.5	0
10:00:00 PM	12	42	2	0	0
11:00:00 PM	11	36	1	0	0

	Average Daily Hourly Energy Consumption Distribution Comparison – Avista and E3					
Hour Beginning	Source	Home L1	Home L2	Work L2	Public L2	Public DCFC
12:00:00 AM	E3	18.9%	81.1%	0.0%	0.0%	0.0%
	Avista	0.0%	86.8%	8.0%	3.3%	1.9%
1:00:00 AM	E3	19.2%	80.8%	0.0%	0.0%	0.0%
	Avista	0.0%	84.6%	9.6%	3.5%	2.3%
2:00:00 AM	E3	22.2%	77.8%	0.0%	0.0%	0.0%
	Avista	0.0%	84.0%	9.8%	4.2%	2.0%
3:00:00 AM	E3	20.0%	80.0%	0.0%	0.0%	0.0%
	Avista	0.0%	89.0%	7.3%	2.5%	1.2%
4:00:00 AM	E3	12.5%	87.5%	0.0%	0.0%	0.0%
	Avista	0.0%	86.3%	7.1%	5.7%	0.9%
5:00:00 AM	E3	14.3%	85.7%	0.0%	0.0%	0.0%
	Avista	0.0%	77.1%	9.4%	12.5%	1.0%
6:00:00 AM	E3	5.3%	73.7%	21.1%	0.0%	0.0%
	Avista	0.0%	58.5%	13.9%	26.7%	0.9%

7:00:00 AM	E3	3.6%	50.0%	42.9%	3.6%	0.0%
	Avista	0.0%	25.2%	25.7%	48.3%	0.8%
8:00:00 AM	E3	2.3%	32.6%	60.5%	4.7%	0.0%
	Avista	0.0%	19.3%	25.8%	54.0%	1.0%
9:00:00 AM	E3	1.8%	25.5%	61.8%	10.4%	0.5%
	Avista	0.0%	26.1%	21.4%	51.3%	1.3%
10:00:00 AM	E3	1.7%	23.7%	61.0%	13.1%	0.5%
	Avista	0.0%	39.2%	20.8%	38.0%	1.9%
11:00:00 AM	E3	3.3%	26.7%	56.7%	12.8%	0.5%
	Avista	0.0%	48.9%	21.0%	27.4%	2.7%
12:00:00 PM	E3	6.9%	31.0%	51.7%	9.8%	0.5%
	Avista	0.0%	52.4%	22.2%	22.4%	3.0%
1:00:00 PM	E3	7.1%	32.1%	50.0%	10.2%	0.5%
	Avista	0.0%	54.0%	19.3%	23.4%	3.4%
2:00:00 PM	E3	7.4%	37.0%	48.1%	6.9%	0.5%
	Avista	0.0%	57.7%	17.6%	21.4%	3.3%
3:00:00 PM	E3	10.3%	48.3%	34.5%	6.4%	0.5%
	Avista	0.0%	68.8%	14.6%	13.8%	2.7%
4:00:00 PM	E3	11.4%	60.0%	25.7%	2.4%	0.5%
	Avista	0.0%	76.7%	12.0%	9.1%	2.2%
5:00:00 PM	E3	14.6%	66.7%	16.7%	1.6%	0.5%
	Avista	0.0%	80.5%	10.9%	6.9%	1.7%
6:00:00 PM	E3	16.8%	70.6%	11.3%	0.8%	0.5%
	Avista	0.0%	81.5%	10.6%	6.1%	1.7%
7:00:00 PM	E3	17.6%	70.6%	10.3%	1.0%	0.5%
	Avista	0.0%	82.7%	10.1%	5.4%	1.7%
8:00:00 PM	E3	18.6%	72.9%	7.8%	0.3%	0.5%
	Avista	0.0%	81.9%	8.8%	7.6%	1.7%
9:00:00 PM	E3	19.2%	75.2%	4.8%	0.8%	0.0%
	Avista	0.0%	85.1%	7.7%	5.6%	1.6%
10:00:00 PM	E3	21.4%	75.0%	3.6%	0.0%	0.0%
	Avista	0.0%	86.7%	7.6%	4.0%	1.7%
11:00:00 PM	E3	22.9%	75.0%	2.1%	0.0%	0.0%
	Avista	0.0%	87.8%	7.3%	3.4%	1.6%

Appendix G: Interoperability

While EVSE infrastructure has grown in a fragmented way, there is support for standardizing the framework for EV charging to simplify and improve customer experience. This framework for interoperable systems can be broken down into four categories: 1) physical charging EVSE interface, 2) EVSE-to-network systems, 3) network-to-network systems and 4) vehicle-grid systems.[47] Interoperability in EV charging is an important element as it allows for a reliable, standardized and easy refueling experience for the driver. It also helps site hosts and utilities to minimize the risk of stranding assets that aren't capable of functioning on different vehicles and charging networks, while also supporting the development of vehicle grid integration.

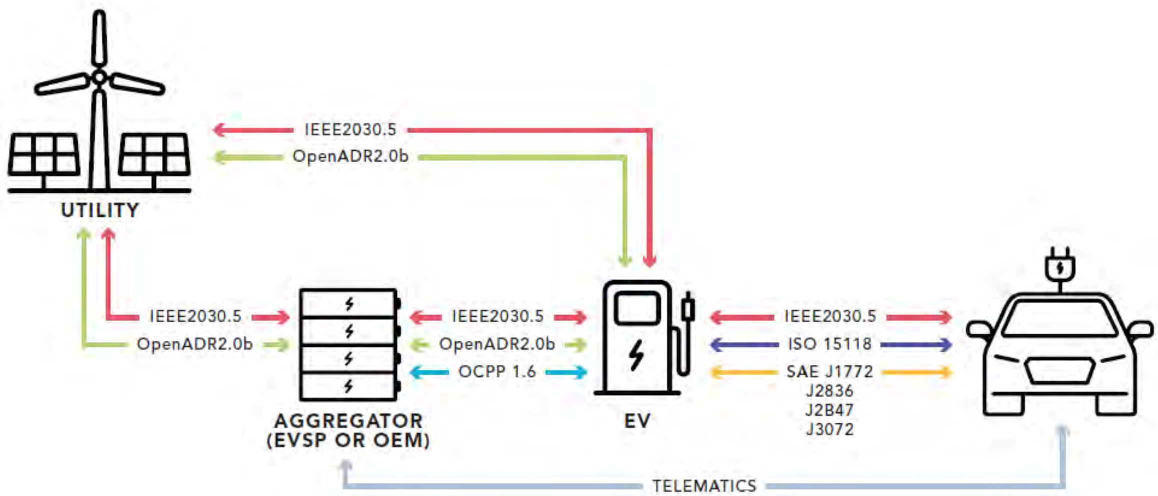


Figure 104: Interoperable EV Charging

Within the U.S., SAE J1772 is the prominent standard for communication between the EVSE and EV. The J1772 plug is used by all major EV manufacturers – except for Tesla – in AC L2 charging. DCFCs have three different DC charging ports consisting of the Tesla combo plug , the CCS combo plug used by most American and European manufacturers, and the CHAdeMO plug used by many Asian manufacturers.[48] The variety of DCFC port standards places an extra burden on site hosts and charge station owners as it requires them to purchase stations with multiple port types – or exclude certain port types. The driver is also burdened by this variety as they might be required to carry costly adaptors to use a station with a different plug type, an experience common for Tesla owners at non-Tesla DCFC sites. Conversely, non-Tesla drivers can't use Tesla's Supercharger network, as no adaptors exist for Tesla stations. This is currently the greatest roadblock to physical infrastructure interoperability, and a single DCFC connection standard is essential as the EV industry moves towards mass adoption.

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[47] "Interoperability of Public Electric Vehicle Charging Infrastructure." EPRI (2019)

[48] See https://afdc.energy.gov/fuels/electricity_infrastructure.html for explanation of plug types

Many different network types are available to support communications between the EVSE and the EVSP. Currently OCPP is the de facto standard for EVSE-to-network communication as it is openly developed, widely implemented and potentially reduces the risk of "vendor lock-in" that can lead to stranded assets and low return on investment. Hardware manufacturers are often responsible for updating software and resolving hardware-software integration issues, and the manufacturer's support team is often required when advanced software troubleshooting or diagnostics are needed. In the event that the hardware manufacturer becomes unresponsive or under-resourced, long lead times to repair may result. An emphasis on strong engineering and technical capability is required by network service providers and manufacturers to improve individual station reliability, given the higher frequency EV drivers interact with refueling equipment relative to ICE drivers.[49,50]

Ultimately, precise and transparent protocols guiding EVSE hardware-software integration are needed when the EVSE is independently manufactured. As an example, fault detection is within the scope of OCPP,[51] but the degree to which detection capabilities are fully integrated is highly variable. Adding clarity to existing protocols, creating new protocols based on field experience, and clarifying support roles and performance metrics are all essential for satisfactory EVSE-to-network interoperability. Migrating an EVSE from one EVSP to another usually requires minor hardware changes, e.g. swapping SIM cards if a cellular connection is used, but it avoids major changes and allows site hosts and managers to avoid being locked into any one EVSP. Ultimately the ability to choose and switch EVSPs provides evidence of the success of interoperability's intended outcomes and supports competition – to the benefit of drivers and utility ratepayers. Avista is currently in the process of testing EVSP migration for a small test group of EVSE, in order to verify cost and required effort.

In the past two years, network-to-network interoperability has improved through roaming agreements between EVSPs. This is important for drivers and site hosts, as it allows customers to easily charge between networks without requiring multiple network subscriptions.

Currently vehicle-grid interoperability is the least developed of the four interoperability components, but holds the key to realizing utility and customer grid benefits over the long term. OpenADR is an open-source protocol that can be used to integrate the grid with DERs, aggregators and grid loads,[52] which can enable a variety of automated demand response programs that could prove economical and practical at scale.

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[49] Public networked stations in Avista's network were available for use an average of only 78% of the time. See the Reliability section of this report for more details.

[50] Assuming average annual miles driven of 12,000, fuel efficiency of 22 mpg, gas tank size of 16 gallons and completely refueling the gas tank when at 20% tank capacity for ICE vehicles, drivers interact with a gas station every 8.5 days, or roughly 43 times per vehicle per year. This compares with commuters charging at work over two days a week and the typical EV driver charging at home five times a week on average.

[51] See https://www.openchargealliance.org/downloads for OCPP 1.6 and 2.0 specifications

[52] See https://www.openadr.org/specification-download for OpenADR 2.0 specifications, examples and architecture

Looking forward, promising standards such as ISO 15118 will allow vehicles to communicate with EVSEs, EVSPs or the utility directly. ISO 15118 also provides the architecture for more advanced VGI such as V2G. Other protocols like EPRI's OVGIP similarly allow the EV to authenticate transactions through the OEM simply by plugging in the connector. SEP 2.0 is a smart grid protocol based on IEEE 2030.5 standard that can help utilities manage peak loads through a home gateway – potentially interacting with the EVSE or EV through OpenADR, ISO 15118, OCPP, or directly.[53] Research, development, and demonstration projects as well as personnel technical skills and knowledge will be required in partnership between EVSE manufacturers, EVSPs, vehicle OEMs, and utilities to make VGI a reality and realize net grid benefits for customers.

[53] Electric Vehicles and the California Grid. Next10. https://next10.org/sites/default/files/evs-ca-grid-op.pdf

Appendix H: Economic Modeling Details

Detailed here are the different components used for costs and benefits in Avista's economic modeling in the "regional" and "ratepayer" perspectives. Note that all variable components listed in the figure were used in the E3 model, but in order to simplify analysis several were removed from consideration in the Avista model, after it was shown they would have little to no effect on results. E3 was consulted to develop similar inputs for Avista's model, comparable to E3's "WA+OR" baseline results. However, Avista's model algorithms were independently developed. The descriptions that follow further detail the variable inputs used in Avista's study.

	Regional Perspective	Ratepayer Perspective
Electricity Supply Costs		
Electric Energy Generation (incl. Losses)	-	-
Generation Capacity Cost	-	-
T&D Cost	-	-
Ancillary Services Cost	-	-
RPS Cost	-	-
Electric Carbon Cost	-	-
PEV Costs and Benefits		
Incremental Electric Vehicle Cost	-	
Federal Tax Credit	+	
Gasoline Savings	+	
Gasoline Carbon Savings	+	
Vehicle O&M Savings	+	
Charging Costs		
Charger Cost	-	
Vehicle Charging Utility Bills		+

Figure 105: Variable impacts on economic models (source: E3)

Federal Tax Credit

The federal tax credit included in this assessment runs through 2022 and provides a benefit of up to $7,500 per EV purchased. Following this tax credit's expiration, no other credits are included.

Generation Capacity Costs

Generation capacity was determined based on Avista's 2017 IRP. Due to power purchase agreements (PPA) and conservation measures, Avista has sufficient capacity of these adoption scenarios until 2027 without requiring additional generation capacity. That is, the additional load from electric vehicle charging on Avista's system through year 2026 is less than the additional capacity available for system load growth. Under the assumption that the addition of EV charging was still less than the planned capacity through 2026, the generation capacity costs during these years were considered to be zero. Following 2027, generation cost is based on the levelized cost for an advanced small frame combustion turbine with annual cost growth of 2% per year.

Energy Cost with Losses

Energy costs were modeled from Avista's IRP, which was derived from historical demand and load growth using established costs from commercially available resources in Avista's generation mix. The compounded annual growth rate of average yearly energy costs escalate 1.9% in real terms during this period. Energy costs fluctuate with demand seasonally and daily, with peaks occurring during in the afternoon year-round and in the morning hours during the winter. For this model, average daily energy costs were determined by using empirical charging data from Avista's EVSE pilot. Using the weighted average of on-peak to off-peak EV energy consumption produced the weighted annual costs used in this analysis.

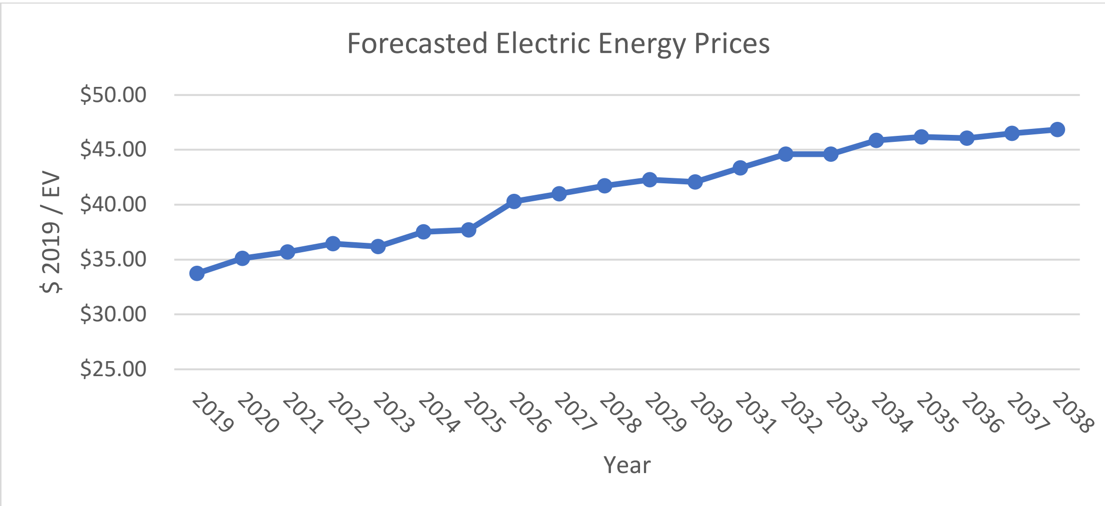

Figure 106. Forecasted electric energy prices used in model

EV Population

Annual EV population is a function of newly purchased and replacement EVs to the existing EV stock minus any retired EVs. In the base case model, the population trajectory is based on new technology adoption models, with EVs reaching 15% of new LDV sales in 2030. The assumed lifetime of an EV in this model is ten years and the age of each vehicle in the existing population is tracked. While replacements and new EV sales are added to the population during the first 20 years of the study, beginning in 2038 no new EVs are sold and none of the retiring stock is replaced. As a result the EV population declines to zero in 2048 where no additional costs or benefits are realized in the model.

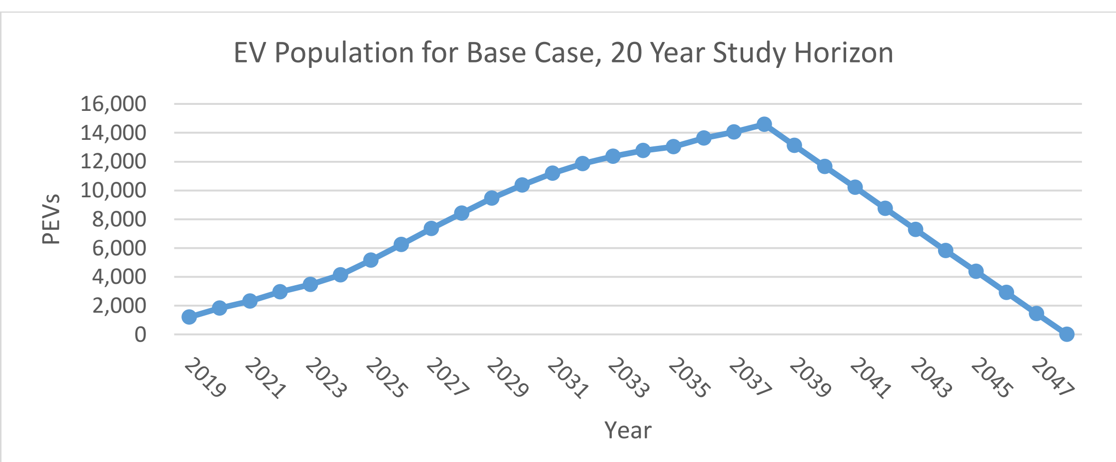

Figure 107. Forecasted baseline EV population in Avista Washington service territory used in model

EVSE Infrastructure

EVSE sales are driven by new EV sales and replacements. In this model, EVSEs have the same ten year useful life as EVs. EVSEs are distributed between residential, public and workplace sites in proportions derived from Avista's EVSE pilot data. This equates to EVSE port distribution of approximately 55% residential, 25% workplace and 20% public per EV sold. Since new and replacement EV sales cease in 2038, no additional EVSEs are purchased beginning that year. The cost per EV is based on current market prices and decreases on average 2.1% per year. The total cost of EVSEs is a function of this cost, EV sales and the proportion of EVSEs purchased per EV. While infrastructure requirements change based on EV mix (BEV, PHEV) due to different charging needs, this model treats the EVSE infrastructure mix consistently.

T&D Costs

T&D replacement costs were derived by first determining each residential transformer's peak demand as a percentage of maximum transformer rated capacity on a system-wide basis. The analysis then assumed coincident load from a single EV charging occurred during each transformer's peak historical demand. This gave the worst case transformer load total, as the existing peak plus EV load. When the transformer's peak plus EV load exceeded 125% of the transformer's capacity, it was considered due for replacement. Performing this analysis on Avista's transformer assets showed a need to replace transformers due to EV load 5.2% of the time. That is, approximately one transformer would need to be replaced for every 20 EVs added to Avista's system due to exceeding the transformer's peak capacity threshold. Only one EV per transformer was assumed, and this assumption is in line with empirical data Avista has collected as part of its pilot program to date. As adoption increases this will change as EV adoption tends to occur in clusters. However the EV penetration will need to reach at least 1 in 5 households – without any demand response measures – before making any meaningful impact on this transformer replacement percentage. This study has front loaded transformer upgrades during the first year due to prior EVs in Avista's service territory being treated as new additions. Feeder and substation impacts were not included as detailed in the report, due to uncertainty in modeling and the likelihood of minimal impacts given the low level of transformer replacements. Additional investigation is warranted for cases of higher adoption rates and to examine important second-order effects.

Incremental Vehicle Cost

The cost of current EVs today is higher than comparable ICE vehicles. The trend of this cost over time is expected to decline as shown below over the next 18 years, according to E3.

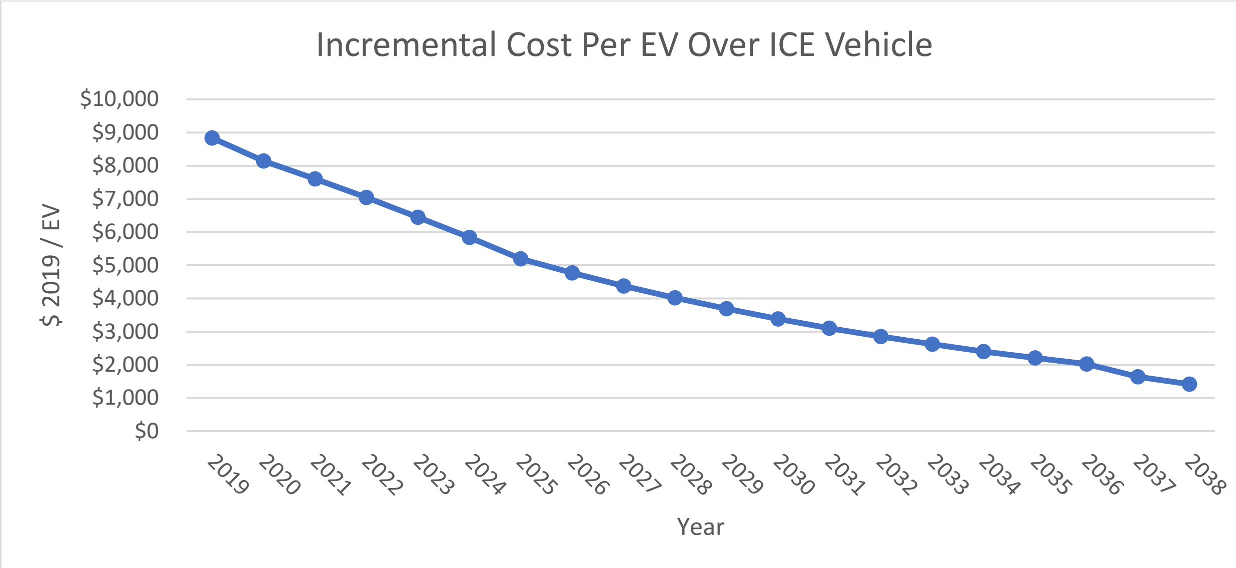

Figure 108: Forecasted incremental EV cost compared to ICE vehicles

Vehicle O&M Cost

EV's typically require much less maintenance over their service life compared to ICE vehicles. Estimated savings from money saved on maintenance and repairs over a EV's lifetime relative to the same cost for a comparable ICE vehicle.

Charger Cost

There is a cost associated with providing adequate infrastructure to support EV adoption. EV chargers are necessary to support this adoption. The cost of chargers per vehicle is dependent on the magnitude of EV adoption, the price of the charger, and the number of chargers needed for each EV (Impacts of EV Adoption in WA & OR, 58-59). This cost is expected to decrease over the 20-year forecast shown below.

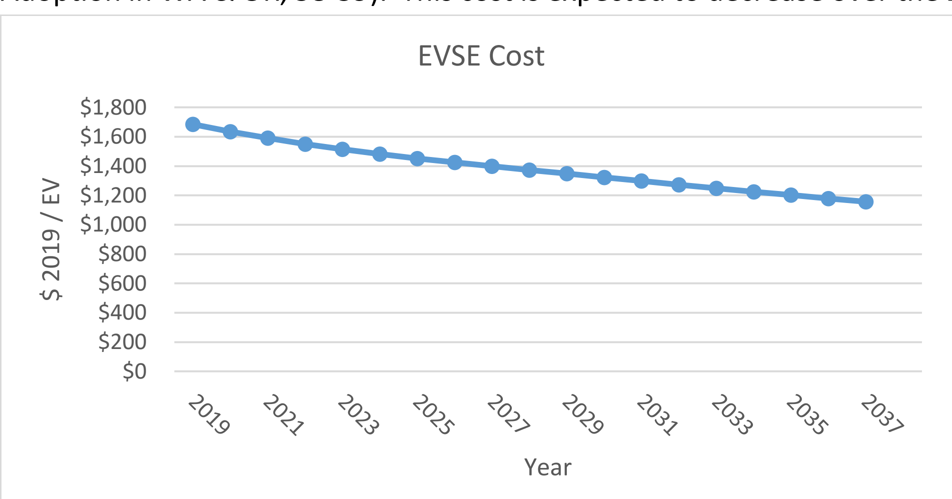

Figure 109. Forecasted EVSE cost used in model

Vehicle Charging Utility Bills

Utility bills were based on current electric rates for residential Avista customers, along with historical and expected load growth found in Avista's IRP. Projected rates include costs of generation resources as power delivery costs on Avista's system. No time-of-use (TOU) or special EV charging energy rates were incorporated into this study. Additionally, no demand charges as a result of residential EV charging were included in the EV charging bill revenue model. Each EV was assumed to drive 11,181 miles per year, with 3.3 miles per kWh of electricity consumption.

Gasoline Savings per EV

Gasoline savings per EV value is calculated each year based on the difference in costs between the electric utility bill and the cost of driving an ICE vehicle the same distance of 11,181 miles. Model inputs assume gasoline fuel efficiency increases from 34 mpg in 2019 to 48 mpg in 2036, and the price of gasoline modestly increases from \$2.58/gal to \$3.50 over the same timeframe.

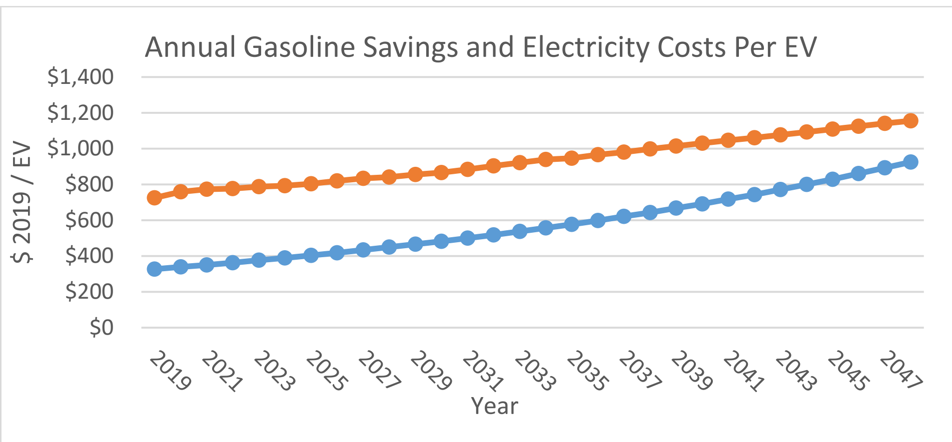

Figure 110. Forecasted gas savings and electricity fueling costs per EV used in model

Avista's first DC fast charging site in partnership with the town of Rosalia, Washington (2017)

Transportation Electrification Plan

2020

AVISTA

About Avista

Huntington Park, Spokane, Washington

Avista Corporation is an energy company involved in the production, transmission and distribution of energy as well as other energy-related businesses. Its largest subsidiary, Avista Utilities, serves more than 600,000 electric and natural gas customers across 30,000 square miles in eastern Washington, northern Idaho and parts of southern and eastern Oregon.

Avista's legacy begins with the renewable energy we've generated since our founding in 1889, and grows with our mission to improve customers' lives through innovative energy solutions.

Avista – Better Energy for Life!

Front Cover – Avista's first DC fast charging site installation in partnership with the Town of Rosalia, Washington

March 10, 2020

Draft Submitted for Stakeholder Review and Comment

July 1, 2020

Revision Filed with the Washington Utilities and Transportation Commission for Acknowledgment

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Acknowledgments

The following organizations are recognized and appreciated for their support of electric transportation and the Transportation Electrification Plan

Alliance for Transportation Electrification
Chargeway
Charlie Allcock Consulting, LLC
ChooseEV
City of Colville
City of Liberty Lake
City of Palouse
City of Pullman
City of Spokane
Climate Solutions
Colvico, Inc.
Edison Electric Institute (EEI)
Electric Power Research Institute (EPRI)
Energy + Environmental Economics (E3)
EV Connect
Forth
GEM Electric NW, Inc.
Gonzaga University
Greenlots
Kendall Yards
NW Energy Coalition
Pacific NW Utility Transportation Electrification Collaborative
Port of Clarkston
Plug-in America
Pullman Transit
Spokane Regional Health District
Spokane Regional Transportation Council
Spokane Transit Authority
Town of Garfield
Town of Rosalia
Transitions for Women
Washington State University
Washington State Transportation Electrification Stakeholder Group
Washington Trust Bank
Wendle Nissan
Whitworth University

Table of Contents

Our Vision – Better Energy for Life! 1
Executive Summary 2
Background 16
Technology and Markets 20
Environmental, Economic and Grid Impacts 31
Costs and Benefits 39
Analysis and Reporting 44
Programs and Activities 45
- EVSE Installations and Maintenance 45
- Education and Outreach 55
- Community and Low-Income Support 58
- Commercial and Public Fleets 61
- Planning, Load Management and Grid Integration 65
- Technology and Market Awareness 67
- Rate Design 69
- Utility Fleet Electrification, Facilities and Employee Engagement 72

References 74
Appendix A: Glossary of Terms 76
Appendix B: Light-Duty EV Adoption Forecasts 81
Appendix C: Stakeholder Engagement, Comments and Support 84

Our vision: better energy for life!

Imagine an electrifying future . . .

By the year 2045, renewable and clean energy sources power the electric grid and a vibrant modern economy, including the transportation sector. Whether moving people or goods on the road, off the road, by rail, in the air, or over water, clean electricity makes it happen. The majority of transportation is electrified and the use of fossil fuels is no longer dominant. Customers have new and exciting transportation choices. Major economic benefits of over $1 billion per year in fuel and maintenance cost savings are realized in the local economies served by Avista. This is accomplished while eliminating more than 80% of harmful air pollution and greenhouse gas emissions from transportation—formerly the largest source of emissions in the region.

EVs Fueling Up with Clean Energy – The Future is Electric !


Avista's Noxon Rapids Hydroelectric Generation Plant
– 562 MW of Clean Hydropower –

In this exciting future, transportation accounts for over 20% of utility electric load and revenue, helping to pay for fixed grid costs and keeping rates low for all customers. A combination of cost-effective load management and transfer technologies, energy storage, and price signals act to optimally integrate flexible transportation loads with the grid—including a wide array of new distributed energy resources. This reduces peak loads on the system, provides for better grid resiliency, and maximizes the use of renewable energy sources.

Autonomous electric transportation has also revolutionized the way we move people and goods, dramatically increasing vehicle and equipment utilization, driving down transportation costs, freeing up people's time, and saving thousands of human lives and serious injuries every year.

The vehicles themselves are integral parts of a new age in communications and connection, opening the door to a wide variety of new products and services that improve people's lives.

In just 25 years, an amazing transformation has occurred—the transportation sector has converged with the energy and information technology sectors—fundamentally changing the way we live our lives and making the world a better place. Avista has played a key role in this transformation, working over several decades with industry partners, policymakers and regulators, community leaders, and customers to innovate and create a better energy future for all.

Executive Summary

Guided by our vision of a better energy future, Avista's Transportation Electrification Plan (TEP) details strategy and planned activities in the service areas of Washington and Idaho, with an emphasis on near-term actions from 2021 through 2025. Avista's strategic approach is informed by industry and customer research; the current landscape of policy, technology and market forces; projected impacts on the economy, the environment and the grid; and the valuable experience gained through the Electric Vehicle Supply Equipment (EVSE) pilot launched in 2016.

Today, driving a passenger EV fueled by Avista's electricity results in zero tailpipe emissions, causes total CO_2 emissions reductions of 80%, costs less than an equivalent $1 per gallon of gasoline to fuel, and saves $300 per year in maintenance expenses.[1]

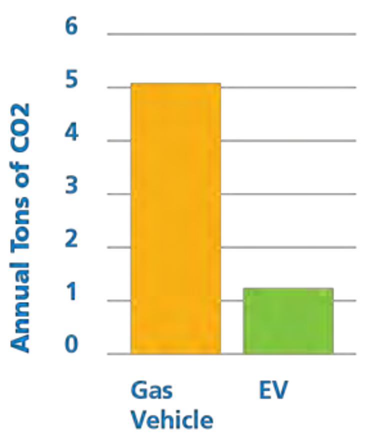


Figure 1: EVs using Avista's electricity reduce emissions by 80%

If all light-duty vehicles were electric, this would result in regional savings of over $1 billion per year—creating a powerful ripple effect for the economy—and avoiding annual emissions of 2.5 million tons of CO_2. Other electrified transportation beyond light-duty passenger vehicles would result in even greater reduced emissions and operational savings.

In addition, electric transportation provides grid benefits for all utility customers, in the form of net revenue that helps pay for fixed system costs. In 2025, over 6,800 EVs in Washington and Idaho service territories are expected to provide Avista with gross revenue of $2.1 million from EV charging. Subtracting an estimated $0.5 million in marginal utility costs to generate and deliver this energy results in $1.6 million in net revenue—savings which may be passed along to all utility customers in the form of decreased rate pressure. This is just the beginning. With over one million registered vehicles in the region, consider the enormous customer savings and grid benefits that a high percentage of EVs would provide, especially when charging is optimally done during off-peak times of the day and night.

[1] Estimates assume Avista's current mix of electric generation sources, 3.3 miles/kWh and $0.11/kWh for EVs, and $3/gallon, 26 mpg for conventional vehicles.

EV charging loads are very flexible, as 80% or more of EV charging may occur while the vehicle is parked at work during the day and at home overnight. In the future, the greatest benefits may be realized by capitalizing on this flexibility, charging EVs when renewable energy resources such as solar and wind are abundant. For example, EVs could utilize more solar power on the system during the day and in the summer, as well as more wind power when it is typically more available at night and during the winter. In this way, EVs could help maximize the integration and use of an increasing amount of renewable resources on the grid.

In other words, electric transportation can benefit all customers and society as a whole—not just those using EVs and other forms of electrified transportation equipment—by using a cheaper and cleaner fuel, more efficiently utilizing grid infrastructure, and integrating renewable power resources that energize a healthy and more sustainable economy.

Policy, Technology and Market Landscape

Given these realities, policy support for electric transportation is strong and expected to grow with increasing climate concerns caused by greenhouse gas emissions, the recognition that transportation accounts for nearly half of all emissions in the Pacific Northwest, and that major economic benefits may be realized over the long term as the transportation sector is electrified.

While adoption forecasts are subject to uncertainty, it is clear that a major transition from fossil fuels to electrically powered transportation is underway on a broad, global scale. This is currently led by China, followed by Europe as shown in the charts below.

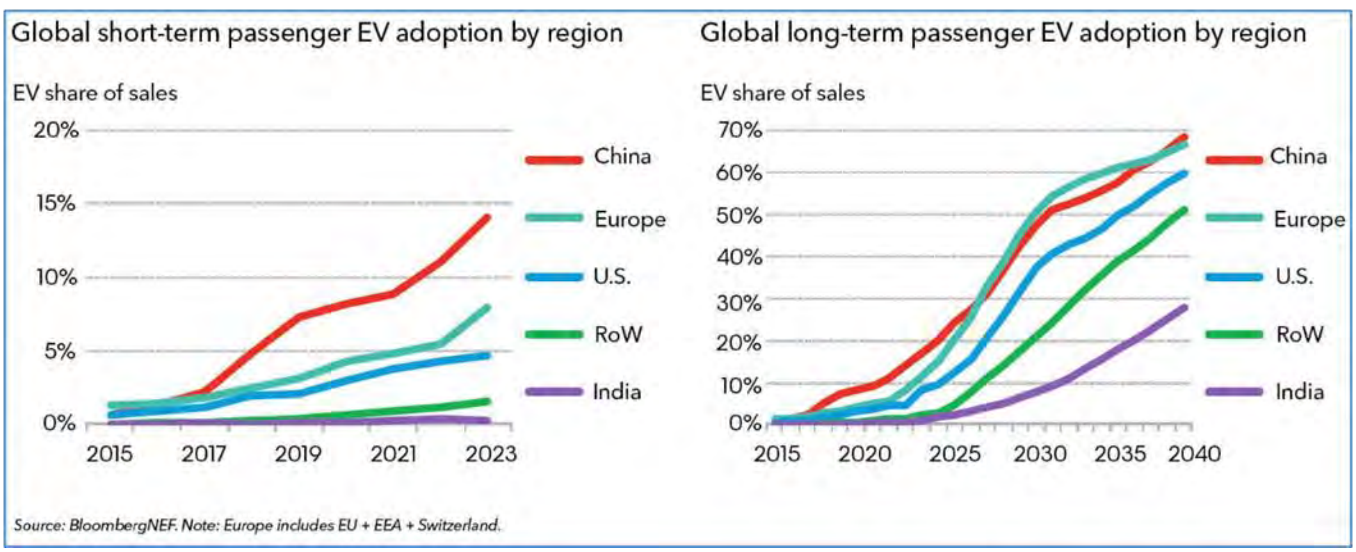


Figure 2: Global EV adoption forecasts (Bloomberg New Energy Finance, EV Outlook, 2019)

Technical advances and industry investments of over $362 billion annually[2] indicate that EV performance, features and costs will continue to improve, perhaps reaching purchase cost parity with conventional vehicles by 2025 without subsidies.[3]

In the U.S., EV sales have grown considerably for many years but contracted by 9% in 2019, compared to an overall decline in light-duty vehicle sales of 2%. Most recently, the COVID-19 pandemic has dramatically reduced overall auto sales in 2020 and may continue to reduce EV demand well into 2021. While this presents considerable uncertainty in the near term, sales are likely to rebound as new EVs are introduced in the 2021—2022 timeframe and the used market provides more affordable EVs to a growing number of people. Tesla continues to dominate new EV sales in the U.S., and its announcement of the Model Y production ahead of schedule in 2020 is likely to further boost EV sales.

Annual EV registrations in Avista's eastern Washington service area grew by 23% in 2015, improving each year since then and reaching 50% in 2019, surpassing the state average, and correlating with support from the EVSE Pilot. However, EVs represent less than 2% of annual fleet turnover in the region and are still in the very early stages of market growth.

Product and investment commitments announced by major automakers including Ford, GM and VW, as well as the rise of Tesla and startups such as Rivian, indicate that we can expect a growing number of electrified truck, SUV and crossover model introductions over the next several years. Trucks and SUVs accounted for a record 69% of light-duty U.S. sales in 2019, and these vehicle types dominate sales in Avista's service territory; they are key to making serious inroads into the mass market.

Even with major commitments and deliveries made good by the automotive industry, it will most likely take several years to significantly raise vehicle availability and inventory levels at price points needed to achieve substantial momentum and market transformation. Furthermore, Avista serves a customer base with relatively lower personal incomes and more rural geographies with smaller population densities. This may continue to dampen EV adoption in the Company's service territories.

In consideration of all these factors, we expect light-duty EV growth in our region to continue, with steady but gradual improvement for three to four years, followed by relatively strong growth starting in the 2023–2024 timeframe. This presents a limited window of just a few years to solidify a foundation of supporting infrastructure and programs which will need to be in place to enable accelerated growth starting as early as 2023.

Beyond light-duty passenger EVs used for household and commercial fleets, the first deployments of mass transit buses powered by electric batteries are scheduled in 2021 by two transit agencies served by Avista. An excellent opportunity also exists today to support the local adoption of electrified lift truck (forklift) equipment, resulting in swift paybacks on investment in terms of emissions reductions, customer transportation savings and beneficial utility revenue.

[2] Atlas EV Hub, see www.atlasevhub.com

[3] "When Will Electric Vehicles Be Cheaper than Conventional Vehicles?" Bloomberg New Energy Finance (2018).

Table 1: Overall light-duty fleet and EVs in Avista's electric service area (2019)[4]

	Population in Electric Service Area	Registered Light-Duty Vehicle Fleet	Annual Fleet Growth (2%)	Annual Fleet Turnover (7%)	Total EV Registrations in Service Area	% of Fleet on Road	Estimated New EV Registrations (2020)	% of Fleet Turnover/ Sales
Washington	676,746	512,297	13,535	35,861	1,331	0.3%	481	1.3%
Idaho	321,415	243,311	6,428	17,032	409	0.2%	143	0.8%
Total	998,161	755,608	19,963	52,893	1,740	0.2%	624	1.2%

Other commercial opportunities are expected to become more viable over time, such as commercial delivery vehicles, school buses, airport ground support equipment, truck stop and refrigerated freight electrification, and electrified agricultural equipment. Over the longer term, advanced technologies such as vehicles connected to homes, buildings and the grid (V2X); transactive energy systems; rail, marine and aircraft electrification; “last mile” or micro-mobility innovations; hydrogen powered EVs and electrified autonomous vehicles (AVs) could further and dramatically alter both utility grid management and the transportation sector.

Avista’s Electric Vehicle Supply Equipment (EVSE) Pilot

At a minimum, the electric utility has an obligation to prepare for the future of electric transportation, ensuring good stewardship of grid assets, public service and safety levels. It also has a historic opportunity to serve its customers in new and better ways for the long term, realizing major economic and environmental benefits. In this context, the Company carried out its Electric Vehicle Supply Equipment (EVSE) pilot from 2016 through 2019, seeking to understand costs, benefits and impacts of EVs; explore customer needs; test utility program models; and begin supporting beneficial EV adoption. This direct experience along with ongoing research and customer feedback has positioned the Company to propose informed strategies and programs as outlined in this Plan.

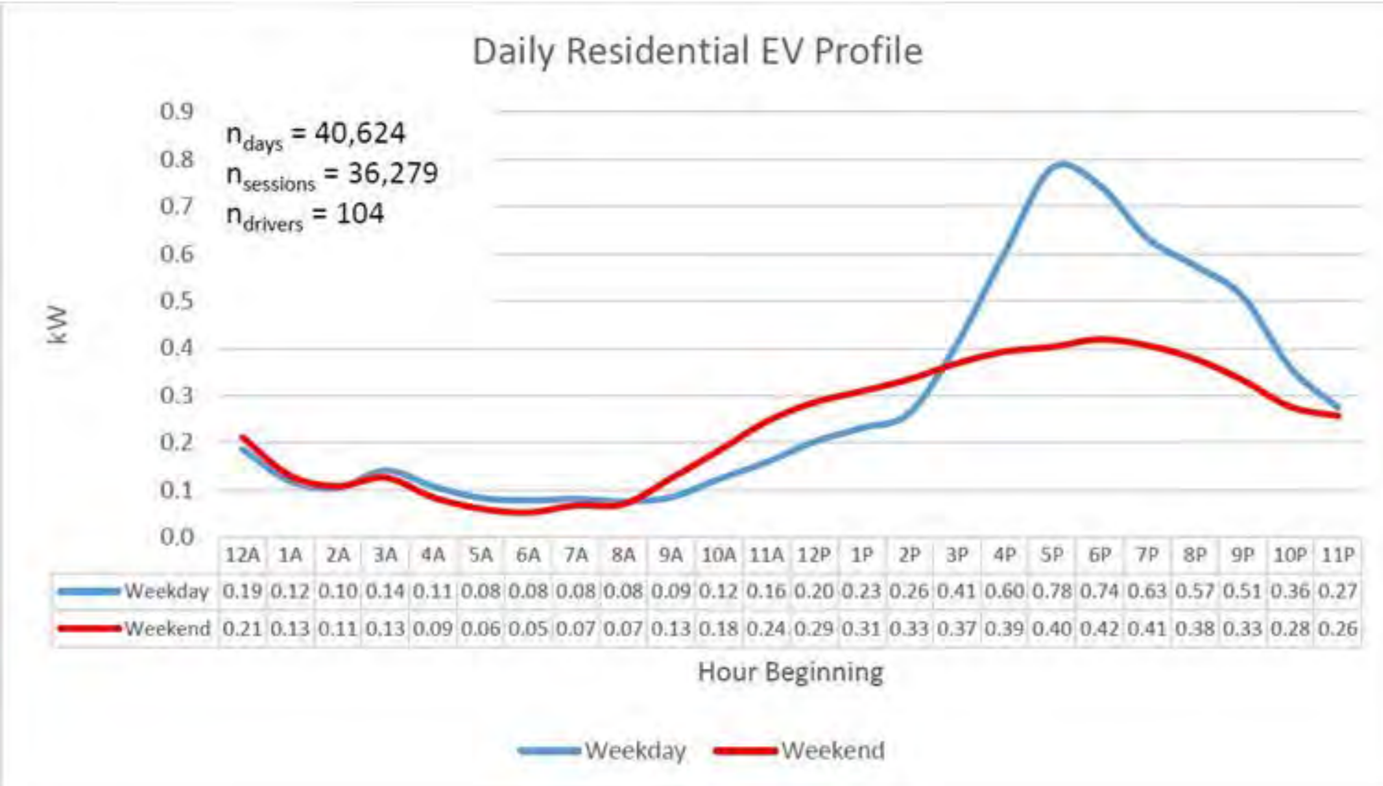
Among many things, the EVSE pilot demonstrated cost-effective utility programs that were well received by customers and correlated with significantly increased adoption rates. It also highlighted the value of workplace charging, a need for more public charging infrastructure, and industry improvements in networked charger costs and reliability.

Public charger in partnership with the City of Liberty Lake (2017)

Modeling and analysis showed that load growth from EVs provides net benefits to all grid customers, and that new electric loads from transportation should be manageable over the next decade. It also showed the importance of developing cost-effective load management capabilities over the longer term, as this can provide additional net benefits and will become increasingly important at higher adoption levels beyond 2030.

Given that 70% or more of EV charging is expected to occur at residential locations, one key to maximizing benefits at scale is to shift this peak load as much as possible to off-peak times of the day and night—when energy is more abundant and less expensive to acquire. Eventually at high adoption levels above 30%, coincidence factors could also play a role in driving up distribution costs associated with local transformers, feeders, and perhaps even substations unless this peak load is shifted to off-peak.

The following chart shows a detailed load profile from residential charging data collected over the course of the pilot. Demonstrating charging for the average EV on the system, it illustrates how peak loads are much



	12A	1A	2A	3A	4A	5A	6A	7A	8A	9A	10A	11A	12P	1P	2P	3P	4P	5P	6P	7P	8P	9P	10P	11P
Weekday	0.19	0.12	0.10	0.14	0.11	0.08	0.08	0.08	0.08	0.09	0.12	0.16	0.20	0.23	0.26	0.41	0.60	0.78	0.74	0.63	0.57	0.51	0.36	0.27
Weekend	0.21	0.13	0.11	0.13	0.09	0.06	0.05	0.07	0.07	0.13	0.18	0.24	0.29	0.31	0.33	0.37	0.39	0.40	0.42	0.41	0.38	0.33	0.28	0.26

Figure 3: Average daily load profile for residential charging (EVSE Pilot data, 2016—2019)

higher on weekdays and typically occur between 5 pm and 6 pm throughout the week, coinciding with peak loads on the grid year-round.

Utility Role, Strategy and Objectives

Strategically, Avista will adopt a flexible and adaptive approach, align with policy guidance,[5] partner with industry experts and other key stakeholders, facilitate healthy market competition, improvements, interoperable industry standards, and enable direct benefits for disadvantaged communities and customers. Efforts will focus on supporting cost-effective new customer choices in a variety of transportation market segments over the next several decades.

This begins with appropriate utility support that enables and accelerates sustained entry into the mass market for light-duty EVs by 2030 or earlier, depending on the strength of products and other factors enabling mass adoption. While staying abreast of changing technologies and market conditions, utility programs will focus on overcoming critical barriers of adequate charging infrastructure and customer awareness, which Avista is uniquely positioned to address. In addition, these programs are intended to establish a foundation for load management and maximum off-peak charging at scale, which optimally integrates with the grid over the long term.

Activities and funding levels are flexibly designed in the TEP to match technology and market conditions, transitioning from moderate to strong levels of utility support in earlier phases, to more regular and enabling programs as different market segments sustainably enter the mass market and the industry matures and scales in later phases.

[5] Policy and Interpretive Statement Concerning Commission Regulation of Electric Vehicle Charging Services." Washington Utilities and Transportation Commission, Docket UE-160799 (2017).

Guiding Principles

- Flexible, adaptive approach to changing market conditions and different market segments
- Early utility role supports healthy market growth and grid integration, ensuring net benefits for all utility customers over the long term
- Plan and programs align with legislative and regulatory policy
- Program focus areas: EVSE infrastructure, customer education and outreach, community and low-income support, fleet support, and grid integration/ load management
- Utility programs support healthy market competition, innovation and interoperable industry standards
- Customer-centric, high-satisfaction program results; provide objective information and choices that enable informed customer decisions
- Cost-effective, integrated management across all programs and activities
- Regular updates to load profiles and forecasts for utility Systems Planning and the Integrated Resource Plan (IRP)
- "Walk the talk" with effective utility fleet electrification, facility EVSE and employee engagement programs
- Partner and collaborate with key stakeholders

Much is dependent on the vehicles provided by original equipment manufacturers (OEMs) in terms of price, functionality, variety and availability, of which the utility has little influence. Given this reality, Avista's programs and activity levels will scale up from baseline support levels starting in 2021 to stronger support coinciding with improved market conditions expected in the 2023-2024 timeframe when more competitive products are widely available, including light-duty trucks and SUVs. In the near term, Avista will consider ways to effectively raise awareness levels, improve the availability of EVs in the area, and work with stakeholders to build out the EVSE infrastructure that will be needed by 2025.

In other words, a solid foundation must be set in place starting today, in order to enable strong growth in the future.

Eventually, as EVs begin to make sustained entry in the mass market (at roughly 15% of total vehicle sales each year), certain education and outreach programs may no longer be necessary. Beyond this point, utility infrastructure and load management programs could play an ongoing, enabling function that is fully integrated with day-to-day utility operations. To illustrate, three plausible adoption scenarios for light-duty EVs are shown in the chart below, corresponding to OEM product levels matched with appropriate utility support programs. Note the anticipated points of sustained entry in the mass market by 2030 for the“Baseline” adoption scenario, and in 2027 for the “High” adoption scenario.

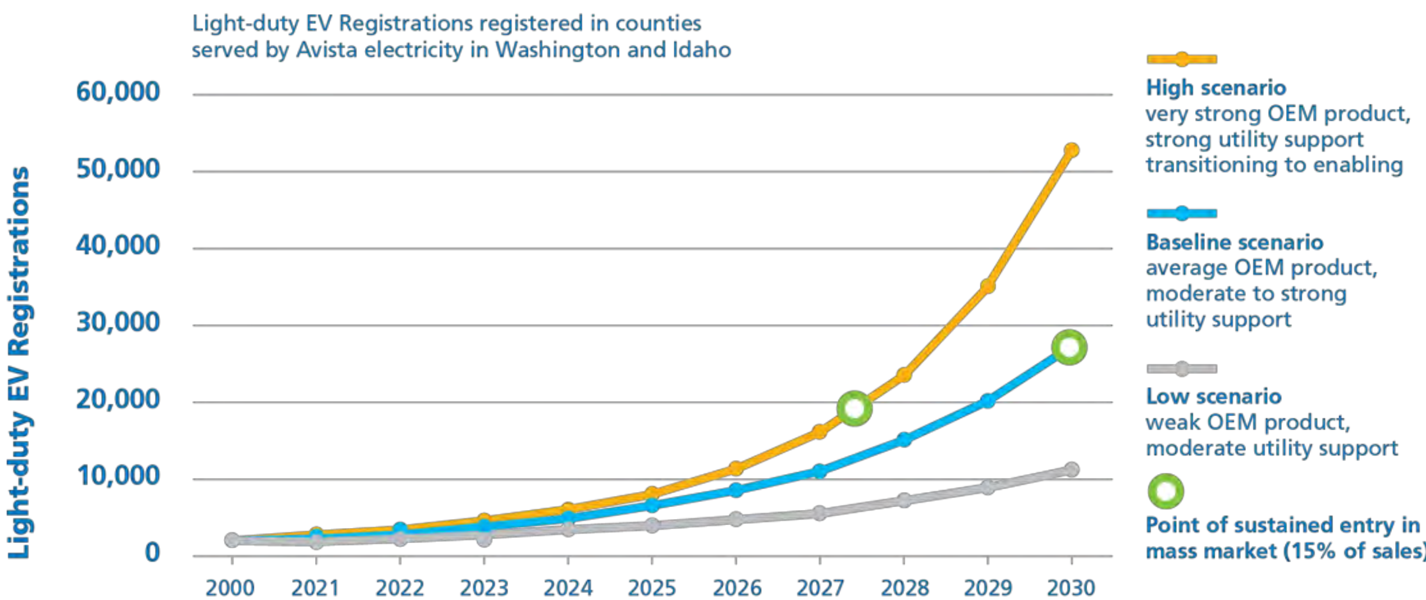


Figure 4: Light duty EV adoption forecasts for registered light-duty vehicles in Avista's service territory; sources include Washington and Idaho registration data; Bloomberg New Energy Finance Electric Vehicle Outlook, 2019; "Economic & Grid Impacts of Electric Vehicle Adoption in Washington & Oregon." Energy and Environmental Economics (2017).

Strategic Objectives and Goals

1. **Achieve sustained entry in the mass market for light-duty EVs**
    - > 15% of annual vehicle sales by 2030 or earlier
    - Install EVSE needed by 2025 for rapid market growth, owned and maintained by Avista and third parties
    - Maintain EVSE uptime > 99%
    - By 2025, raise positive awareness of EVs by 500%

2. **Support electrification of commercial and public fleets**
    - Implement a commercial EV time-of-use (TOU) rate starting in 2021
    - Invest in "make-ready" utility upgrades
    - Deploy and expand fleet support programs, starting with lift trucks and light-duty passenger vehicles in 2021

3. **Meet aspirational goal of 30% overall spending on programs benefiting disadvantaged communities and low-income customers**

4. **By 2025, achieve net benefits from load management and EV TOU rates with > 50% reduction of EV peak load**

5. **Monitor new technologies and markets; implement pilot projects starting with mass transit and school buses in 2022-2023**

6. **Expand utility fleet electrification with 5% or more of annual fleet budgets, install EVSE at Avista facilities and by 2025 raise employee EV adoption 300%**

A flexible, adaptive utility approach is replicated in other emerging market segments, such as initiating a fleet support program for lift trucks in the near term, followed by anticipated opportunities that arise with freight delivery vehicles, school buses and other applications in ensuing years. In the early stages of each market segment, pilot programs may be explored. For example, the value of greater community resiliency in the event of severe weather events could be tested in a pilot project, using schools with on-site renewable power generation and electrified buses providing emergency energy storage.

The utility must also monitor technology and market developments, and over the longer term investigate and support emerging opportunities including electric micro-mobility innovations, vehicle-to-home or vehicle-to-building (V2H/V2B) as backup power, vehicle-to-grid (V2G) bi-directional power transfer, open software platforms enabling broad energy transactions, rail and aircraft applications, marine transport, hydrogen-powered EVs, and electrified autonomous vehicles.

In summary, the Plan's strategic objectives and goals follow from the Company's aspiring vision, direct experience through the EVSE pilot, and a realistic assessment of technology and market trajectories. Programs and activities planned for the 2021–2025 timeframe are briefly described below, designed to meet these strategic objectives and set the foundation for beneficial electric transportation growth for the long term. More details are provided in respective sections of this Plan, supplemented by information in Appendices.

EVSE Infrastructure and Maintenance

The utility is in a unique position to install EVSE infrastructure that will be needed by a growing EV market, in a way that is most cost effective for the public interest and supports off-peak charging over the long term. Charging infrastructure for public DC fast charging (DCFC), workplace charging and fleets is a top priority, followed by public AC Level 2. Workplace, fleet, MUD and residential charging programs are essential to support early EV adoption and may be leveraged to enable load management and reduced on-peak loads from EVs.

A portfolio of proposed programs support both Avista and third-party EVSE ownership, off-peak charging and customer choice through proven cost-effective methods, "make-ready" options, load management and a pilot EV TOU rate for commercial customers. Ideally, third-party EVSE ownership makes up 50% or more of all EVSE in the marketplace through 2025. The coordinated buildout of EVSE is also intended to foster healthy market competition and growth among EVSE and electric vehicle service providers (EVSPs).

DCFC site in partnership with Gonzaga University, in the Spokane U-District (2019)

Based on anticipated market needs, a coordinated public DCFC buildout of 60 DCFC sites in the region by 2025 will be prioritized through a deliberate process involving key stakeholders. This includes DCFC sites within 40 miles along all major travel corridors, as well as high-traffic and key destination locations within more populated areas. Avista will endeavor to install, own and maintain up to 50% of the anticipated market need, or 30 DCFC sites, by 2025. A "make-ready" utility extension policy and pilot EV TOU rate schedule will be applied at DCFC sites to encourage off-peak charging and third-party ownership to the greatest extent possible, ideally meeting or exceeding 30 DCFC sites by 2025.

Public AC Level 2 sites will be built out per stakeholder review and selection at up to 10 sites per year in the region.[6] AC Level 2 EVSE for workplace, fleet, MUD and residential use will be completed on a first-come, first-serve basis subject to eligibility requirements and program limitations. Avista will own and maintain EVSE

[6] Additional public AC Level 2 sites may be installed under Community and Low-Income programs.

assets, covering direct installation costs and 50% of premises wiring installation costs up to $2,000 per port for commercial installations and $1,000 for residential installations. In the future, equipment lease and/or rebate programs may also be considered for customer-owned EVSE, and coverage of premises wiring costs may be reduced as the market improves and effective load management programs are well established. Customer site agreements will include enrollment in load management programs and future TOU rates, so that off-peak charging and net benefits for all customers may be maximized over the long term.

EVSE maintenance and uptime at 99% or greater is an important priority—a high performance level that Avista will work to achieve and maintain in collaboration with industry partners.

Education and Outreach

Raising awareness through effective Education and Outreach activities is also of great importance to accelerate market adoption. Avista will engage with stakeholders in a number of activities, by 2025 raising customers' positive EV awareness by 500%. This includes a $250 dealer referral, EV education and awareness campaigns, and support for peer-to-peer interest groups and transportation network companies (TNCs). The Company will also maintain online information and tools, customer call center assistance, and support for local ride-and-drive events.

In addition, Avista will consider new and innovative ways to raise positive awareness and EV availability, such as with informational kiosks, training and certification programs at auto dealerships, and partnering to establish an innovative EV Experience Center delivering effective information and education, charging availability, and EV rental and purchase services.

Community and Low-Income Support

Avista is committed to help provide benefits from electric transportation to disadvantaged communities and low-income customers, in collaboration with other service organizations and community leaders. An aspirational goal of up to 30% of overall electric transportation funding will be applied to this program category, subject to practical limitations of the market and viable, cost-effective technologies.[7] The EVSE pilot demonstrated a successful model that will be expanded upon, providing EV and EVSE assistance for community organizations that serve the disadvantaged, through a collaborative process and competitive proposal selections. In addition, Avista will provide additional EVSE installation assistance for low-income rural towns, multi-unit dwellings, and residential customers receiving low-income bill assistance.

New pilot programs may be developed with public transit agencies and TNC platforms, as well as partnerships with organizations such as Envoy to pilot ride-sharing and car-sharing services for disadvantaged groups.

Commercial and Public Fleets

Opportunities to support electric transportation in commercial and public fleets exist today and will grow in the future. Avista can begin to effectively support this growth. This starts with information, tools and consulting services for light-duty passenger EVs and electric lift trucks (forklifts) in 2021, followed by commercial delivery vehicles, airport ground-support equipment, and refrigerated trailer units in subsequent years. A pilot EV TOU rate for commercial customers and "make-ready" utility investments will further support electric fleet expansion.

Electric forklifts — transportation electrification includes the movement of both people and goods

[7] See UTC docket UE-190334, et. al, Partial Multiparty Settlement Stipulation, pp. 11-12.

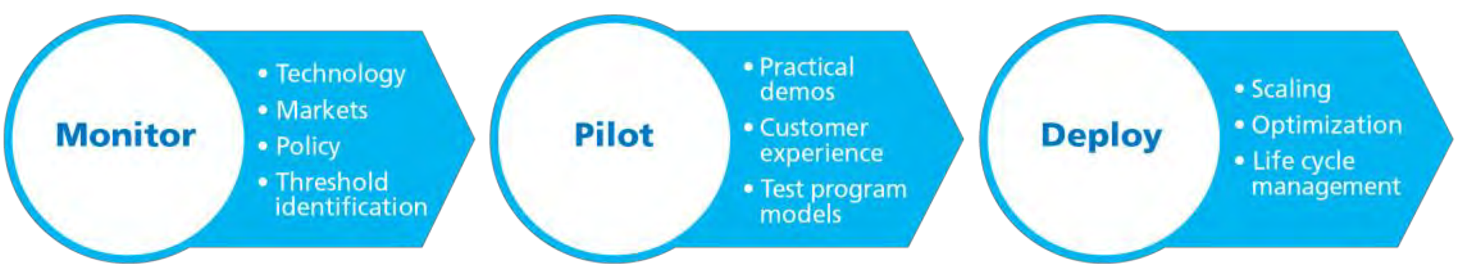
A new program supporting lift trucks is modeled after other successful utility programs in the U.S. The program provides information resources, incentives of $2,000 to buyers, $250 to dealers, and an additional incentive of $1,000 for lithium-ion batteries, for purchases of Class 1 electrically powered lift trucks. Annually per lift truck, this will result in avoiding 16 metric tons of CO_2 tailpipe emissions, customer fuel savings of 76%, and $1,500 per year in beneficial utility revenue. EVSE consultation and load management services will also be provided.

By 2022, Avista may consider a pilot program with a transit agency and/or school district to electrify buses, in conjunction with services benefiting disadvantaged and low-income groups, as well as testing technologies and models for load management and emergency backup power.

Avista will deploy cost-effective load management services leveraged with EVSE installation programs. This will initially be accomplished through vehicle programming and the utilization of programmable non-networked EVSE. Experimentation with new technologies and industry innovations will also be considered, such as the utilization of advanced metering infrastructure (AMI).

Load Management, Planning and Grid Integration

Avista will continue to monitor and document EV load profiles, using a smaller test pool of customers with



vehicle telematics connectivity starting in 2021. Updated annual load profiles and forecasts for EVs will be integrated with System Planning and the Integrated Resource Plan (IRP). This will be used in conjunction with updated modeling of grid assets and conditions, other load forecasts, and the effects of distributed energy resources (DERs), providing a sound assessment of system generation capacity, localized distribution system impacts, and optimized asset management.

Avista will deploy cost-effective load management services leveraged with EVSE installation programs. This will initially be accomplished through vehicle programming and the utilization of programmable non-networked EVSE. Experimentation with new technologies and industry innovations will also be considered, such as the utilization of advanced metering infrastructure (AMI) and other technologies that communicate with EVs and other distributed energy resources, given the potential to optimally manage loads and integrate with the grid at scale. Residential TOU rates may also be considered and piloted with groups of customers participating in the EVSE program, starting in 2023. By 2025, the goal is to demonstrate greater than 50% peak load reduction from EVs, achieving grid benefits larger than expenses required to perform load management.

Technology and Market Awareness

Avista will utilize a deliberate process of innovation and testing of emerging opportunities in electric transportation. During the initial monitoring phase, thresholds may be identified based on total cost of ownership (TCO) assessments and other promising technology and market developments, triggering pilot programs that test technical feasibility, costs and customer experience on a small scale and at low risk. Pilots may lead to informed deployments that can scale up over the long term, achieving sustained benefits for all utility customers.

In the light-duty sector, installed battery pack price and energy density of batteries are key metrics to track, along with the number of models, charging speeds, prices and sales penetration levels. In other sectors, various technologies and the state of the market will be monitored in medium and heavy duty applications, micro-mobility innovations, V2X and networking/control systems, autonomous EVs, aircraft, rail and marine applications, and hydrogen-powered EVs.

Rate Design

A new pilot rate schedule as proposed in this Plan is essential to support sustainable growth in fleet electrification and public DC fast charging. The proposed rate provides for reasonable recovery of utility costs based on additional time-of-use (TOU) energy charges, while eliminating demand charges that currently inhibit market growth. In this way, it establishes sensible electric billing rates for businesses that invest in electric fleets and public charging, encouraging early and sustained fleet adoption, larger workplace charging facilities, and third-party ownership of public DC fast charging. Through higher on-peak price signaling, it also encourages more off-peak charging which is beneficial to all customers.

The new EV rate schedules will be made available to commercial customers, provided that EV charging loads are metered separately from other loads and peak demand does not exceed 1 MW. Above this threshold, verified load management systems may be required and it must be demonstrated that all reasonable measures are being taken to mitigate impacts to the local distribution grid as a condition of utilizing the pilot rate. The EV TOU energy charge on the order of $0.05 per kWh is applied, in addition to regular energy charges on a seasonal basis, during the hours of 7am to 10am and 5pm to 8pm from November through March, and 3pm to 7pm from April through October. Provisions of existing commercial rate schedules apply other than the removal of demand charges and the addition of on-peak energy charges, and the EV TOU rate will adjust commensurate with other normal adjustments to respective commercial rates.

Eligible customers may choose to adopt the pilot EV TOU rate starting in 2021, with open availability through 2025. At that time, the Company intends to propose a more permanent commercial EV TOU rate based on collected data and analysis completed during the 2021-2025 pilot period. Customers initially participating in the pilot rate may then choose between the new EV TOU rate or elect to continue with the pilot rate for another five years through 2030. Early adopters are thereby given reassurance that the pilot rate may be applied through 2030 when they consider making sizable capital investments in new electric fleets and charging infrastructure with long service lives.

A relatively small number of customers is expected to participate in the pilot EV TOU rate, so that the general body of customers is not materially affected. In addition to encouraging early adoption, the pilot TOU rate is intended to provide valuable data, including local coincident loading patterns and impacts on the distribution system, enabling development of a more permanent EV TOU rate schedule.

Experience with a limited number of commercial participants will also be valuable in consideration of a pilot EV TOU rate for residential customers starting in 2023, potentially on a larger scale with the deployment of Advanced Metering Infrastructure (AMI).

Testing Battery Electric Buses—Spokane Transit Authority (2019)

Utility Fleets, Facilities and Employee Engagement

Utilities must set a good example for customers in electrifying their own fleets and facilities, as well as encouraging employee engagement around electric transportation. In addition to realizing fleet and employee benefits, through direct experience in these areas the Company is better able to advise customers, and employees who drive EVs act as credible ambassadors in the community, raising positive awareness and long-term adoption of EVs in the region.

Avista has successfully electrified its small pool of passenger vehicles and plans to continue evaluating and piloting fleet electrification, including medium- and heavy-duty utility vehicles and auxiliary equipment. These initiatives will be carefully considered and deployed in operational fleets, as reliable operations must be ensured. Adequate workplace charging at Avista facilities coupled with effective employee engagement around electric transportation options, can make a big difference in employee adoption—which translates to higher awareness and long-term EV adoption in the community. The Company will look to partner with OEMs to offer purchase discounts to employees and at some point may consider supplementing this with incentives funded by shareholders when EV availability and choices in the market would yield the greatest positive effects.

Programs and Activities with Budget Targets

45%	EVSE Installations and Maintenance
30%	Community and Low-Income Support
10%	Education and Outreach
5%	Commercial and Public Fleets
5%	Load Management, Planning and Grid Integration
3%	Market and Technology Monitoring & Testing
2%	Data Management, Analysis and Reporting

Programs and Activities Summary

Programs and activities for 2021–2025 are summarized below, with budget targets to overall program funding. These are initial budget targets subject to uncertainties in customer participation levels, partner capacities, and diligent adjustments based on regular assessments of program costs and benefits. Activity and spending levels will also change over time with new learning and changes in technology, policy and market conditions. For example, changes in actual EV adoption trajectories would effect EVSE buildout plans; or similarly, as viable markets develop for fleets, supportive utility programs addressing those opportunities would grow as appropriate. Different program elements are related and support each other, requiring integrated management and regular adjustments in order to be most effective.

Avista proposes to fund these programs and activities over the next five years with an overall capital and expense budget of $2 million to $6 million per year in Washington, and $0.5 million to $1.5 million per year in Idaho. This is the estimated level of activity required to achieve strategic objectives, adjusting to changing market conditions as appropriate.

Utility capital investments will result in an increase of less than 0.25% annual revenue requirement in Washington for electric customers, net of benefits from electric billing revenue, load management and any monetized environmental benefits that may become available.[8] Programs and activities in Idaho are in the early stages of consideration, tailored to its market condition and focusing on early learning and more limited programs that demonstrate the value of beneficial electric load growth in transportation; including mitigation of peak loads, leveraging lessons learned and integrating with respective programs in Washington.

Over the longer term, the benefits from electric transportation are expected to outweigh utility costs, thereby providing direct and recurring net benefits to all utility customers. This outcome and the realization of major economic and environmental benefits for the region are the ultimate goals of the TEP.

[8]As directed by legislation, see Revised Code of Washington (RCW) 80.28.360 (1), https://app.leg.wa.gov/RCW/default.aspx?cite=80.28.360, Washington State HB1853 (2015), HB2042 (2019), and SB5116 (2019). https://app.leg.wa.gov/billinfo/

The TEP will be updated and reissued in five-year intervals starting in 2025. Summary year-end updates will be provided for 2021 and 2023 focusing on expenses, revenues and high-level program results. A more comprehensive mid-period report will be provided in early 2023 including updates on EV adoption and forecasts; program activities; lessons learned; and adjustments.

Detailed reporting will also be included with the updated TEP submitted by year-end 2025, along with modeled impacts on the environment, the economy and the grid.

New program filings may be submitted for regulatory review on an ongoing basis and later incorporated in regular revisions to the TEP.

Table 2: Program and activity timeline (2020-2025)

Program/Activity	2020	2021	2022	2023	2024	2025
Develop public EVSE buildout plan with stakeholders	X					
Initiate DCFC site acquisitions	X					
Solicit public AC Level 2 applications		X	X	X	X	X
Launch EVSE installation programs — all categories including low-income assistance		X	X	X	X	X
Design and launch education and outreach campaigns	X	X	X	X	X	X
Solicit proposals and award EV and EVSE to community service organizations	X	X	X	X	X	X
Launch and sustain fleet support program — lift trucks and light-duty passenger EVs		X	X	X	X	X
Extend fleet support program — airport GSE, refrigerated trailers, other commercial vehicles			X	X	X	X
Design and pilot an EV Experience Center	X	X	X	X	X	X
Design and pilot a TNC program		X	X	X	X	X
Design and pilot mass transit and school bus pilots			X	X	X	
Collect telematics and meter data; update load profiles for System Planning and IRP		X	X	X	X	X
Perform load management experiments including telematics and programmable EV/EVSE		X	X	X	X	X
Update grid impacts, costs and benefits		X	X	X	X	X
Expand utility fleet electrification, facility EVSE and employee engagement programs	X	X	X	X	X	X
Pilot commercial EV TOU rate		X	X	X	X	X
Post-pilot commercial EV TOU rate						X
Pilot residential EV TOU rate				X	X	X
Submit annual updates and mid-period report		X	X	X	X	
Submit revised TEP						X

Background

On April 28, 2016, the Washington Utility and Transportation Commission (UTC) issued Order 01 in Docket UE-160882 approving Avista's tariff Schedule 77 for its EVSE Pilot Program. The initial two-year installation term of the program began with the first EVSE installation on July 20, 2016.

On June 14, 2017, the UTC issued a Policy and Interpretive Statement Concerning Commission Regulation of Electric Vehicle Charging Stations in Docket UE-160799. It provides background and guidance principles for utility EV charging as a regulated service, and notes that the purpose of Avista's pilot program is to obtain data and experience that will inform future programs and rate designs.

On February 8, 2018 the UTC issued Order 02 in Docket UE-160882 approving Avista's proposed revisions to tariff Schedule 77. This included extending the installation period of the program with additional EVSE installations through June 30, 2019, as well as adding a program benefiting low-income customers and a few other minor adjustments. The pilot's EVSE installations were concluded in June, 2019, and a final report was completed in October, 2019. Ongoing program management includes EVSE maintenance and data

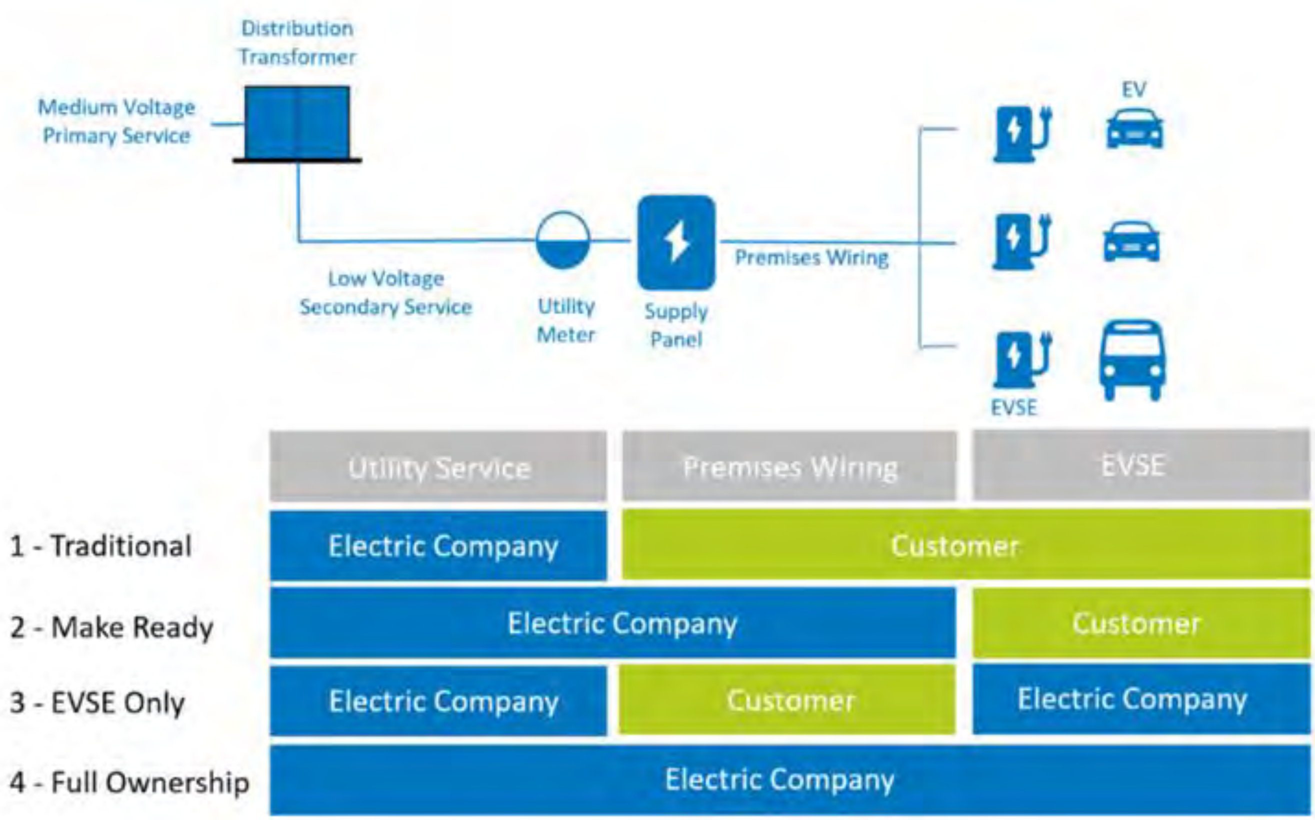


Figure 5: Ownership models for utility and customer EVSE infrastructure

Avista's AC Level 2 installations followed the "EVSE only" model in both residential and commercial locations, and DC fast charging sites followed the "full ownership" model.

A simple EVSE rebate program is an example of the "traditional" business model, where nothing is owned by the utility beyond the meter and conditional rebates from the utility are provided for EVSE purchased and installed by the customer. A "make ready" program typically involves new utility commercial service, including dedicated meters and in many cases premises wiring or supply infrastructure that is owned and maintained by the utility, stubbed out to the EVSE location. In "make ready" models, the EVSE itself is owned and maintained by the customer, and in some cases the utility may provide subsidies to the customer for EVSE purchase, installation and/or maintenance. Full ownership involves a dedicated transformer, meter, supply infrastructure and the EVSE itself, all owned and maintained by the utility. AC Level 2 or DC fast charging sites can fall in this category, with EVSE user fees applied and subject to regulatory oversight.

Avista chose the "EVSE only" and "full ownership" models for the EVSE pilot as an alternative to other, more common utility EVSE rebate and "make-ready" programs. It was felt that by utilizing existing supply panels and other supply infrastructure owned by the customer in residential and commercial locations in the "EVSE only" model, costs could be much lower than comparable "make ready" installations with new dedicated services and infrastructure. Further, it seemed possible that utility EVSE ownership and maintenance might be an effective way to provide the most value and satisfaction for customers in terms of reducing the costs, risks and difficulties of installing EVSE, while providing a means for effective load management, without the need for further incentives or a time-of-use (TOU) rate to shift peak loads. Due to the more substantial investments and effort to implement DCFC sites and maintain them, the full utility ownership model was chosen to ensure long-term DCFC operability and public access.

In order to comprehensively understand EV charging behavior and electrical loads from different locations, it was necessary to build an EVSE "ecosystem" integrated by a single network, thereby capturing the charging data for individual EV drivers wherever they might charge – at home, at work or in the public — for both AC Level 2 and DC fast charging. It was important to incorporate hardware and software that was "interoperable," using industry-standard communication protocols (such as the OCPP standard), so that risks and operational flexibility could be well managed. This enables "plug and play" deployment of alternative EVSE or EVSP providers in the future as the competitive market and products mature. The overall design is depicted below, with the maximum allowed number of ports in each major category.

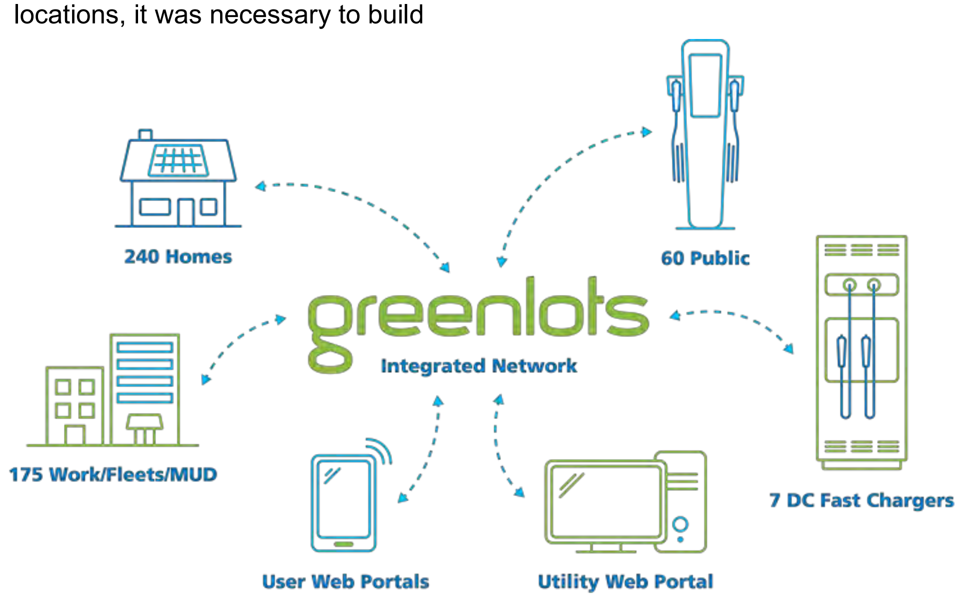


Figure 6: Integrated EVSE network design for the EVSE pilot (2016—2019)

The numbers and proportions of EVSE in each category were carefully chosen to accomplish learning objectives and begin to support EV adoption in Avista's service territory, while containing costs to a modest level. Uninfluenced load profiles for different EV driver types and in different locations could be reasonably established in the first phase of the pilot, followed by direct load management of networked AC Level 2 EVSE at residential, workplace, fleet and MUD locations.[9]

These comparisons allow for a better understanding of customer behaviors and more robust grid impact and economic modeling, influencing future program designs. The proportional targets were also informed by the literature, showing different volumes and supporting roles that EV charging plays in each segment. As shown by the "Charging Pyramid," all types of charging are important in the overall light-duty EV "ecosystem," but as much as 90% or more of all charging occurs at residences, fleet locations and the workplace, where EVs are parked for long periods of time and may charge at lower power levels and at reduced costs. This is especially so if the charging may be reliably and economically shifted to off-peak times, maximizing benefits for all utility customers.

Program design also incorporated the objective of providing support for early EV adoption. This could be accomplished by addressing the barriers of low awareness and lack of EVSE infrastructure, through initial education and outreach efforts, dealer engagement including a referral program, and residential EVSE offerings, as well as commercial EVSE buildout at workplace, fleet and public locations—all intended to help form the first substantial backbone of EVSE infrastructure in eastern Washington.

Finally, with the backdrop of legislation passed in Washington State in 2015 and 2019[10] and growing consensus and support on a global scale, a societal purpose has been established for the reduction of greenhouse gas emissions (GGEs). It is recognized that the transportation sector is the largest contributor of GGEs and other hazardous air pollutants, that electrification of the transportation sector can provide a high return on investment in reducing emissions, and that utilities must be fully engaged to play a key role in this transformation. The EVSE pilot was therefore launched as a starting point to explore how the Company may better serve all customers, achieving major economic and environmental benefits in the long-term effort to electrify transportation, partnering with industry, customers, local governments and policymakers.

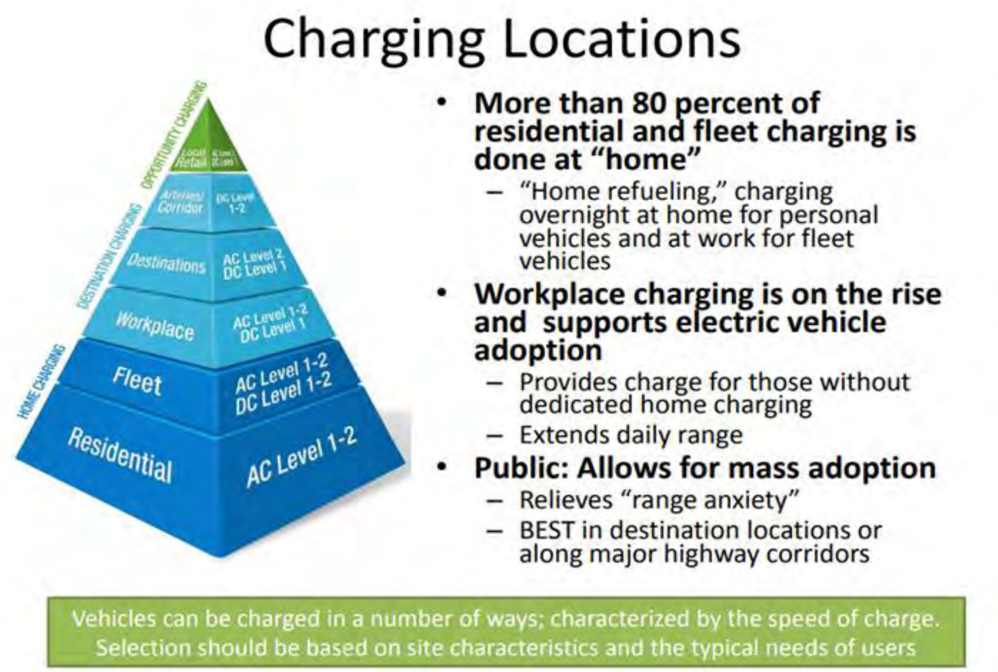


Figure 7: The Charging Pyramid (courtesy EPRI)

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[9] Load management of public AC Level 2 and DC fast chargers is not feasible as EV drivers need maximum charge for limited periods of time at public locations.

[10] See Washington State HB1853 (2015), HB2042 (2019), and SB5116 (2019). https://app.leg.wa.gov/billinfo/

In summary, key takeaways from the EVSE pilot included the following:

1. Data and analysis show that grid impacts from light-duty EVs are very manageable over at least the next decade, net economic benefits can extend to all customers, and significant reductions of greenhouse gas emissions (GGE) and other harmful air pollutants may be achieved with EVs. However, grid impacts and costs resulting from EV peak loads could become significant over longer time horizons, with higher EV adoption, and as other loads and the grid change. The EVSE pilot represents a good start in the Company's ongoing effort to understand how EV loads may be optimally integrated and managed, in an evolving system that brings the most benefit to all customers.

2. Avista was able to cost-effectively install EVSE, resulting in high customer satisfaction, and the pilot correlated with a significant increase in the rate of EV adoption in the area. This demonstrated that utility programs can be effective in supporting and enabling beneficial EV growth. Partnerships with industry providers, a focus on providing value for the customer, and contractor performance were keys to success.

3. Workplace charging stands out as a powerful catalyst for EV adoption, while simultaneously providing grid benefits from reduced EV charging at home during the evening peak hours.

4. Low dealer engagement, a lack of EV inventories, and persistent customer awareness and perception issues continue to be a major barrier to mainstream EV adoption in the region. The utility can help overcome these issues with robust education and outreach programs, including dealer engagement.

5. Avista successfully demonstrated the use of EVs to reduce operating costs for a local non-profit and government agency serving disadvantaged customers. The Company expects local stakeholder engagement to continue in the development and expansion of similar programs, as well as other innovative ways to serve communities and low-income customers.

6. Surveys showed a widespread desire for more public AC Level 2 and DC fast charging sites, which may be supported in future utility programs and rate designs. A new rate should be developed to address operational cost barriers resulting from traditional demand charges, while reasonably recovering utility costs.

7. Networked EVSE reliability, uptime, costs and customer experience are all important opportunities for improvement, reinforcing the importance of utilizing interoperable networked EVSE. Non-networked EVSE are very reliable and cost effective, and should be utilized wherever possible unless data collection, user-fee transactions, remote monitoring or other requirements necessitate the use of networked EVSE.

8. Load management experiments showed that the utility may remotely curtail residential peak EV loads by 75%, while maintaining customer satisfaction and without a TOU rate or additional incentives other than the installation of the EVSE owned and operated by the utility. More DR experimentation may show the feasibility to shift an even higher percentage of peak loads. While EVSE load management utilizing DR and V1G technology appears acceptable from a customer perspective, reliability and costs must be significantly improved to attain net grid benefits and enable practical application at scale.

9. Data and analysis were somewhat limited by the available pool of participants and EVSE sites. However, results compared well with other studies using larger population samples, and EVSE data was satisfactorily replicated and verified by telematics data. As the industry evolves, light-duty EVs with larger battery packs may become the norm. In this respect, the EV load profiles developed and examined in this study may under-predict electric consumption and peak loads to some degree.

Technology and Markets

Transportation electrification is affected by a variety of technology and market forces, which Avista will closely monitor to inform the TEP. There are factual trends as noted below, but it is uncertain how these forces will shape vehicle and equipment design, production and timing decisions, and how this in turn will interact with evolving market and customer preferences. One thing is clear—the Company must keep abreast of the changing landscape and adjust its plans accordingly on a regular basis.

Given these changes and historical examples of technology adoption, it seems likely that the transportation sector is on the cusp of a major transition toward electrification. To illustrate, the following chart shows the rate of new technology and product adoption in U.S. households over the last century.[11]

Note that adoption rates for new technologies typically follow an S-curved shape. A period of initial slow growth is followed by rapid acceleration, before flattening out with market saturation and in some cases eventually declining, such as that for landline telephones. While these examples cannot be used to reliably predict the adoption curves for various forms of electrified transportation, they do provide insight and highlight the importance of monitoring technology and market trends in a rapidly changing environment. Due to a number of complex and interactive factors, adoption of a given set of technologies and products may suddenly surge unexpectedly, such as the case for cellular phones. To help explain this, as the market and technologies developed for cellular phones, they could increasingly be used for more than just telephone conversations—they could be used to send text messages; take pictures; store, play and share music and other media; and connect with the internet and its myriad of

[11] "Electrification Futures Study", NREL 2018 (p. 16).

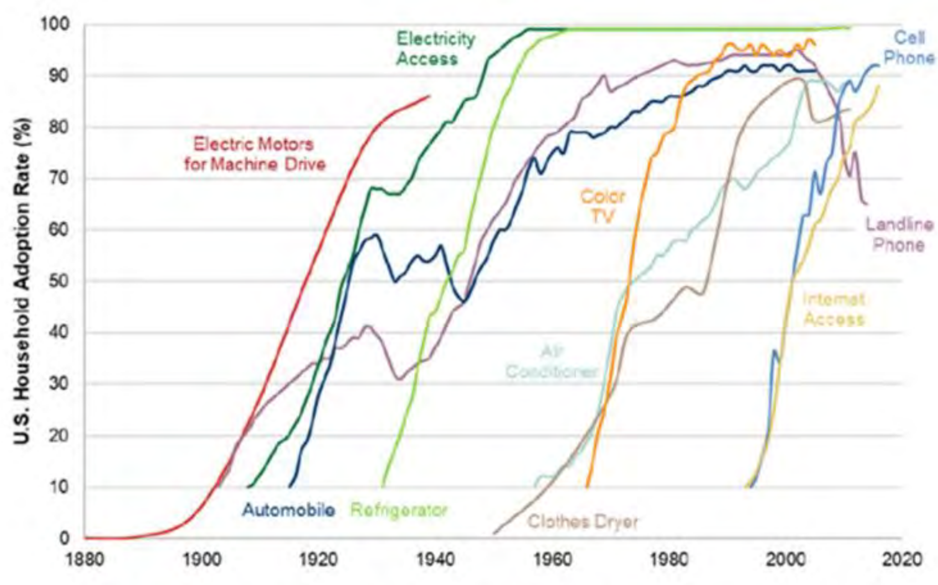

Figure 8: Diffusion of various technologies in U.S. households

expanding, derivative services.

Beyond the advantage of mobility, cellular phones opened up a whole new platform for greater connectivity, functionality, and access to other services and benefits that land-line phones could not offer. Similarly, EVs may open doors to a variety of benefits and services that traditional vehicles cannot, in addition to tremendous operational savings and a superior driving experience. Together with supportive policy and societal factors, this could strongly influence customer preferences and adoption rates beyond first-order economics. On the other hand, considerable technological and market hurdles remain, and transportation electrification could be dampened by existing fleets and infrastructure with long service lives, as well as powerful influence by incumbent interests and the inertia of the status quo.

Another useful framework to consider is the Technology Adoption Lifecycle for disruptive products as originally described by Everett Rogers and later expanded upon by Geoffrey Moore in his classic work, "Crossing the Chasm." [12,13,14] As explained by Moore, when a new disruptive technology enters the market, first adopters known as "innovators" and "early adopters" are most interested in new technology and performance. These two groups represent about 15% of the total market assuming a bell-curve distribution, and they are willing to deal with some inconvenience and price premiums as a trade-off to using a new and exciting innovation. 2019 saw U.S. sales of plug-in EVs at 325,000 vehicles, about 2% market share in a new-car market of 17 million vehicles—clearly still in the early stage of market adoption. In order to sustainably gain entry into the mass market beyond this level, a "chasm" must be crossed whereby the product appeals to the "early majority", typically when it is able to be sold on a more practical basis to non-technologists less willing to tolerate inconvenience and higher prices.

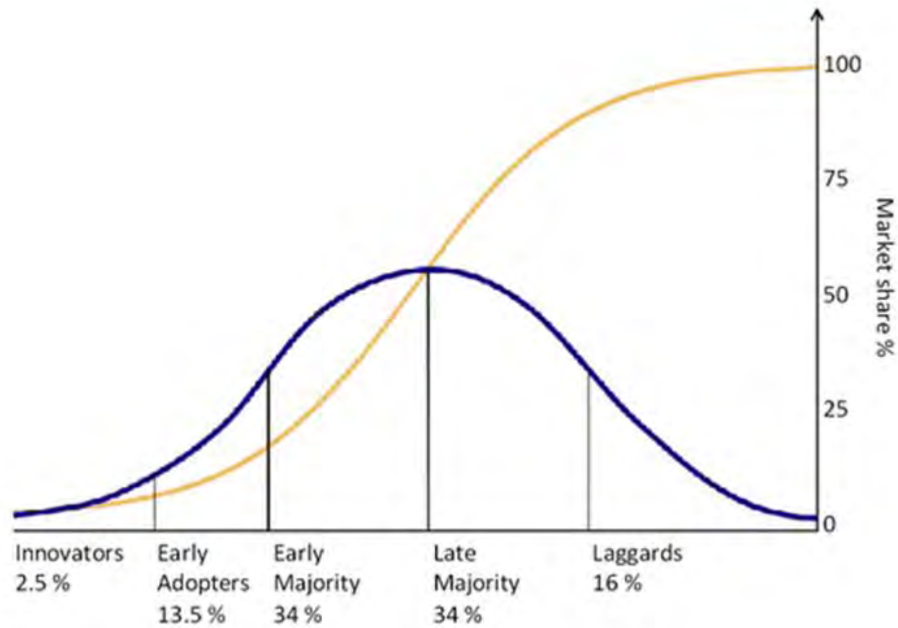

Figure 9: The Diffusion of Innovations (Rogers)

[12] Everett, Rogers. "Diffusion of Innovations." 1st Ed. (1962).

[13] Moore, Geoffrey A. "Crossing the Chasm: Marketing and Selling Disruptive Products to Mainstream Customers." Harper Business, 3rd Ed. (2014).

[14] UTC (p. 29).

The challenges of crossing the chasm are often considerable—many disruptive innovations never cross it and remain confined to a small segment of the market, or decline into obscurity. However, based on the level of global investment, the march of technology advances and cost reductions, and supportive policy based on rising concerns of climate change, we can reasonably expect an inflection point in the light-duty EV market in the 2023-2024 timeframe, and possibly some other market segments as well, such as battery electric transit buses. Assuming OEMs deliver strong product and critical market barriers such as charging infrastructure and awareness issues are addressed, EVs appear likely to cross the “chasm” soon thereafter, and sustainably make inroads into the early mass market at the 15% penetration level sometime between 2026 and 2030.

In this timeframe, Avista can play a strong role in addressing a number of market barriers – particularly EVSE infrastructure and customer awareness – while paying close attention to key technologies and changing conditions as noted below.

Battery Technology

Falling battery costs and improved performance are key trends to monitor as they represent a significant cost item in electrified vehicles. Average market prices for battery packs fell from $1,100/kWh in 2010 to $156/kWh in 2019, and may further decrease to $100/kWh by 2023, according to Bloomberg New Energy Finance (BNEF). Ongoing price reductions will be driven by battery production at scale and the utilization of high-energy density cathodes that store energy more efficiently. Further price reductions are not "impossible," but will be more complicated because "there are a variety of options and paths that can be taken," such as standardizing battery pack designs across different EV models or introducing new technologies to improve the batteries themselves, like new cathode materials.[15]

Changing battery chemistries and thermal management are two areas where the most cutting-edge R&D work is happening. While lithium-ion (Li-ion) batteries are expected to continue as the predominant EV battery technology in the near term, various other chemistry combinations with Li-ion are advancing, and solid-state batteries are also expected to emerge as cost-viable options. Newer cell chemistry, and different materials in battery cathodes and anodes, are expected to result in higher energy densities and lower reliance on rare materials such as cobalt.

Rising battery voltages. Current vehicles powered by internal combustion engines (ICE) use a 12V battery for starting the engine and supplying auxiliary loads. By comparison, early EV models such as the Nissan Leaf, GM Bolt, Tesla Model S and Audi e-Tron all have battery voltages at the pack level between 300 to 400 volts. Next-generation EV models such as the Porsche Taycan have pack voltages at 800 volts and as high as 1200 volts, which will allow for much faster charging times as EVSE power capacities rise from 50kW to 350kW and possibly higher without increasing electric current.[16] This is necessary to minimize heat and maintain conductor size and weight within limits for human use. In addition to overcoming the issue of charging infrastructure availability, these higher power levels will reduce refueling time by 67% to 86%, making it much more convenient to charge an EV in public.

Battery management systems, impacts on battery life and OEM warranties. Automakers typically cover the lithium-ion battery pack under warranty for an extended period. In recent years the standard offer has been at least eight years or 100,000 miles, whichever comes first. Some manufacturers will cover the battery pack against total failure, while others will replace it if the battery’s capabilities fall below a certain level, such as 60-70% of the battery’s original capacity. More recently, the state of California mandated automakers to extend the battery coverage for EVs sold within that state to 10 years or 150,000 miles. Other OEMs have gone further; for example Hyundai, has increased its battery warranty to lifetime coverage on the Kona Electric. Battery performance and warranty concerns were a significant unknown when the first EVs began to be sold in the 2011-2016 timeframe. Batteries lose capacity over time due to

[15] 2019 Battery Price Survey, Bloomberg New Energy Finance.

[16] Batteries and Electrification R&D Overview. Steven Boyd, Program Manager, US Department of Energy, June 18, 2018.

factors including the number of discharge/recharge cycles, depth of discharge, and ambient operating and storage temperature, all of which can exacerbate degradation depending on cathode and anode chemistry.[17] Through improvements in chemistries and robust battery thermal management systems, significant long-term degradation can be minimized while operating applications can expand.[18] A GM battery engineer recently noted that they had conservatively treated the battery's capabilities in the Volt and Bolt vehicles.[19] We are now seeing EVs sold in the last four to five years driven well over 100,000 miles, and it is becoming clear that battery management systems will enable EVs to travel at least this far and possibly much further before there is a significant reduction in battery performance and driving range.

Battery degradation and second-life use. EV battery packs tend to degrade slightly with each charge and discharge cycle, eventually losing their ability to fully charge. Draining most or all of a battery's charge on a regular basis tends to cut into its capacity more quickly over time. For this reason, older EVs with shorter operating ranges can suffer incrementally faster deterioration than newer EVs with 200+ miles of range, as they can be drained more deeply and frequently to meet driving range requirements. Until recently, EV batteries were best maintained by avoiding deep discharges and frequent DC fast charging. Today, thanks to more advanced battery management systems, these concerns are gradually being eliminated. The inherent chemistry and design of an EV battery varies from one make and model to another. EV battery packs generally contain a series of connected individual cells, perhaps several hundred of them depending on the model, instead of a single massive unit. It is often difficult, if not impossible, to combine cells from different manufacturers and different chemistries in second-life applications.

As long as detailed battery charging history at the cell level is available, battery remanufacturers (such as 4R Energy, Spiers New Technologies and others) have expressed a willingness to take less degraded cells from an EV battery pack and "repackage" them for other applications, including use in another vehicle and for stationary storage applications. One such application is the secondary use of batteries originally in Class 8 heavy-duty trucks, deployed for second-life use in smaller, lighter-duty vehicles for local deliveries where required travel distances are not as long. This use case is facilitated when both the first and second vehicles are from the same manufacturer. However, it is possible that advanced new-battery costs may approach "refurbished" battery costs when this market materializes, probably in the 2030 timeframe. Other stationary applications may someday extend the use of batteries beyond their first applications, such as for traffic lights, streetlights, and home energy storage. American Electric Power is currently testing this application using batteries from older -model Nissan LEAFs.

Today, the market is hesitant to commit to acquisitions of second-life batteries at some future date, mainly due to rapidly falling battery prices and the challenges involved with "mixing-and-matching" batteries from different manufacturers. Second-life battery uses may become more feasible when a change in battery ownership does not occur— i.e., the battery continues to be owned by the same party that bought the original vehicle. In this case, the owner can confidently know the battery history and condition, and its suitability for future use. Owners and operators of future electric fleets in the tens or hundreds of thousands of vehicles are a natural market for refurbished batteries, as their vehicles and business-use cases have varying performance and range requirements. Fleet owners at some point will also likely need to add local energy storage at their depots in order to reduce demand on the local distribution grid, and to acquire and store energy when utility TOU rates are lowest. In this respect, second-life use of fleet batteries may become a viable option.

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[17] https://www.researchgate.net/publication/335672438_A_Wide_Range_of_Testing_Results_on_an_Excellent_Lithium-Ion_Cell_Chemistry_to_be_used_as_Benchmarks_for_New_Battery_Technologies

[18] https://www.energy.gov/sites/prod/files/2017/10/f38/XFC%20Technology%20Gap%20Assessment%20Report_FINAL_10202017.pdf

[19] https://electrek.co/2020/02/10/gms-director-of-battery-cell-engineering-were-nowhere-near-the-bottom-of-the-price-curves/

Much has been written in the industry media about the possibilities of utility purchases of second-life batteries for smart grid deployments. Recent utility RFPs for energy storage applications at generation and substation sites require large volumes of identical cell technologies which the current “refurbished” battery supply chain cannot meet. This is because battery chemistries are unique to each OEM and in many cases, to each vehicle model and model year. In general, the financial viability of second-life battery use in utility applications remains elusive today, but this could eventually change and therefore progress in this area should be monitored.

Battery recycling. Once the primary (in an electric vehicle) and secondary (stationary storage applications) uses have expired, the battery can be recycled to obtain reusable materials such as lithium, cobalt, nickel and other metals. Advanced processes are still in development to make recycling these materials more economical, with several companies currently working on the technology. However, if the electric vehicle market grows as expected, significantly increased demand for battery materials may become a major challenge. Avista plans to monitor battery recycling developments, but the current assumption is that the market will be able to successfully recycle large numbers of EV batteries when they reach end-of-life, estimated to be at least a decade away. New chemistries that are currently in development may further mitigate the issue, for example, reducing the need for rare materials such as cobalt.

EVSE Technology

Smaller footprint and higher power output. 50kW is the current baseline for DCFC connected to light-duty (Class 1) passenger EVs, using both the CHAdeMO and CCS-1 charging protocols. While still an industry mainstay, the 50kW platform is quickly being overtaken by fast charging at the 100kW to 175kW level. Many Tesla Supercharger sites, for example, currently offer fast charging at 120kW and higher. Within the next few years, the 50kW “standard” will be superseded by 175kW as the de facto standard, and the subsequent “standard” after that will be 350kW. Electrify America is already installing 350kW DCFC at some of its locations, such as the current site in the Spokane Valley near I-90. In the heavy-duty vehicle space (Class 6 and above), a number of vehicle and EVSE manufacturers are working through a CharIN committee to develop an industry-wide set of specifications for charging at the 1MW to 2MW level and above.[20] According to CharIN, the High Power Charging for Commercial Vehicles (HPCCV) standard will be used for charging in the range of 200 to 1500 volts and up to 3000 amps. That should be enough to address the needs of heavy-duty electric vehicles with very large battery packs of 1 MWh.[21]

Communications interoperability. There is a clear global movement among EV charger manufacturers and software providers to make their equipment and capabilities comply with the Open Charge Point Protocol (OCPP).[22] Current compliance is at the entry 1.6 level, with the industry moving toward the more complex and sophisticated 2.0 level that provides additional security, functionality, transactions handling and smart charging capabilities. Innovative Charging Protocol ISO/IEC 15118 is mostly about communications standards between the EV, EVSE and the cloud. It’s important to stay aware of developments in this area and ensure compatibility with other smart grid initiatives that Avista may undertake in the future.

EVSE interchangeability is an important capability when owning and operating a portfolio of EV chargers from different manufacturers and vintages. To manage this diverse portfolio, it will be important to adopt open standards such as OCPP as much as possible for several reasons, including minimizing operational and financial risks associated with adopting proprietary products and services. In other words, EVSE that are fully compliant with OCPP may be more readily swapped out with other EVSE or switched to another EVSP in the event of performance issues or business failure with either EVSE or the EVSP. This also has the added benefit of supporting healthy competition in the marketplace.

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[20] https://insideevs.com/news/372749/charin-hpccv-over-2-mw-power/

[21] https://www.charinev.org/fileadmin/HPCCV/High_Power_Commercial_Vehicle_Charging_Requirements_v2.0.pdf

[22] https://insideevs.com/news/372749/charin-hpccv-over-2-mw-power/

Connector standards are another aspect of interoperability that must be monitored. While the EV industry was able to broadly adopt a common plug configuration for AC Level 1 and Level 2 charging using the J1772 standard, there are now de facto three-plug configurations for DCFC in North America: CHAdeMO, CCS-1 and Tesla. CHAdeMO and CCS-1 are not compatible. Tesla vehicles cannot be fast charged using the CCS-1 connector in North America. It is possible to purchase a special cord/adapter[23] to enable a Tesla driver to use a CHAdeMO charger, but this adapter is often out of stock, and CHAdeMO currently limits power output to 50kW, well below the 120kW or higher capability of the Tesla Supercharger network. Given the three different DCFC connector standards, two developments have occurred which merit attention. One is the co-location of CHAdeMO, CCS and Tesla chargers in the same location. The Marengo Charging Plaza in Pasadena, CA is an example.[24] EVGo and Tesla have entered into an agreement offering Tesla's proprietary connectors at EVGo DCFC sites, which previously offered only CHAdeMO and CCS connectors. Similarly, Avista should consider partnering with Tesla to allow for additional investment by Tesla to install their chargers at DCFC sites, providing for greater utilization and beneficial utility revenue while avoiding additional utility investment.

Inductive charging. Much of recent charging technology development has involved conductive charging for both passenger and heavier-duty vehicles, with less attention to inductive charging despite the early lead it enjoyed with inductive "paddle" chargers in the late 1990s. A number of wireless charging companies and auto OEMs have worked on making inductive charging more viable over the last decade, but aside from a few demonstration projects, commercial scale projects have been limited. Most recently, however, the Antelope Valley Transit Authority (AVTA) in California installed inductive chargers for in-route charging of its electric fleet of 50 buses, including both 40-foot and 60-foot articulated buses, in daily operations. Many inductive chargers have been installed, with a total of fifteen (15) 250kW wireless charger installations expected by April, 2020. Clearly, if this technology works well at 250kW, it will become a viable option for charging smaller vehicles as well, but requires the inductive charging mechanisms to match on both the vehicle and the charger embedded in the ground. As such, the initial applications for inductive charging are likely to occur where both decisions are made by a single decision maker (such as public and private fleets). Initial concerns include higher power losses when compared to conductive charging, and its uncertain durability and performance in harsher weather climates, including colder temperatures and snow/ice. Avista will monitor the progress of inductive charging closely, as it could affect EVSE deployments needed in the marketplace, as well as inform and assist potential commercial customers as appropriate where opportunities emerge.

Light-duty EV Market and Consumer Preferences.

Key considerations for passenger vehicle buyers include the items listed below. Each of these considerations is probably a "gating" factor – if each item can't be met satisfactorily, car buyers in the mass-market segments are not likely to proceed with an EV purchase.

- No range anxiety. Over 300 miles of range on a full charge probably eliminates most concerns over range
- Charging locations — at home, at work, in the community near home, and in other destinations in the area as well as along longer trip routes
- Style of vehicle – sedan, crossover, SUV, truck, etc.
- First cost (purchase price) of an EV compared to an equivalently sized and featured ICE vehicle
- Fuel and maintenance costs for electricity compared to gasoline/diesel

There are currently over 40 passenger EV models available in US markets (including both PHEV and BEV). Another 20 models are expected in the next two years, including more light-duty passenger vehicles and pickup trucks.[25] More delivery vans, transit and school buses, and heavier duty (Class 6-8) vehicles are in the process of prototyping or commercial service deployment.

[23] https://shop.tesla.com/product/chademo-adapter

[24] https://cleantechnica.com/2020/02/17/largest-ev-fast-charging-station-in-the-us-opens-in-pasadena-california/

[25] https://www.latimes.com/business/story/2020-01-17/ev-sales-fizzle

In the passenger market, almost all traditional OEMs have limited EV production runs and have not made great strides in increasing EV sales. Tesla, coming from a technology background, is a noticeable exception. They successfully captured the “EV lifestyle” attractive to key early adopter customer segments with a product line that fundamentally started fresh, as opposed to electric versions of ICE models offered by legacy auto OEMs. About half of the 325,000 U.S. EV sales in 2019 occurred in California. Out of total U.S. sales, Tesla’s three models accounted for 192,500, dominated by Model 3 sales of 158,925.[26] While not a traditional OEM, Tesla is clearly the market leader with a 59% market share of all new EVs sold in 2019. Utilities cannot ignore the fact that among their customers choosing to buy an EV, a large majority are buying Tesla products. In the case of Spokane County, 70% of new EVs were Tesla models, with customers buying these vehicles online, accepting delivery outside the Spokane area, and driving them back home.

Announced investments by auto OEMs in electric vehicles. Many auto OEMs have announced a significant increase in the number of electrified models made available over the next 5 years, such as the Tesla Model Y compact SUV, Ford’s new Mustang Mach E, the Volvo XC40 compact SUV, a plug-in version of Toyota’s best-selling RAV-4 compact SUV, and an electric SUV from Rivian, a U.S. startup that is also working on custom-designed delivery vans for Amazon. Of particular interest to Avista’s customers more interested in pickup trucks are Ford’s plans for an electric version of its F-150 pickup truck on sale starting in 2021, GM’s plans to offer a Hummer electric pickup truck starting in 2022, and Tesla’s Cybertruck with orders being taken now for deliveries starting in late 2021.

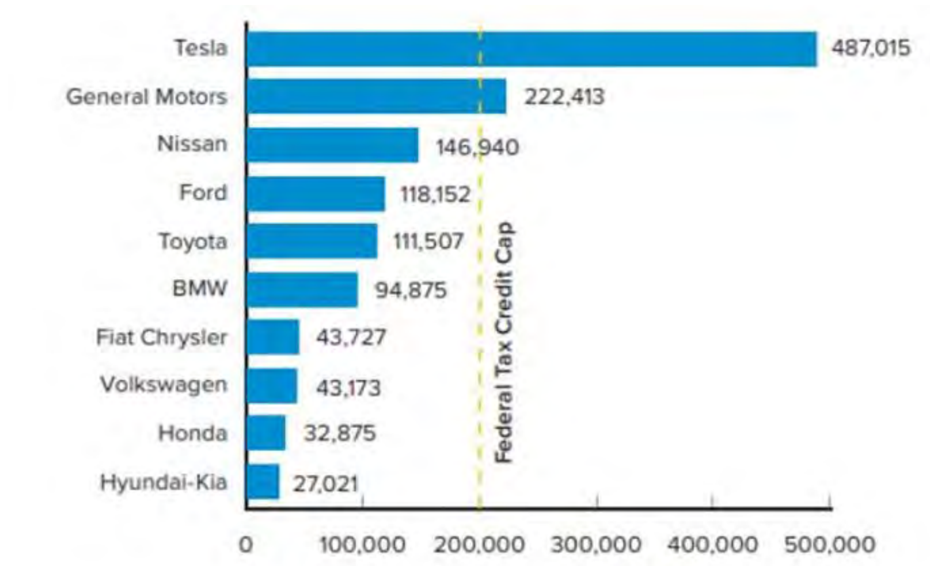

Figure 10: Cumulative EVs sold in the U.S. (EEI, 2019)

First cost. A variety of studies have been published over the years speculating on when EVs will be sold at the same initial cost as their ICE counterparts. In a March 2019 study, McKinsey estimated a $12,000 cost difference between an average EV and comparable vehicles powered by internal combustion engines in the small- to midsize-car segment.[27]

[26] https://insideevs.com/news/392372/us-tesla-sales-graphed-through-q4-2019/

[27] “Making electric vehicles profitable”, McKinsey & Company, March 2019.

McKinsey further identifies cost-reduction measures that could achieve purchase cost parity in 2025. ICCT, in a 2019 study, estimated electric vehicle initial cost parity coming within 5-10 years, in 2024-25 for shorter-range vehicles and 2026-28 for longer-range EVs in sedan, crossover and SUV models.

While most consumers consider initial cost as the key factor when acquiring a personal vehicle, the full economic comparison between an EV and its ICE counterpart is clearer when the total cost of ownership (TCO) is considered. There is close to total cost parity now for drivers covering over 30,000 miles annually, likely will be in the 2022-24 timeframe for drivers averaging 20,000 high-mileage miles per year, and almost certainly will be by 2025 for almost all other drivers. Avista customers who drive for transportation network companies (TNCs) such as Lyft and Uber typically travel more than the average customer, and may become a strong initial market segment for EVs if they see robust and reliable charging infrastructure in place.

New vehicles, particularly EVs, have significant **communications and computational technology** built-in, allowing for more connectivity with consumers' other electronic devices such as mobile phones, home energy management and security systems, electronic calendars, etc. In some ways EVs are like a powerful new mobile communications platform with a motor and wheels.

More vehicle OEMs are expected to offer information on their EVs and market **directly to consumers via web and social media**. Tesla only offers direct sales to consumers, and Ford recently took the same approach to accept online reservations for the upcoming Ford Mustang Mach-E. Consumers appear to be more willing to order or place a deposit for new EVs online. If this trend continues, the primary consumer engagement and education touchpoint will shift away from the dealership. Avista will be monitoring this trend along with EV inventory and sales at area dealerships to help identify the most cost-effective methods to share information on electric vehicles with its customers, including the traditional dealer channel and emerging web and social media conduits.

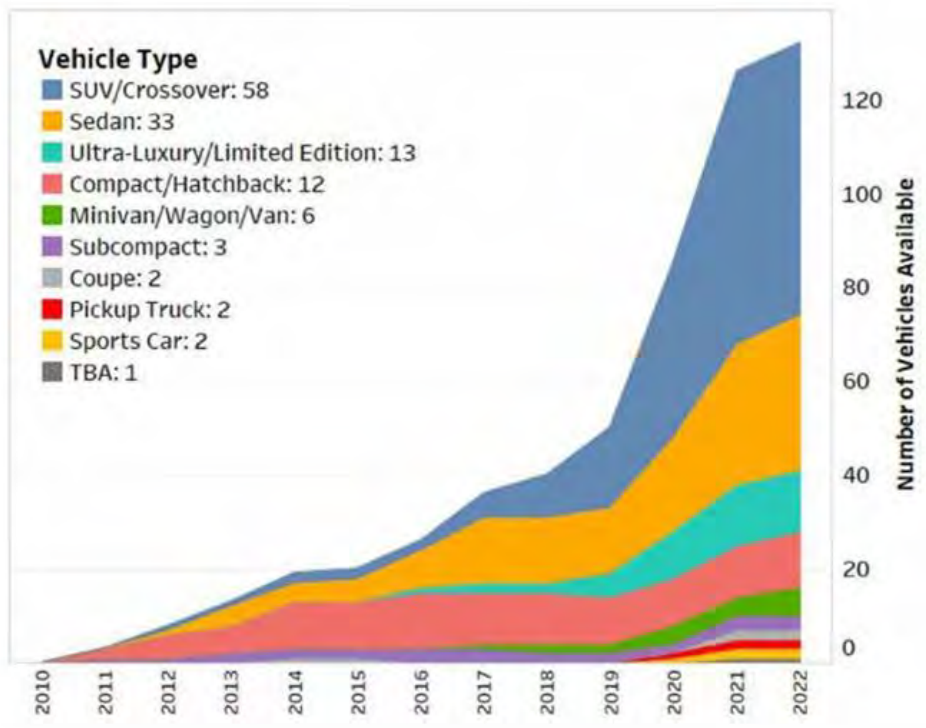

Figure 11: EV model availability (2019 EPRI consumer guide to EVs)

Other consumer and market trends of interest include the rate of driver licenses among younger generations (which has been declining in recent years), car-sharing services such as ReachNow and car2go, and TNC ride-sharing growth on software platforms such as Uber and Lyft.

[28] International Council on Clean Transportation. International Council on Clean Transportation.

[29] Recent Decreases in the Proportion of Persons with a Driver's License across All Age Groups, Michael Sivak and Brandon Schoettle. University of Michigan Transportation Research Institute, January 2016.

[30] Cracks in the ridesharing market—and how to fill them." McKinsey & Company, July 2017. Available at: https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/cracks-in-the-ridesharing-market-and-how- to-fill-them

Medium- and Heavy-duty Vehicle Electrification

Avista intends to monitor industry adoption of medium- and heavy-duty electric vehicles, learn from other utilities serving these applications, build on this information with pilots when appropriate, and adopt best practices as they become known and feasible. A good example of public corporate commitments to fleet electrification is Amazon, which recently pledged to purchase 100,000 electric delivery vans by 2030.[31] Amazon's initiative is part of a plan to convert its entire delivery fleet to using 100% renewable energy by 2030. Upfront costs associated with electric trucks and buses are expected to decline significantly through 2030 as battery prices fall, making them competitive on a TCO basis.[32] According to Atlas Public Policy, estimated TCO parity timelines are imminent for electric transit buses, in the 2025-30 timeframe for electric school buses, and after 2025 for electric medium-duty trucks. Key factors influencing these timelines include battery costs, availability of public incentives, and operational fuel and maintenance cost savings.

Mass-transit battery electric buses (BEBs). A number of transit agencies have adopted plans to switch to a zero -emission vehicle fleet by the 2030-40 timeframe. In addition to "brand-new" buses, several mass transit districts are converting used buses from diesel to electric, leveraging existing bus chassis, and reducing the cost of electric buses. In Avista's service territory, STA and Pullman Transit have initiated the deployment of BEBs. Avista will work closely with these and other transit agencies to understand the realities of technology and operational limitations, trends and market barriers that the Company can help address. This includes load-management technologies, optimal rate design, and charging technologies including overhead conductor and underground inductive power transfer.

Electric school buses. Dominion Energy is currently implementing a program to bring 50 electric school buses to 16 localities within Dominion's Virginia service area.[33] Locations were selected on the basis of benefits the batteries in the buses could bring to Dominion's distribution grid. Thomas Built Buses were chosen as the supplier in phase one of the project. These 50 buses will be configured with 220 kWh of battery energy capacity each with an operating range of up to 134 miles, charged overnight using a 60kW DC fast charging system.[34] The buses are expected to provide environmental and health benefits through reduced emissions and reduce operation and maintenance costs for schools by up to 60%. In subsequent phases, Dominion plans to expand the program to bring at least 1,000 additional electric school buses online by 2025. Once phase two is fully implemented, the buses' batteries could provide enough energy to power more than 10,000 homes. Phase three would set the goal to have 50% of all diesel bus replacements in Dominion Energy's footprint be electric by 2025 and 100% by 2030.

Electrification of **other medium- and heavy-duty vehicles** is increasing in the United States, particularly in California. High upfront costs and lower levels of commercialization for all vehicle categories other than transit buses have limited deployment to date. Increasing investment in the sector from public and private sources, however, is expected to generate growth and significantly increase the number of commercial electric vehicles of these higher classes in the near term. Initial deployments of heavy-duty electric trucks (Class 6-8) will have a 150 to 250 mile range, with use cases characterized by dedicated, known routes, consistent charger locations, and relatively predictable environments. It is unlikely the first round of heavy-duty electric trucks will be used in long-haul (cross-country) applications. Class 3-5 markets may be well suited for electrification, as these vehicles are used primarily for deliveries with a larger number of stop-and-go events.

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[31] https://sustainability.aboutamazon.com/sustainable-transportation

[32] Electric Trucks and Buses Overview - The State of Electrification in the Medium- and Heavy-Duty Vehicle Industry. Conner Smith. Atlas Public Policy. July 2019.

[33] https://news.dominionenergy.com/2020-01-16-Dominion-Energy-Moves-Forward-with-Electric-School-Bus-Program?printable

[34] https://thomasbuiltbuses.com/bus-news-and-events/news/thomasbuilt-buses-jouley-selected-for-2019-12-17/

Also, the elimination of idling (less exhaust and noise) may be desirable benefits for certain applications. For similar reasons, truck stop and refrigerated trailer electrification may grow substantially over the next decade, and may be appropriate areas for extending utility fleet support programs in the future.

Other Technologies and Market Opportunities

Vehicle-Grid integration. Eventually, OEMs may deliver viable electrified vehicles and systems that go beyond basic transport needs, such as providing grid benefits in the form of emergency back-up power to homes (V2H) or commercial buildlings (V2B), and possibly even bi-directional power transfer known as full vehicle-to-grid (V2G) capability, economically deployed at scale. Combined with advanced software platforms, hardware and standards enabling efficient transactions and holistic management of local distributed energy resources (DERs), energy storage, and other flexible power demands, a much more resilient and integrated grid of the future could be realized.

Micro-mobility or "last mile" innovations such as the Lime electric scooters and bicycles could continue to grow, providing a good opportunity to partner with local government in reducing traffic congestion and local air pollution.

R&D associated with aircraft, rail and marine electrification is also on the rise, with longer timeframes anticipated for commercial deployments. However, these areas may also present a good opportunity for a pilot test in the 2025–2030 timeframe. For example, smaller electrified passenger aircraft may help expand regional air transportation, relieve traffic congestion at larger hub airports, improve travel times and costs, and reduce pollution from air transportation before the end of the decade.[35] In this area, Avista has been involved with the Washington State Electric Aircraft Working Group and will continue to monitor developments and provide support as requested.

Although significant technical and economic hurdles remain, **hydrogen** could eventually be used as a viable fuel alternative for EVs such that overall emission reductions are feasible, particularly for fleets and medium - to heavy-duty applications such as long-haul freight transport, as advocated by the Renewable Hydrogen Alliance (see www.renewableh2.org/resources). Similar to other technical areas of interest, Avista will monitor developments in this area and develop pilot demonstrations when appropriate, primarily on the basis of technical and TCO feasibility.

[35] "Washington State Electric Aircraft Working Group Report." Washington State Department of Transportation (2019).

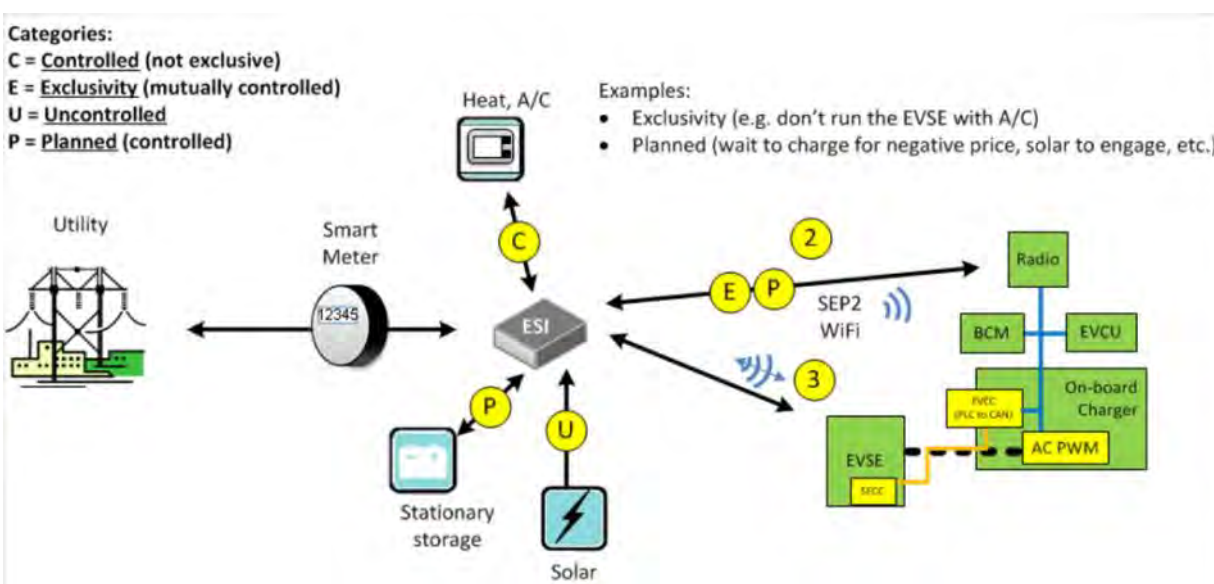

Figure 12: Home or building area network integrated with the grid (Society of Automotive Engineers, SAE J2836/1)

Finally, large global investments in **autonomous electric vehicles** (A-EVs) may eventually result in profound disruptions in the transportation sector. AVs are present today in limited applications. However, a number of major challenges remain to achieve fully autonomous (Level IV and V) vehicles, including advanced sensors, communications and artificial intelligence capabilities, which can reliably perform in the full spectrum of operational conditions. If successful, fully autonomous A-EVs could dramatically change the way we carry out our daily lives—reducing vehicle ownership, freeing up personal time, conserving energy, and avoiding major human injuries and fatalities, all while significantly reducing transportation costs.[36,37] In this area, Avista will continue to monitor developments, including participation in the Autonomous Vehicle Workgroup in Washington State, and providing support as requested.

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[36] Arbib, J. and Seba, T. "Rethinking Transportation 2020 – 2030: The Disruption of Transportation and the Collapse of the Internal-Combustion Vehicle and Oil Industries." Rethink X (2017).

[37] "Autonomous Vehicle Work Group 2019 Annual Report." Washington State Transportation Commission (2019).

Environmental, Economic and Grid Impacts

The transportation sector distinguishes itself in that it uses petroleum as a nearly exclusive source of energy, and has the highest rejected energy to useful energy ratio of all major sectors of the economy. As a result, a very high percentage of overall air pollution and greenhouse gas emissions (GGEs) originate from transportation. This is depicted in the following illustration, showing overall energy sources and consumption in the U.S. economy.

In the Pacific Northwest, hydropower is readily abundant and used to a large extent for electric generation. Avista's generation mix comes from a number of resources, mostly hydropower for base load and natural gas during times of peak demand. These relatively clean sources of energy result in 565 lbs CO_2 emissions per MWh and about an 80% reduction in air pollution and GGEs for electrically powered transportation in our area compared to petroleum-fueled transportation. As coal is phased out and more renewables are added to the generation mix, emissions from electricity generation may be reduced even further.

Overall, given that close to 50% of CO_2 emissions originate from the transportation sector in the Pacific Northwest, transportation electrification may be the most impactful of all efforts in reducing GGEs in the region.

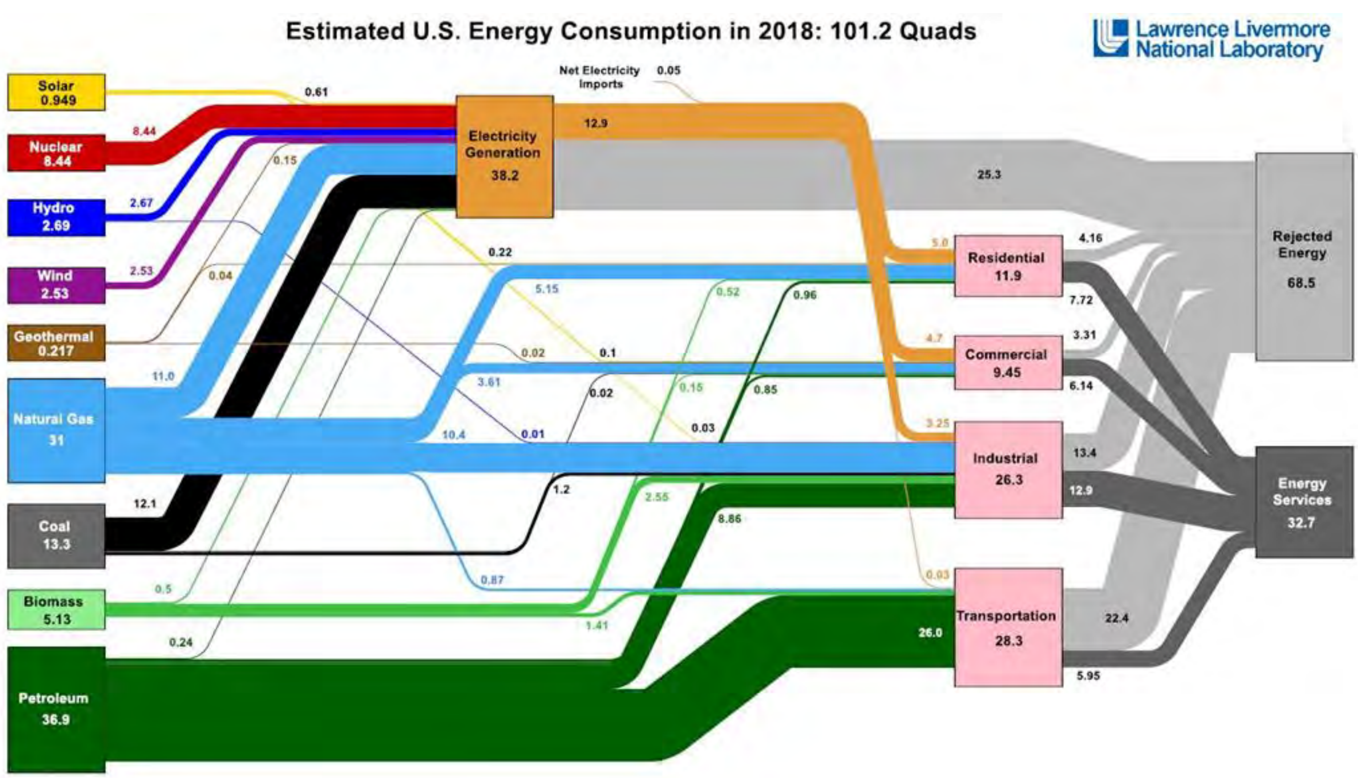


Figure 13: U.S. energy consumption - the transportation sector is powered almost exclusively by petroleum, with a high percentage of rejected energy (source: Lawrence Livermore National Laboratory)

But how might transportation electrification affect the utility grid? Can the utility keep pace with this new demand and extend benefits to all customers? These questions are explored below, starting with a basic introduction to the electric utility grid.

Figure 14: Utility grid generation, transmission, and distribution systems (source: USDOE)

The grid is delineated by three major systems – generation, transmission, and distribution. On Avista's grid, generation power is stepped up to high AC voltages of 115kV or more, traveling long distances on the transmission system before the voltage is stepped down in distribution substations, typically to 13.5kV using 30MVA transformers. Each substation commonly has one to three feeder distribution lines that each usually run 3 to 5 miles in urban areas and 15 to 20 miles in rural areas. Power is distributed on these feeders from the substation to service transformers that step down voltage again and supply one or more service points, which are defined as the connection point at the customer meter. Most service transformers on Avista's system serve one to ten service points in residential neighborhoods, with an average of four.

Peak Native Load	1,716 MW
Total Generation Capability	1,858 MW
Circuit miles of Transmission Lines	2,770
# of Distribution Substations	170
Circuit Miles of Distribution Feeders	5,429
# of Service Transformers	88,783
# of Retail Electric Meters	384,838
Annual kWh per Residential Customer	10,658

Table 3: Quick facts about Avista's electric grid

Modeling by E3 for the Pacific Northwest region and independently by Avista for its service territory indicates that light-duty EV adoption at baseline or higher levels over the next 20 years will provide net benefits over costs, in terms of both regional economic and utility customer perspectives. Regional economic benefits are mostly due to the major fuel savings of EVs. Both regional and utility customer costs are dominated by the additional generation capacity required to serve new EV loads, compared to very small distribution costs. No impact is expected on the transmission system due to EVs in the foreseeable future. The analysis that follows includes details of distribution grid impacts, the results of E3's Pacific Northwest economic modeling, and Avista's economic modeling.

Distribution Grid Impacts

A first-order analysis of light-duty EV loads on distribution transformers was conducted for three different scenarios. The first scenario assumed a single EV load of 6.6kW serviced by each transformer in addition to existing loads, which equates to a roughly 25% EV adoption rate. The second scenario assumed 50% of service points with an added EV load of 6.6kW, and the third with 100%.

The electrical power demand on a service transformer from EVs is modeled as:

$$P_{EV\_aggregate} = n_{EV} * EV_{SE} * CF$$

Where:

$P_{EV\_aggregate}$ = Additional power demand created by simultaneous EV charging

n_{EV} = Number of EVs downstream of a given service transformer

EV_{SE} = Power required to charge a single EV = 6.6 kW

CF = Coincidence factor = 0 to 1

The CF is the percentage of simultaneous EV loads on a given transformer compared to the sum of all potential loads. As more EVs are served by a single transformer, the maximum load on the transformer increases up to a limit governed by the CF. The CF curves used for transformer loading are based on industry and utility standards, and are directly related to the number of service points with EVs served by the transformer.

Estimated transformer replacement costs of $3,516 for underground transformers and $2,318 for overhead transformers include material and labor costs but do not include additional costs such as replacing or installing new pole arms, cutouts, arrestors, brackets or upsized distribution poles which may occur depending on the situation.

In the first scenario, a single EV load of 6.6 kW during peak hours was appended to each transformer's existing peak load, for 88,783 transformers sized between 15 to 100 kVA, each with 10 or fewer service points. A single EV served by each transformer is equivalent to an overall EV adoption rate of 23% of vehicles in service (as distinguished from the percentage of sales). As a result of this load, which represents a high adoption level forecasted to occur many years after 2030 even in a high-adoption scenario, only 5.9% (5,280 of 88,783) of residential transformers exceeded their overloading limits as determined by IEEE Std C57.91.[38]

In the second and third scenarios, applying EV loads to 50% of service points on all transformers caused the peak load to exceed the failure threshold on 19.7% of transformers, compared to a 30% failure rate for the scenario with 100% EV service points. Upgrade costs for the 50% and 100% adoption scenarios were $46.9 million and $72.6 million, respectively.

Note that unusual situations that could alter charging behavior were not modeled. For example, a higher level

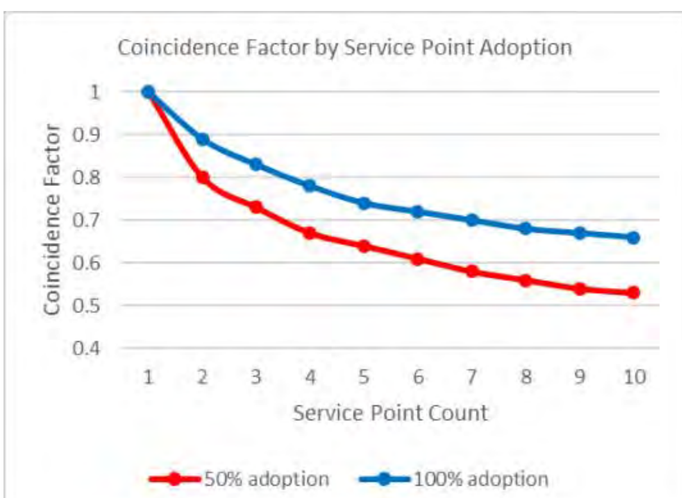


Figure 15: EV charging coincidence factor used in economic modeling

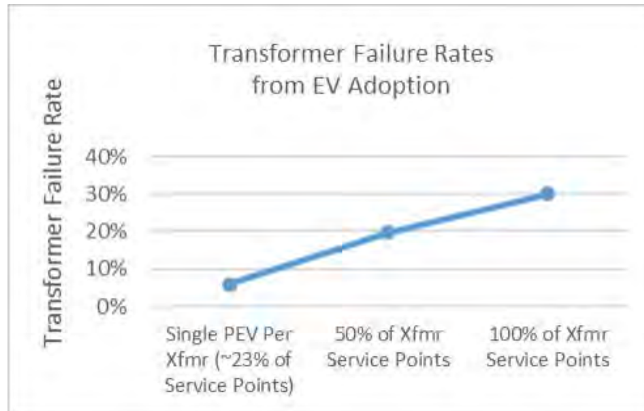


Figure 16: Failure rate *of residential transformers from EV loads*

of EV charging might occur before a major storm if customers felt there was a risk of pending power outages, which could cause additional transformer overloads and failures. Also, it was assumed that only one EV will charge at a time at a given residence, even though at high EV adoption rates many households would have more than one EV, and some of them may choose to install multiple EVSE so that both EVs could charge simultaneously.

Feeders are typically designed and built with 10 MVA capacity, ideally operating at 6 MVA with overload concerns at 8 MVA. Assuming uninfluenced EV load profiles, first-order analysis of a sample of Avista's

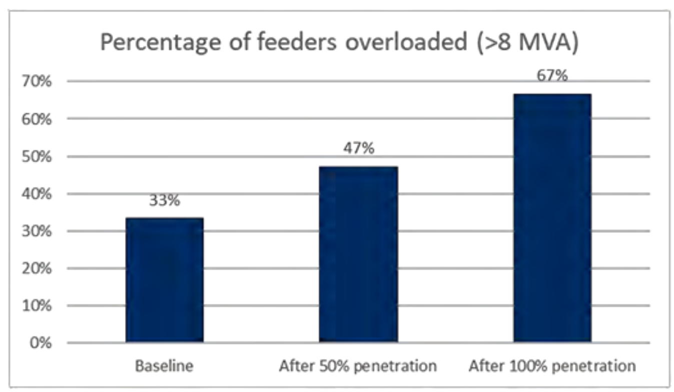


Figure 17: Distribution feeder overloads from EV loads, assuming all other loads held constant

[38] IEEE C57.91-2011 – Guide for Loading Transformers and Step-Voltage Regulators. https://standards.ieee.org/standard/C57_91-2011.html

feeders showed 33% were overloaded, assuming baseline EV adoption and all other existing loads held constant, rising to 47% overloaded with 50% EV adoption, and 67% with 100% adoption. Reconductor costs for urban feeders average $400k per mile, compared to $300k per mile for rural feeders. In turn, impacts to feeders can result in impacts to substations, with the need to increase the number of feeders, or in some cases, build a new substation at an average cost of $2.5 million per substation.

Note that second-order effects arising from the system's ability to "backfeed" distribution feeders in the event of issues and repairs is very important in determining actual overloads and projected costs, which requires a more sophisticated level of modeling. In addition, detailed information at many points in the distribution system for existing loads and forecasts are needed to project feeder and substation impacts from EVs with more certainty.

Based on analysis of detailed feeder -level data for four utilities in the Pacific Northwest, E3's study showed an average distribution cost of $27 net present value (NPV) per EV over the 20-year timeframe from 2017 to 2036. In other words, an NPV of $27 represents the total additional costs to the distribution system over the 20-year time-frame of the study for each EV during that time. Avista's independent analysis indicates an average distribution cost of $38 NPV per EV over a similar 2019-2038 time period. In both studies, similar assumptions were used for baseline EV adoption, EV purchase costs, fuel costs, etc. However, the model's calculation methods and algorithms were developed independently. Please see the EVSE pilot final report for more details on modeling assumptions.

The relatively low EV impacts on the distribution grid as predicted by both models reflect the assumptions of modest baseline EV adoption and reduced distribution peak loads as a result of ongoing energy efficiency and conservation of other loads on the system.[39,40] Higher levels of EV adoption and the sensitivity to energy conservation assumptions could be further explored, as well as important second-order effects on the distribution system beyond a first -order analysis.

E3's Pacific Northwest EV Study (2017 – 2036)

In 2017, E3 completed a detailed study of EV grid and economic impacts in the Pacific Northwest, sponsored by six regional utilities. The study's objectives were to support an understanding of how EV adoption could result in costs and benefits from both a "regional" and a "utility customer" perspective, sensitivity to assumptions, the value of managed charging, CO_2 reductions, and implications for utility planning. In the "regional" perspective, monetized EV costs and benefits that flow in and out of the region are considered, while in the "utility customer" perspective the marginal EV costs and benefits are isolated to the effects on customer utility rates. Over the study's 20-year time horizon, calculated cash flows for each year are translated to an equivalent net present value (NPV) in 2017, using a discount rate of 4.9%. When the NPV of total costs is less than the NPV of total benefits for a given scenario, a net benefit results, and vice versa.

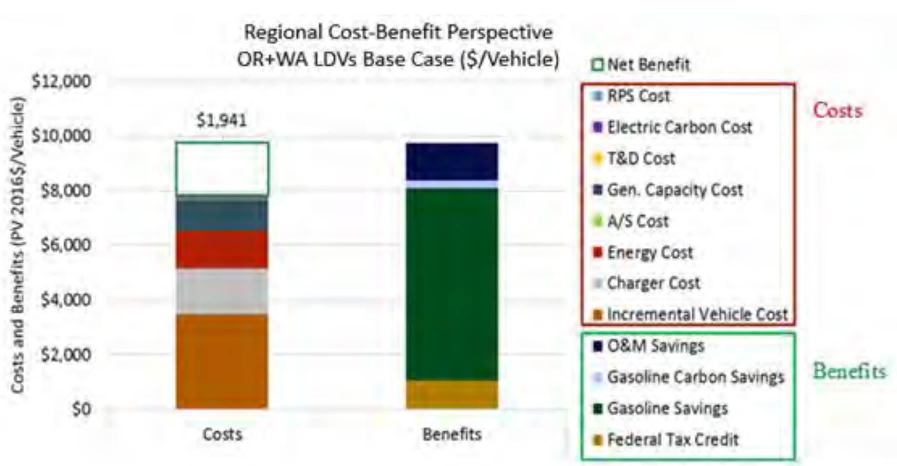


Figure 18: E3 Regional Cost-Benefit

[39] E3 (p.54).

[40] Avista Electric Integrated Resource Plan (2017).

Utility costs associated with investments in transportation electrification and load management are not included in these analyses. For more detail including the analytical approach, input variables, and how they are applied in the regional and ratepayer perspectives, please see the E3 report and the EVSE pilot final report.

From a regional perspective, E3 concluded that all regions in the Pacific Northwest showed a net benefit from EV adoption, calculated at $1,941 NPV per EV for the regional base case scenario. These net benefits were also shown to be most strongly influenced by assumptions of EV adoption, EV purchase costs relative to gasoline vehicles, and gasoline prices. These assumptions result in the largest cost component of incremental vehicle cost, and the largest benefit component of gasoline fuel savings. The analysis further showed that generation capacity cost was nearly equal to energy cost, and distribution costs were insignificant. When examining the benefits of managed charging, E3 estimated an additional $500 to $1,700 regional net benefit per EV, with 70% to 90% of the added value from reduced generation capacity costs and the smaller remainder from energy cost savings. Note that the E3 model is linear and therefore does not include important "interactive" or dynamic second-order effects between input variables (i.e. feedback loops). For example, lower EV purchase costs and higher gas prices would result in higher EV adoption, and vice versa, which greatly affects the cost-benefit result. In reality, these feedback loops are asymmetric in that negative effects such as utility energy and generation capacity costs are mitigated by lower EV adoption, while positive effects such as the benefits of gasoline fuel savings are amplified by higher adoption.

In the "utility customer" perspective, E3 showed that EV adoption would create net benefits for the Pacific Northwest overall, but that results could vary in sub-regions depending mostly on the particular utility's reserve generation capacity. Wholesale electricity prices were also found to have a significant influence on net results, as they impact generation capacity cost. Utility revenue from the additional metered billing of EVs results in a net benefit over total costs of $387 NPV per EV. When considering the potential value of managed charging, E3 calculated an additional NPV of $400 to $1,600 per EV as a result of reducing EV loads that occur during "peak" hours, causing increased generation capacity costs. Distribution costs were insignificant in both cases, as modeled in the base case adoption scenario from 2017 through 2036.

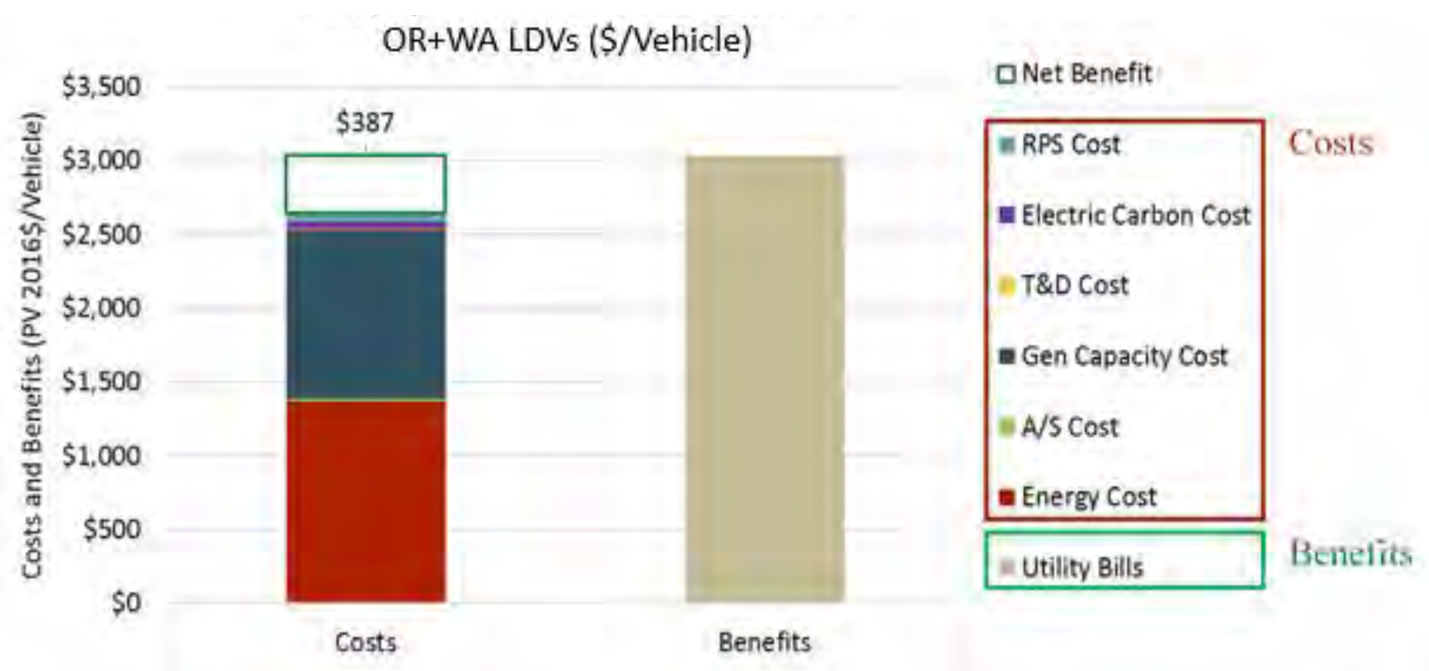


Figure 19: E3 Utility Customer Cost-Benefit

Avista's Study (2019 – 2038)

Following E3's study for the Pacific Northwest, Avista independently developed an economic model that would also calculate EV costs and benefits for the regional and utility customer perspectives, but specific to Avista's grid and service territories, and with the flexibility to alter inputs such as the EV load profiles gathered from the EVSE pilot.

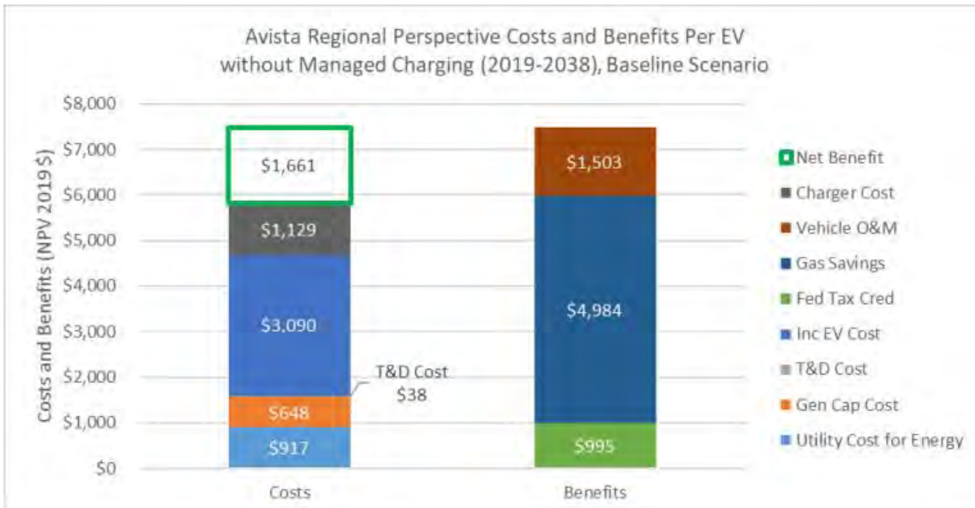


Figure 20: Regional perspective costs and benefits per EV without managed charging 2019-2038

E3 was consulted to confirm input variables over a 20-year time horizon for the Avista model, analogous with the baseline input variables used in E3's Pacific Northwest EV study where EVs reach 15% of light-duty vehicle sales in 2030. A financial discount rate of 6.58% was used to model Avista's weighted cost of capital.

In this way, Avista's results may be compared to E3's using similar inputs and independent modeling methods. If the model outputs are reasonably matched, then a form of independent replication is achieved, establishing additional confidence in both E3's and Avista's modeling and results.

In the regional perspective, Avista's model results in a net benefit of $1,661 per EV without managed charging, comparable to the E3 result of $1,941 per EV for the Pacific Northwest region. Note that in Avista's model, costs for renewable portfolio standards (RPS) and electric carbon cost and ancillary services (A/S) are not considered, as they were shown to be negligible in E3s results. Similar to the E3 study, Avista's regional results are dominated by incremental EV costs and fuel savings benefits. In addition to the embedded utility energy costs consistent with Avista's IRP assumptions, additional utility costs to serve the new EV loads come primarily from generation capacity costs at $648 per EV, with only $38 per EV from distribution costs. Note that while they are tangible and important benefits to the region, this study does not include a monetized value for societal and health benefits resulting from reduced GGE emissions and local air pollutants.

When managed charging is included, regional net benefits increase $464 per EV to a total benefit of $2,125 per EV. This assumed 75% of the residential peak load was shifted to off-peak from the hours of 4pm to 8pm year round, as was demonstrated in the EVSE pilot. Most of the additional benefit comes from reduced generation capacity costs. This is comparable but slightly below the range of E3's regional net benefit from managed charging at $500 to $1,700 additional benefit per EV. Additional benefits in the Avista model could be realized with more peak load shifting, as may be possible. Nominally divided by an assumed 10-year life of an EV, these results mean that the cost to implement load management per EV over the model's 20-year timeframe must be less than $46 per year using Avista's result, or between $50 and $170 per year using E3's results, in order to achieve additional regional net benefits from managed charging.

Using Avista's model for the utility customer perspective baseline scenario without managed charging, a net benefit of $1,206 per vehicle is realized, significantly higher than E3's result of $387 per vehicle. This is due mostly to the lower generation capacity costs in Avista's model, where Avista is long on generation capacity until 2027.

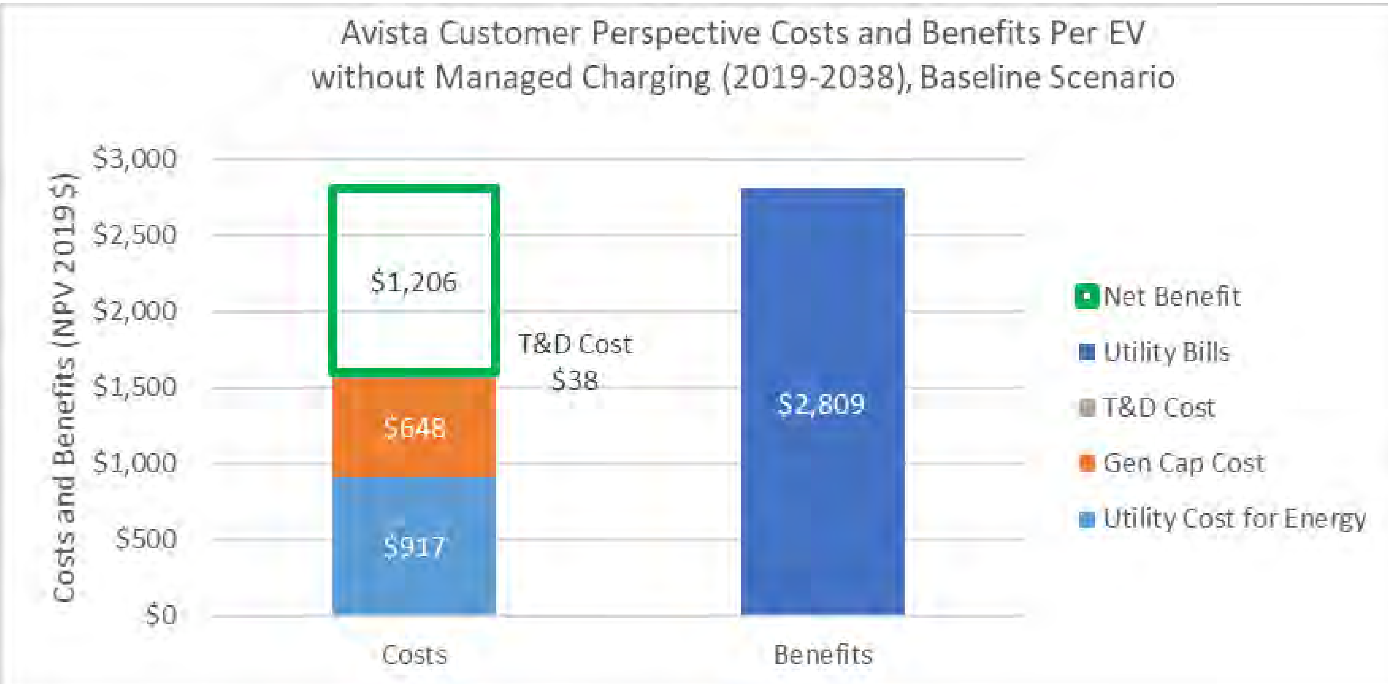


Figure 21: Utility customer perspective costs and benefits per EV without managed charging 2019-2038

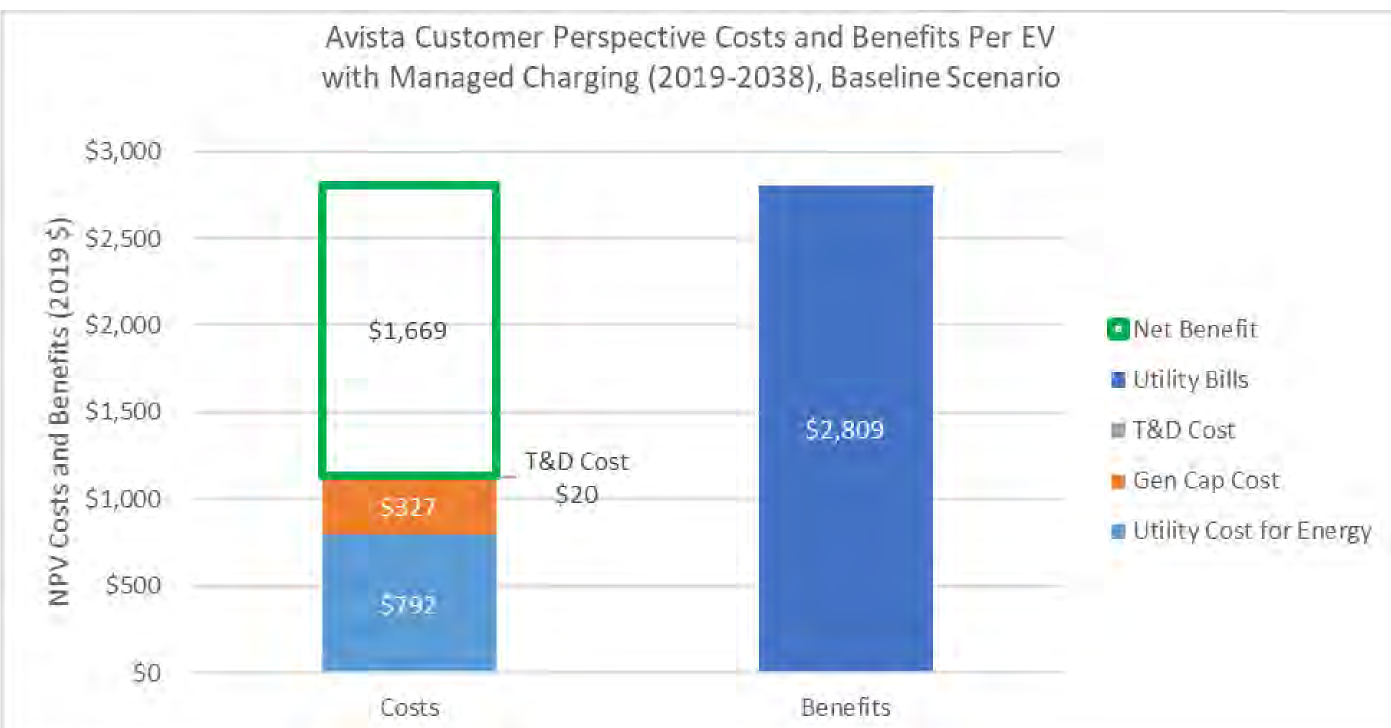


Figure 22: Utility customer pers[ective costs and benefits per EV with managed charging 2019-2038

Considering the utility customer perspective with managed charging, Avista's model results in additional net benefits of $463 per EV. Again, this is mostly due to reduced costs of generation capacity, assuming 75% reduction of residential peak loads from 4pm to 8pm. Given the assumed 10-year service life of EVs, actual costs to implement load management would reduce the net benefit, and would need to be less than $46 per EV per year to result in a net benefit increase. Note that similar cost reductions from shifting on– to off-peak loads by using a TOU rate, must also incorporate reductions in beneficial utility revenue to arrive at net cost-benefits.

In summary, this analysis indicates that grid impacts from light-duty EVs are very manageable over at least the next decade, net economic benefits can extend to all customers (not just to those driving EVs), and significant reductions of greenhouse gas emissions (GGE) and other harmful air pollutants may be achieved with electric transportation. Significant additional benefits may be realized by shifting peak loads in the longer term with higher EV adoption, probably through a combination of TOU rate design and effective load-management programs. However, results also show that the costs to implement load management must be on the order of $50 to $150 per EV, per year, in order to result in additional net benefits over at least the next decade. Beyond this timeframe as EVs represent 30% or more of vehicles on the road, the impacts of peak load could become more significant, making effective load management more important. Therefore, it is prudent for the utility to continue developing load-management capabilities in order to cost-effectively mitigate EV peak loads and resultant costs in the future.

This analysis represents a good start in the evaluation of long-term environmental, economic and grid impacts. Further monitoring, data collection and analysis will refine and adjust estimates as the market, technologies and the grid evolve, including utility costs to utilize more renewables and more detailed modeling of distribution impacts resulting from localized clustering effects.

Please note that the economic models presented in this section of the TEP are intended for informational purposes only (not as a litmus test for utility programs), and do not include environmental benefits or utility expenses supporting transportation electrification. The next section on Costs and Benefits more closely evaluates utility expenses and revenues over the 2020–2030 timeframe including utility investments according to the TEP, and the estimated impacts on annual revenue requirements.

Costs and Benefits

This section provides estimates of Avista's costs to implement the TEP, and benefits in the form of utility revenues from EV charging, net of expenses to generate and deliver electricity. Benefits are also summarized for customer transportation cost savings and avoided CO_2 emissions.

Table 4 below lists the estimated cost of capital investments, allowed capital return, and O&M expenses to implement the TEP over the next ten years. This follows from the strategy and approach explained in previous sections, where a baseline level of supporting programs ramp up initially to match an expected market transition in the 2023-2024 timeframe, leading to stronger EV adoption thereafter and supporting program growth of approximately 15% per year from 2023 through 2030.

Please note that these figures are estimates and will vary from actuals depending on a number of factors including regular program adjustments to market conditions such as EV adoption, customer participation rates and 3rd party private investments; with higher uncertainty as estimates are projected further in the future.

Calculations assume an 8.18% rate of return on capital investments based on a weighted cost of capital that includes the allowed 2% incentive rate of return on equity, and cost recovery of capital investments amortized over the 10-year depreciable life of EVSE.

This is further detailed in the analysis that follows, along with costs to generate and deliver energy, revenues from EV charging, and the resulting net revenue requirement which may not exceed 0.25% of annual revenue requirement for electric customers in Washington State.

Table 4: Estimated TEP costs from Avista capital investments and O&M expenses in Washington State (2021-2030)

Year	Capital Investments	Allowed Capital Investment Return	O&M Expenses
2021	$2,250,000	$245,400	$650,000
2022	$2,887,500	$535,790	$747,500
2023	$3,620,625	$874,647	$859,625
2024	$4,163,719	$1,233,247	$988,569
2025	$4,788,277	$1,614,555	$1,136,854
2026	$5,506,518	$2,126,422	$1,307,382
2027	$6,332,496	$2,788,434	$1,503,489
2028	$6,332,496	$3,519,512	$1,653,838
2029	$7,282,370	$4,423,257	$1,819,222
2030	$8,374,726	$5,525,567	$2,001,145
Totals	**$51,538,726**	**$22,886,830**	**$12,667,625**

Table 5 shows the avoided cost of new resources according to the 2020 Integrated Resource Plan (IRP). These costs represent the average incremental energy and capacity cost to serve Avista customers. The costs include energy and capacity for serving load at time of peak. This shows that starting in 2026, projected capacity will be short of demand and will at that point incur additional costs starting at $108/kW-year. In addition, the "clean premium" is the estimated incremental cost to comply with the Clean Energy Transformation Act (CETA) in Washington, starting in 2022. A full description of these costs is found in the 2020 IRP, pages 11-20 to 11-24.[41] This table is included in the IRP to estimate avoided cost for analysis of resources between IRPs and provide guidance for pricing power contracts under the Public Utility Regulatory Policy Act (PURPA). The assumptions used to estimate these costs are described in the IRP document, and are largely driven by the wholesale electric market forecast, the cost of new generation, and the timing of Avista resource needs.

Table 5: 2020 IRP energy costs

Year	Energy Flat (MWh)	Energy On-Peak (MWh)	Energy Off-Peak (MWh)	Clean Premium (MWh)	Capacity ($/kW-Yr)
2021	19.67	22.64	15.71	0.00	0.0
2022	19.98	22.75	16.28	11.75	0.0
2023	20.44	23.05	16.98	11.99	0.0
2024	21.61	24.09	18.28	12.23	0.0
2025	22.76	25.19	19.50	12.47	0.0
2026	24.27	26.40	21.43	12.72	107.7
2027	23.57	25.27	21.30	12.97	109.9
2028	25.02	26.26	23.35	13.23	112.1
2029	25.92	26.80	24.73	13.50	114.3
2030	26.72	27.08	26.25	13.77	116.6

From these values, utility costs to generate and deliver electricity used for EV charging may be derived, given EV load profile data obtained from the EVSE pilot. In addition, benefits in the form of net utility revenues may be calculated based on the estimated number of EV customers each year, as well as customer fuel and maintenance savings and avoided CO_2 emissions.

These calculations are shown in the tables that follow, assuming separate baseline and high adoption scenarios in Washington for light-duty passenger EVs only. Values are shown for the estimated number of registered EVs owned and operated by Avista's electric customers in Washington. In the future, additional benefits from load management, any monetized environmental benefits that may become available, and separate treatment for EV customers in Idaho will also be included.

Over time as more information is gathered, this analysis may be supplemented by additional cost and benefit estimates from other transportation electrification loads such as transit buses, lift trucks and other market segments.

[41] see www.myavista.com/IRP

Note that coincident peak demand at 6pm in January is the governing peak for the year, which drives system generation capacity and delivery costs to meet maximum peak demand. Please also note that these calculations are derived from the uninfluenced average load profile obtained from EVSE pilot data from 2017–2019. In the future, EV load profiles may increase both in total energy consumed and in peak demand per EV as the market trends toward a larger proportion of EVs with larger battery packs. On the other hand, peak loads may be mitigated by a combination of residential TOU rates, as well as effective load management programs. Avoided emissions per EV currently stands at 4 tons CO_2 per year, given an electricity generation mix producing 565 lbs of CO_2 per MWh. This should improve over time beyond what is stated below as coal generation is eliminated and more renewables are used to generate electricity.

Table 6: Key characteristics per light-duty EV (average annual figures)

3,153 kWh	electric energy consumption
0.78 kW	coincident peak demand at 6 pm in January
$304	utility billing revenue
$1,183	customer fuel cost savings
$300	customer maintenance cost savings
4 tons	avoided CO_2 emissions

Table 7: Baseline EV adoption— annual costs and benefits for Avista Washington customers

Year	# EVs (WA)	Utility Billing Revenue	kWh	coincident kW (January 6pm)	Utility Generation and Delivery Cost	Net Revenue (Offsetting Benefit)	Avoided CO_2 Emis-sions (Tons)	Customer Transportation Fuel and Maintenance Savings
2021	1,605	$487,814	5,059,470	1,252	$99,534	$388,281	6,419	$2,379,700
2022	2,104	$639,530	6,633,019	1,641	$132,530	$507,000	8,415	$3,119,812
2023	2,737	$831,997	8,629,227	2,135	$176,384	$655,613	10,947	$4,058,720
2024	3,604	$1,095,637	11,363,632	2,811	$245,540	$850,097	14,416	$5,344,835
2025	4,811	$1,462,652	15,170,208	3,753	$345,272	$1,117,380	19,245	$7,135,242
2026	6,504	$1,977,097	20,505,880	5,073	$1,044,235	$932,862	26,014	$9,644,853
2027	8,868	$2,695,754	27,959,585	6,917	$1,418,903	$1,276,851	35,470	$13,150,670
2028	12,135	$3,689,051	38,261,765	9,465	$2,017,956	$1,671,094	48,540	$17,996,257
2029	16,411	$4,988,922	51,743,650	12,801	$2,804,287	$2,184,634	65,644	$24,337,404
2030	21,760	$6,615,031	68,609,191	16,973	$3,812,173	$2,802,859	87,040	$32,270,038

Table 8: High EV adoption— annual costs and benefits for Avista Washington customers

Year	# EVs (WA)	Utility Billing Revenue	kWh	Coincident kW (January 6pm)	Utility Generation and Delivery Cost	Net Revenue Offsetting Benefit	Avoided CO_2 Emissions (Tons)	Customer Transportation Fuel and Maintenance Savings
2021	1,678	$510,178	5,291,422	1,309	$104,097	$406,081	6,713	$2,488,798
2022	2,311	$702,678	7,287,975	1,803	$145,615	$557,063	9,246	$3,427,868
2023	3,115	$946,884	9,820,809	2,430	$200,738	$746,146	12,459	$4,619,175
2024	4,262	$1,295,610	13,437,696	3,324	$290,353	$1,005,257	17,048	$6,320,363
2025	5,958	$1,811,376	18,787,072	4,648	$427,589	$1,383,788	23,834	$8,836,419
2026	8,468	$2,574,194	26,698,798	6,605	$1,359,597	$1,214,597	33,871	$12,557,665
2027	12,179	$3,702,402	38,400,242	9,500	$1,948,744	$1,753,658	48,716	$18,061,389
2028	17,857	$5,428,560	56,303,451	13,929	$2,969,483	$2,459,077	71,428	$26,482,086
2029	26,545	$8,069,581	83,695,360	20,705	$4,535,926	$3,533,655	106,179	$39,365,753
2030	40,454	$12,298,165	127,553,008	31,555	$7,087,290	$5,210,875	161,818	$59,994,009

From these values and estimates for utility capital investments in transportation electrification (TE), revenue requirements may be calculated and compared against the 0.25% annual revenue requirement limit. These calculations assume an 8.18% rate of return based on a weighted cost of capital including the 2% incentive rate of return on equity authorized in Washington for capital investments in Transportation Electrification. For purposes of meeting the 0.25% limit as defined by law, capital investment depreciation and allowed return on capital investment, including the incentive rate of return on equity, are included in the revenue requirement calculation for each year, but O&M expenses are not.[42] The Company recognizes that additional TE capital investments that do not receive the incentive rate of return could be pursued; however, such additional investments are not proposed at this time.

Assuming that strong utility support and OEM product results in a transition from baseline to high adoption starting in 2023, corresponding net revenue requirements (RevReq) from TE investments remain under the 0.25% limit for all years in the 10-year timeframe, as shown in the Table 9 below. Actual adoption levels will be regularly monitored with spending adjustments as required to remain under the 0.25% limit.

[42] Revised Code of Washington (RCW) 80.28.360 (1)

Table 9: Net revenue requirement from capital investments in transportation electrification compared to the 0.25% annual limit

Year	Capital Investments	TE RevReq without Offsetting Benefits	Offsetting Utility Customer Benefits	TE RevReq after Offsetting Benefits	TE Incremental % RevReq with Offsetting Benefits	0.25% WA Electric Revenue Requirement Limit
2021	$2,250,000	$482,400	$388,281	$94,119	0.02%	$1,373,963
2022	$2,887,500	$839,940	$507,000	$332,940	0.06%	$1,422,051
2023	$3,620,625	$1,256,019	$655,613	$600,406	0.10%	$1,471,823
2024	$4,163,719	$1,671,826	$927,677	$744,149	0.12%	$1,523,337
2025	$4,788,277	$2,118,920	$1,250,584	$868,336	0.14%	$1,576,654
2026	$5,506,518	$2,706,442	$1,214,597	$1,491,845	0.23%	$1,631,836
2027	$6,332,496	$3,455,457	$1,753,658	$1,701,799	0.25%	$1,688,951
2028	$6,332,496	$4,186,535	$2,459,077	$1,727,458	0.25%	$1,748,064
2029	$7,282,370	$5,190,333	$3,533,655	$1,656,678	0.23%	$1,809,246
2030	$8,374,726	$6,407,705	$5,210,875	$1,196,830	0.16%	$1,872,570

At higher adoption levels beyond 2030, additional distribution costs in the form of service transformer and feeder upgrades may also become more apparent, at a level of significance to include with the figures indicated above. If updated modeling in future TEP revisions indicates material distribution costs prior to 2013, these will be included in updated cost projections.

Again, these estimates represent only light-duty EVs, with cost estimates and assumptions that are subject to uncertainty. Actual costs and benefits will vary depending on market conditions and commensurate adjustments to program spending. Costs and benefits from other market segments beyond light-duty EVs (e.g. commercial delivery vehicles and transit buses) are also expected and will be included in future updates to the TEP as more information and experience is gained in these areas.

Analysis and Reporting

This Plan will be updated and reissued in five-year increments, starting in 2025. New program filings may be submitted for regulatory review on an on-going basis and later incorporated in regular revisions of the TEP.

Summary year-end updates will be provided for 2021 and 2023 focusing on expenses, revenues and high-level program results. A more comprehensive mid-period report will be provided in early 2023 including updates on EV adoption and forecasts; program activities; lessons learned; and adjustments. Detailed reporting will also be included with the updated TEP submitted by year-end 2025, along with modeled impacts on the environment, the economy and the grid, incorporating detailed assessment of energy, capacity, and distribution system impacts.

Key metrics and other information will be monitored and reported, including:

1. Customer satisfaction
2. Number of EVs by type (light passenger, forklifts, buses, etc.) in Washington and Idaho service territories
3. Adoption projections
4. Customer operating cost savings and avoided CO_2 emissions
5. EV load profiles for cases of uninfluenced, load management and TOU rates
6. Electric consumption (kWh) and peak load (kW)
7. Grid impacts integrated with System Planning including Distribution systems and the Integrated Resource Plan
8. EVSE installations, costs and % uptime
9. EV TOU rate participation and results
10. Utility spending, revenue and net benefits, including any monetized environmental benefits and grid benefits from load management

Programs and Activities

EVSE Installations and Maintenance

In support of light-duty EV adoption, the measured buildout of EVSE infrastructure is a top priority, especially in workplace, fleet and public DC fast charging (DCFC) sites. This is because of the powerful support for adoption and inherent grid benefits that workplace and fleet charging provide, and the increasing need for public DCFC as the light-duty market develops.

In addition to public DCFC and AC Level 2, workplace and fleet, Avista's EVSE portfolio is rounded out by residential and MUD programs that support adoption, dealer engagement and equitable access to EVSE. Residential programs lay a critical foundation for effective load management and grid benefits in locations where the large majority of EV charging is expected to occur in the future.

Avista can play an essential role to ensure that the right type and amount of charging infrastructure is in good working order, in the right place and at the right time, relative to market needs. This is absolutely critical to enable unimpeded, beneficial market growth. EVSE buildout must be accomplished with a cost-effective portfolio approach, utilizing low-cost and reliable non-networked EVSE where possible, and scaling with market conditions over time so that adequate supporting infrastructure is in place as the market grows, while avoiding over-investment.

In addition to Avista ownership of EVSE, third-party ownership is encouraged with supportive utility policies, including "make-ready" options and a pilot commercial EV rate applying time-of-use (TOU) energy charges. Ideally, third-party ownership will make up 50% or more of all EVSE installations. "Make-ready" options are available to commercial customers that wish to own and operate EVSE themselves, or act as a site host for other third-party ownership. Avista will install required infrastructure to an agreed location for the meter connection, with the utility investment limited to $20,000 per public DCFC site, and $2,500 per commercial AC Level 2 port connection intended for fleet, workplace, public or MUD primary utilization, in addition to the servicing transformer. This should cover the utility costs for most installations sited reasonably close to required utility power, thereby encouraging cost-effective installs. In these cases, the customer agrees to maintain access and operability of the EVSE for at least 10 years, and may charge a user fee at their discretion. Avista will offer consultation on the user fee to balance owner cost recovery and user acceptance. Until conditions change to warrant reconsideration, Avista will recommend applying the rate of $0.35/kWh as set by the Washington UTC for DCFC owned by Avista.

For details on the commercial EV TOU rate that also supports third-party ownership of EVSE, please see the Rate Design section.

EVSE uptime is of major importance to customer satisfaction and mass adoption at > 99% per charging site. Avista will work with industry partners and contractors to achieve and maintain this performance benchmark.

Public DCFC

Public DCFC will play an increasingly important role for reliable and fast public charging of light duty vehicles, for both longer distance and intra-city travel. Building upon the success of the EVSE pilot, Avista will continue to build out DCFC sites along major travel corridors and in urban areas for public charging. This will be accomplished in partnership with local stakeholders and in alignment with state agency guidance and the degree to which EV adoption requires support, reviewed on an annual basis. DCFC owned and maintained by Avista will complement DCFC installed outside of Avista's network, in a coordinated way that avoids overlapping coverage and appropriately supports EV adoption, while mitigating the costs and risks of overbuilding too far ahead of market needs and/or technology obsolescence and stranded assets.

Prioritized locations for public DCFC sites will be made through a deliberate process involving the WSDOT, regional transportation planners, community leaders, customer feedback, and other key stakeholder collaboration. Siting identification and selections for public EVSE will be prioritized according to assessed criteria including cost, accessibility, low-income support, nearby amenities, site host commitment, and utilization. Reputable evaluation methods and tools for DCFC siting prioritization will be considered and tailored for use as appropriate, with stakeholder engagement.[43]

Benchmarks for adequate EVSE infrastructure by 2025 include DCFC sites along travel corridors every 40 miles, and in prioritized urban locations for intra-city use at 1 DCFC port per 150 BEVs.[44] Longer term, as markets mature, this ratio may be increased to 1 DCFC port per 200 BEVs or more. Based on these benchmarks and baseline EV adoption forecasts, Table 10 shows the estimated DCFC infrastructure needed by 2025, when the EV market is expected to have reached an inflection point and a lack of public DC infrastructure would seriously impede market growth. This is on the order of 60 new DCFC sites, or 12 DCFC sites per year on average for the five-year period from 2021 through 2025.

At an estimated total cost of $150,000 per DCFC site, this equates to an investment of $1.8 million per year and a total of $9 million over five years for 30 DCFC sites. In comparison, Avista installed seven DCFC sites at an average cost of $128,000 during the three-year EVSE pilot from 2016 to 2019.

[43] For example, see "Electric Program Investment Charge (EPIC) Final Report." Pacific Gas and Electric Company (2016).

[44] See Nicholas, et all (p. 13), Wood, et al (p. xi), and "Considerations for Corridor DCFC Infrastructure in California", (p. 11).

Table 10: Projections for light-duty EVs in Avista's service territory and required DCFC in 2025

	BEV	PHEV	Total EVs	EVs Owned by Avista Electric Customers	Corridor DCFC Sites	IntraCity DCFC Sites	Total DCFC Sites Needed by 2025	DCFC Installed as of 2019	New DCFC Required by 2025
Washington	3,764	2,509	6,273	5,521	25	25	50	9	41
Idaho	1,129	923	2,052	1,313	13	8	21	1	20
Total	4,893	3,433	8,326	6,834	38	33	71	11	60

Avista will plan to install 5 new DCFC sites in 2021 owned and maintained by the Company, ramping to 7 DCFC sites in 2022 and 9 sites in 2023 and 2024—a total of 30 out of an estimated 60 required sites, or 50% of the estimated market requirement by 2025. Plan adjustments to the number of new sites and expansion of existing sites will be made with stakeholder involvement, based on annual evaluations of EV adoption, respective EVSE market needs, and the number of DCFC installations owned by third-parties. Ideally, third-party ownership makes up 50% or more of the regional installations, with the support of the "make-ready" policy and the pilot EV TOU rate schedule used for public DCFC.

Effective buildout along major travel corridors including I-90, I-95, US 395/195, US 2 and US 12 in Avista's service territory requires extending the initial DCFC network in eastern Washington to target sites in Sprague, Clarkston, Chewelah, Colville, Deer Park, Davenport, Airway Heights, Cheney, south Spokane and Newport in Washington, as well as Post Falls, Coeur d'Alene, Sandpoint, Bonners Ferry, Spirit Lake, Hayden, Rathdrum, Orofino and Grangeville in Idaho. Some of these strategic locations are not served by Avista electricity and will require investment by other organizations and/or grant funding. The maps below show existing DCFC and a preliminary DCFC buildout plan along major travel corridors in the region and in the Spokane metro area. Note that this is relative to higher traffic patterns shown by red "heat" marks correlating with greater than 25,000 average daily vehicle traffic, and does not include DCFC sites available only to Tesla vehicles.

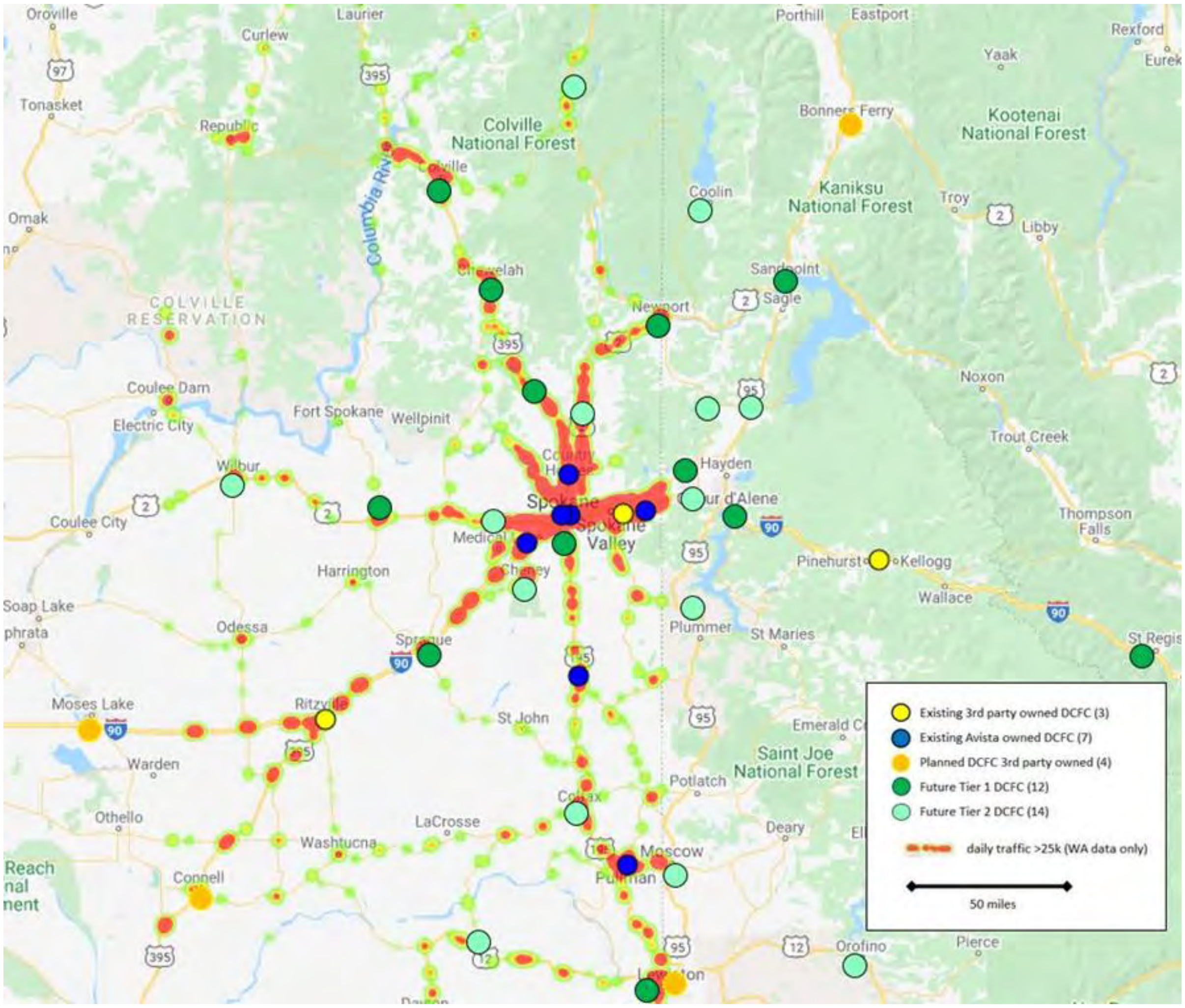


Figure 23: Preliminary DCFC buildout plan for regional travel corridors (2020-2024)

In more populated areas, DCFC buildout is targeted at 1 DCFC site per 150 BEVs registered in each zip code, including DCFC sited at locations supporting TNCs and high-traffic locations, such as the Spokane International airport and major shopping centers. The map below shows the EVSE buildout plan for the Spokane metro area, as developed with local leaders including the Spokane Regional Transportation Council, the City of Spokane, Urbanova, and other local leadership as part of the recent grant application for the Clean Energy Fund—Electrification of Transportation Systems, administered by the Washington State Department of Commerce.

DCFC site under construction at Wandermere shopping center, in partnership with Washington Trust Bank (2018)

Figure 24: Preliminary EVSE buildout plan for the Spokane Metro area (2021– 2024)

DCFC sites should be “future proofed” where practical, with additional capacity allowing for low-cost expansion as EV demand grows. The illustration below shows standard plans for the DCFC sites installed in the EVSE pilot, allowing for low-cost expansion from 50 kW DCFC to 150 kW DCFC and additional dispenser units and parking stalls in two construction phases.

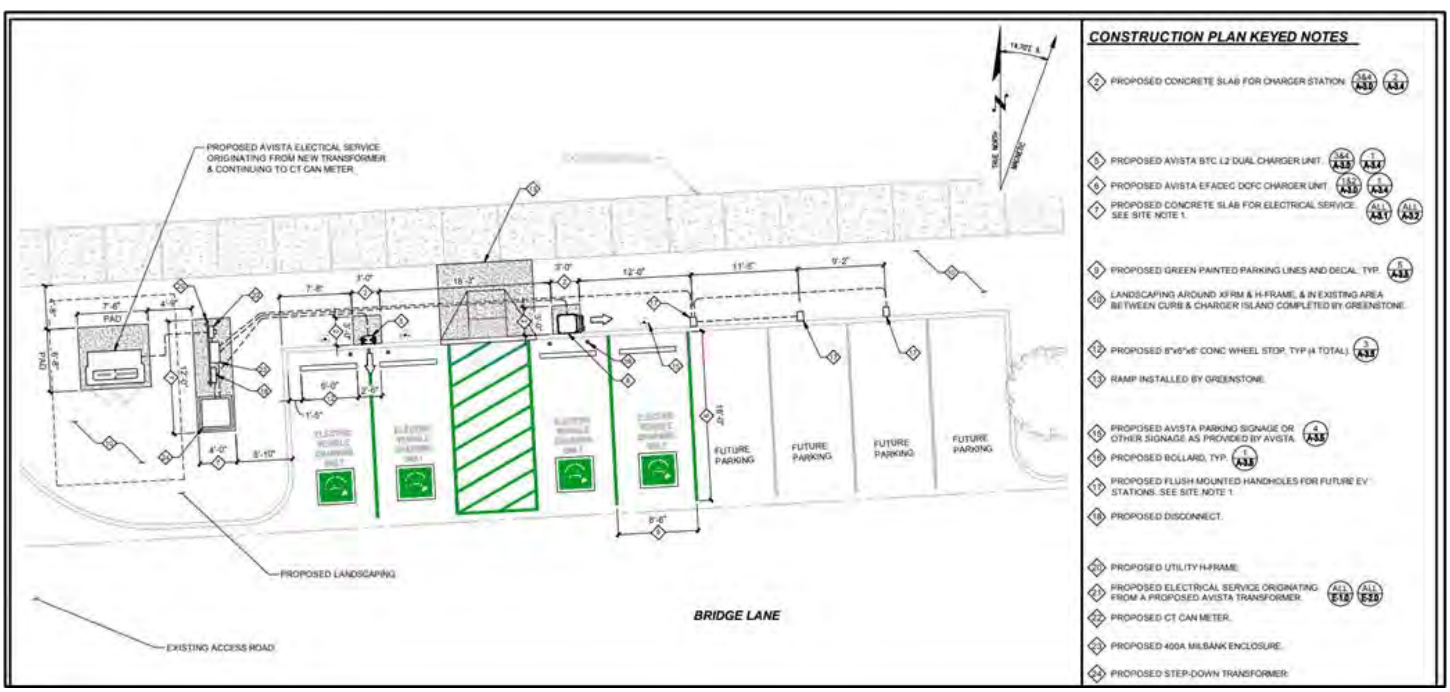


Figure 25: Standard DCFC site design for the EVSE pilot (2016—2019)

Standard DCFC installations in the EVSE pilot included a dedicated 225kVA transformer, 50 kW DCFC and a dual-port AC Level 2 backup EVSE in the first phase of construction, serving four parking stalls. Additional infrastructure capacity allows for low-cost expansion in the second phase of construction with an additional 150 kW DCFC, up to three dispenser units, and four additional parking stalls.

DCFC sites require both CHAdeMO and CCS-1 port connections, allowing for all drivers with different DC port connection standards to use the EVSE (Tesla drivers can use the DCFC with a purchased adapter for the CHAdeMO connector only in North America). DCFC owned and maintained by Avista require a user fee, currently set at $0.35/kWh in Washington State and regulated by the Washington UTC. A property easement or access agreement with the property owner is necessary for DCFC sites for a period of at least 10 years correlating with the estimated service life of the DCFC equipment.

New standard DCFC site designs are in process, incorporating the latest proven technologies and industry best practices. A standard 1MW site plan is envisioned, with two 175kW power dispensers installed in phase 1, and expansion capacity to add two additional 350kW power dispensers in Phase 2. Options beyond the standard design include on-site solar power, energy storage and micro-mobility charging. These options may be pursued as a technology demonstration project with local and industry partners.

All DCFC will meet network interoperability requirements to help mitigate long-term operational risks, and will include payment capability through credit-card readers so that customers may easily and seamlessly access all DCFC in the network without mandatory network memberships or subscriptions.

For planning purposes through 2025, average cost for standard DCFC site designs is estimated at $150,000 per site, assuming DCFC power delivery at 150 kW or higher, and 225 kVA to 1500 kVA transformer capacity depending on site conditions.

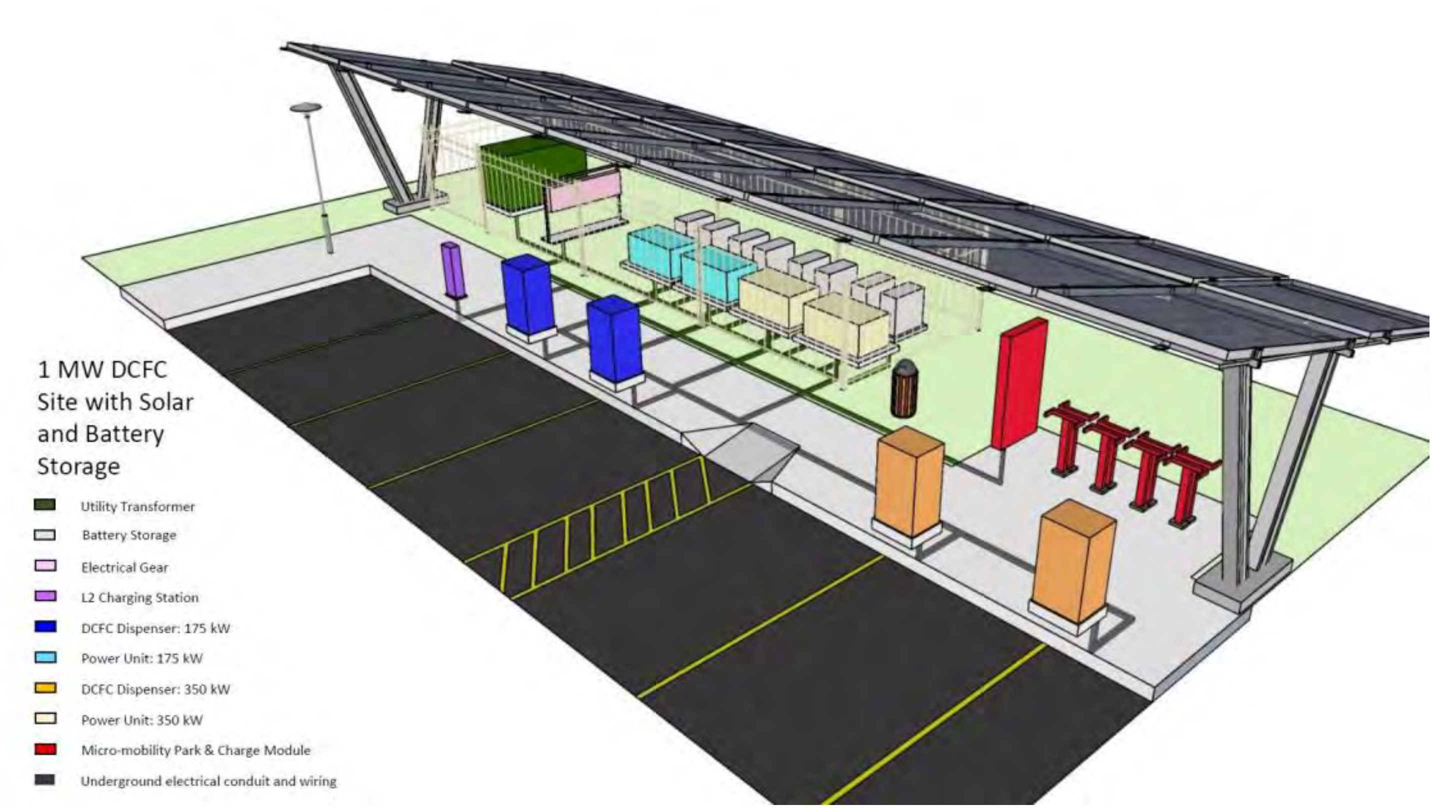


Figure 26: Concept layout for 1 MW DCFC site with solar, energy storage, and micro-mobility options

Public AC Level 2

AC Level 2 EVSE are very different from DCFC. They typically deliver less than 7.2 kW of power per port compared to 50kW or more for DCFC, and as a result, charging sessions are often much longer than the 30-minute average charging sessions for DCFC. Installation costs are also much lower, at an average of $12,000 per public ACL2 site compared to $128,000 for DCFC in the EVSE pilot.

The appropriate quantity of public AC Level 2 EVSE to support the market over the next five years is approximately one port per 25 EVs.[45] Given an estimated 8,326 EVs in the region in 2025, this equates to 333 AC Level 2 ports. Subtracting the 78 public ports currently installed in the area yields 255 ports for buildout, or 51 ports per year on average over the five-year period from 2021–2025. Assuming an average of 2 ports per AC Level 2 installation gives an estimate of roughly 25 new public AC Level 2 sites needed per year.

Another helpful guideline for public AC Level 2 buildout is related to the geographic distribution and coverage of high-traffic site locations with available EVSE. Customer feedback indicates that public AC Level 2 at all major shopping centers and large grocery stores, as well as major parks and other destinations, would be beneficial. Public AC Level 2 EVSE spread throughout the area in smaller rural towns could also provide a beneficial charging network that enables regional EV trips where the user intends to stop for several hours at a given location. This may be accomplished at relatively low installation cost compared to DCFC, and provides more equitable access to EV charging for early adoption in these areas.

Public and workplace EVSE installed at a neighborhood shopping center (2018)

Avista will plan to support up to 12 sites per year for public AC Level 2 buildout in the region from 2021 through 2025 – roughly 50% of the estimated market need. Application and selection rounds will be made each year, involving local stakeholders including regional transportation planners and community leaders. Selection criteria will be based on factors including cost, access, low-income support, geographic diversity, nearby driver amenities, projected utilization and site-host commitment. Avista will coordinate installations, covering 50% of premises wiring installation costs up to a maximum of $2,000 per port, similar to the installations completed in the EVSE pilot. This amount may be reduced in the future as market conditions change. Additional conduit allowing for low-cost future expansion will be included where practical.

Non-networked EVSE will be encouraged due to their proven higher reliability and lower costs. However, some site hosts may require the EVSE to transact a user fee or collect data. In these cases, site hosts may choose from networked EVSE certified as meeting interoperability standards, but will be responsible for fees and maintenance associated with the network service provider (EVSP). Site hosts may also set the user fee at their discretion, with consultation available from Avista and the EVSP to set an appropriate fee in-line with other fee-based EVSE in the market. Public EVSE applying user fees should have credit card readers installed to ensure convenient access by all users.

In the future, Avista may consider an EVSE lease and/or rebate program, maintenance fees, and modifications to "make-ready" offerings for commercial customers, provided assurance that effective load management development, EVSE access, reliability, and cost controls may be achieved.

[45] See Nicholas, et all (p. 13), and Wood, et al (p. xi)

Workplace, Fleet and MUD AC Level 2

Workplace, fleet and multiple-unit dwelling (MUD) EVSE installations are critical to support adoption and provide net grid benefits. Workplace charging in particular is of major importance, as it has been shown to be a cost-effective, powerful catalyst for EV adoption while reducing amount of charging that would otherwise occur during evening on-peak periods.

Avista will support EVSE installations in this category owned and maintained by the utility, accepting customer applications on a first-come, first-served basis subject to eligibility requirements. Avista will cover 50% of premises

Workplace and Fleet EVSE installed for the City of Spokane (2019)

wiring costs up to a maximum of $2,000 per port, similar to the installations completed in the EVSE pilot. This amount may be reduced in the future as market conditions change. The number of ports and configurations are dependent on site-specific conditions, limited according to the number of existing EVs that will utilize the EVSE and assessments of near-term and long-term adoption potential according to the size of the organization and facility. Where feasible, additional conduit will be installed enabling low-cost future expansion.

Avista will offer a reliable and low-cost non-networked EVSE, typically delivering between 3.3 kW and 7.2 kW per port. In most cases, EVs in these locations may be expected to charge for longer periods of time at lower power levels. Off-peak charging will be maximized by enrollment in load-management programs including vehicle programming, non-networked programmable EVSE and vehicle telematics. In all cases, the customer agreement allows the utility to perform load management where practical for workplace, fleet and MUD sites, and the customer agrees to future application of TOU rates to encourage off-peak charging. In most cases it is expected that lower costs will result from utilizing available capacity in existing supply panels; however, those sites with segregated meter service to EV charging loads will be eligible for the pilot EV TOU rate.

In the case of workplace, fleet or public installations, if the customer desires a networked AC Level 2 EVSE that enables user payments, they may choose from certified EVSE that have passed interoperability and reliability testing. The customer will be responsible for any EVSP fees and maintenance, and may set the user fee at their discretion with consultation available from Avista and the EVSP, similar to public EVSE.

Alternatively, customers in these locations may choose to own and operate their own AC Level 2 EVSE, or act as site host for other third-party ownership. “Make-ready” utility investments as previously described and a commercial EV TOU rate are intended to help support and encourage third-party ownership.

In the future, Avista may consider an EVSE lease and/or rebate program, maintenance fees, and modifications to “make-ready” offerings for commercial customers, provided assurance that effective load management development, EVSE access, reliability, and cost controls may be achieved.

Residential AC Level 2

The residential EVSE program supports adoption and dealer engagement, and provides a pathway to develop cost-effective load management where the large majority of charging will occur. Avista will support EVSE installations in this category owned and maintained by the utility, accepting customer applications on a first-come, first-served basis subject to eligibility requirements. Avista will cover 50% of premises wiring costs up to a maximum of $1,000 per port, similar to the installations completed in the EVSE pilot. This amount may be reduced in the future as market conditions change.

For residential installations, a reliable and low-cost non-networked EVSE is installed, with load management achieved by programming the vehicle or the EVSE to charge during off-peak hours. A smaller subset of customers will be enrolled in telematics data collection and load-management tests, which will allow for ongoing load profile monitoring and new load-management experiments communicating directly with the EV, rather than through a networked EVSE.

Customers may select a certified EVSE of their choice but will be responsible for any additional costs, including EVSP fees that may apply. In all cases, customers agree to participate in future TOU rates and replacement of the EVSE at Avista's discretion with new products enabling robust load-management experimentation.

In the future, Avista may consider a lease and/or rebate program offering, maintenance fees, and/or networked EVSE utilizing AMI equipment for residential customers, provided assurance that effective load management development, reliability and cost controls may be achieved. For at least the near term, the proposed residential program achieves desired outcomes of greater EV adoption, EVSE reliability, dealer engagement and development of load-management capabilities and benefits at least cost.

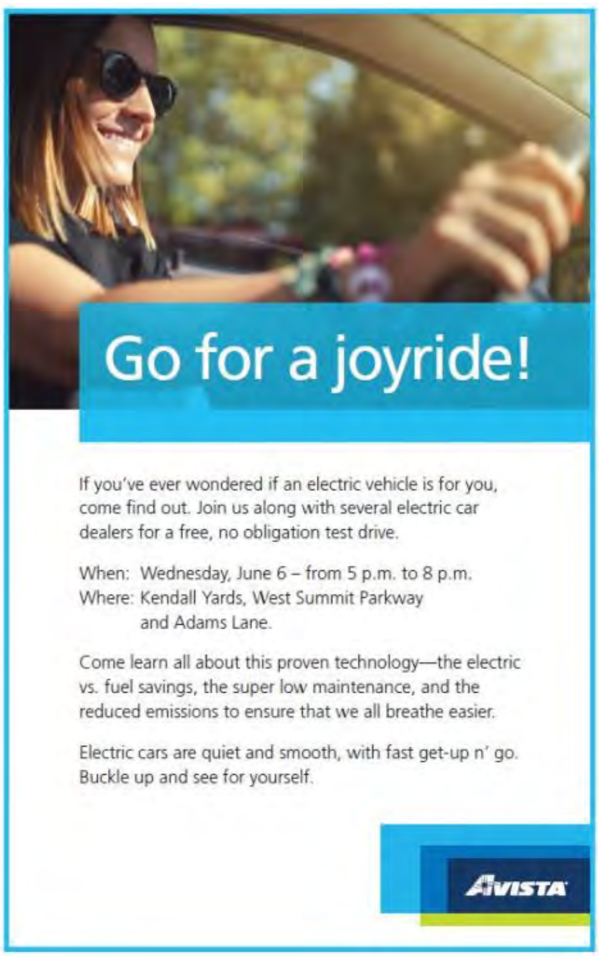
Residential EVSE installation with direct load management capability via homeowner WiFi and the Greenlots network (2017)

Summary – EVSE Installations and Maintenance

- 45% budget target
- > 99% EVSE uptime goal
- Programs support both Avista and third-party EVSE ownership, off-peak charging, and customer choice through “make-ready” options, load management and a pilot EV TOU rate.
- Coordinated public DCFC buildout, prioritized and selected with stake-holder engagement. Goal is to install 30 new sites owned by Avista by 2025, with another 30 owned by third-parties. Pilot EV TOU rate schedule applied in all cases.
- Public AC Level 2 selected with stakeholder engagement at up to 12 sites per year. Avista covers 50% of premises wiring costs up to $2,000 per port, with EV TOU rate applicability.
- Workplace, fleet and MUD installations on a first-come, first served basis. Avista covers 50% of premises wiring costs up to $2,000 per port, with load-management requirements and EV TOU rate applicability.
- Residential installations on a first-come, first served basis. Avista covers 50% of premises wiring costs up to $1,000 per port, with load-management requirements and future EV TOU rate applicability.

Education and Outreach

With respect to light-duty passenger vehicles, low awareness of EVs continues to pose significant market barriers for both residential and commercial customers. This is exacerbated by a persistent lack of new and used EV inventory, and generally low (although improving) interest and engagement of auto dealerships. In 2019, while most area dealerships carried minimal to zero EV inventory, over 50% of EV sales in the region occurred outside traditional dealer channels, through online sales dominated by Tesla and other used EV sales between private parties. While regional EV adoption rates have increased considerably in recent years, EVs are still less than 2% of new vehicle registrations – far short of entering the mass market at the 15% level.



Communications flyer for an EV Ride & Drive event — in partnership with Kendall Yards and Forth (2018)

Customer surveys and interviews showed that Avista's efforts to provide objective information about EVs and charging during the pilot were appreciated, with many suggestions and encouragement to increase these efforts in the future. Consultation with Plug-In America and interviews with area dealerships showed that Avista's dealer referral and EVSE installation pilot programs were well regarded and gaining traction in the dealer community by the time these programs were concluded in June of 2019. New and similar programs were universally requested among interviewed dealers, along with a strong desire to partner with Avista in the future to increase customer awareness and EV adoption.

The customer purchase journey starts with awareness, proceeding to the critical consideration stage, and closing with the purchase decision. Beyond awareness, customers often need trusted referrals and direct experience with riding, driving and charging an EV to overcome perception issues at the consideration stage and make a good purchase decision. It is clear that as a trusted energy advisor with strong customer relationships, Avista is in a unique position to address awareness issues—and to some degree, EV availability and experiential opportunities—to help customers make well informed transportation choices. This may be accomplished in a variety of ways, including continued customer support functions, new programs based on proven pilot successes, strengthened partnerships with dealerships, and exploration of new education and outreach efforts as follows:

1. Provide supportive customer programs and engage with automotive dealers, original equipment manufacturers (OEMs), and local interest groups to improve vehicle inventory levels, EV awareness and demand, and the customer purchase experience. This will include a $250 dealer referral per customer (limited to 100 referrals per year); a program offering installation of residential, fleet and workplace charging subject to load-management requirements; and periodic visits with area dealership management and sales staff. Within budget constraints, the Company plans to pursue EV education campaigns in partnership with area dealers and local media channels. Support and engagement of local peer-to-peer interest groups leveraging social media may provide the most effective results in terms of raising

public awareness and local demand for EVs. Depending on the results of further research, Avista may support informational kiosks, such as the Chargeway Beacon at area dealerships, as well as dealer EV training and certification programs.

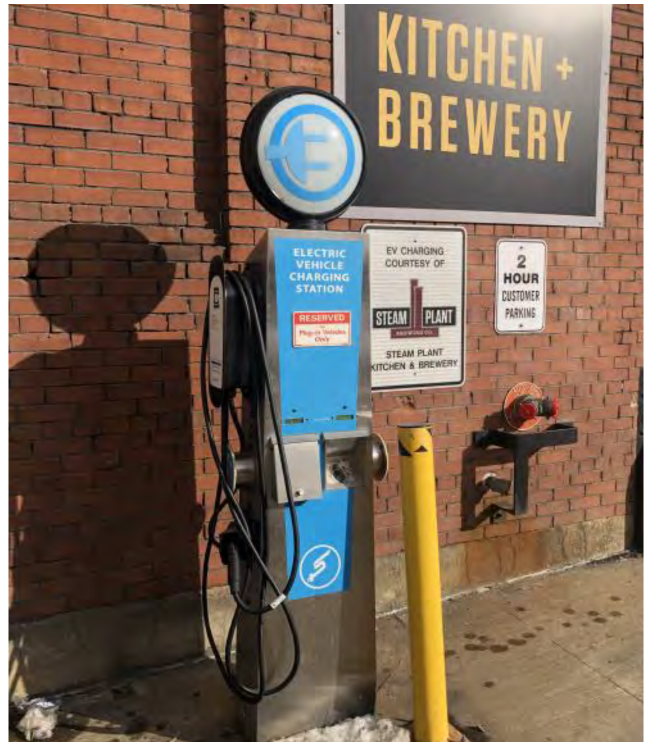
2. Continue installs of public AC Level 2 EVSE across Avista's service territory, in partnership with local government and businesses. This will help provide a backbone of regional public charging infrastructure at low cost, and at the same time increase education and awareness due to public visibility and promotion, as well as provide benefits to disadvantaged individuals and communities in these areas.

3. Consider establishing an EV Experience Center in the Spokane metro area, where the public could learn in a hands-on environment about EVs, charging, incentives and utility programs—similar in some respects to the Forth showcase in Portland, Oregon. This could conceivably be combined with a check-in and check-out service for EVs available for rent through Turo, a charging hub for EV drivers using transportation network company (TNC) platforms such as Uber and Lyft, and purchase of used and new EVs in partnership with an experienced auto broker and/or dealers. If successful, this could provide substantially greater visibility and access to local and more remote EV inventories, as well as direct ordering channels, and effectively raise public awareness on a larger scale. Collaboration, partnerships and support from local organizations and individuals is important to success.

4. Support EV drivers using transportation network company (TNC) platforms such as Uber and Lyft. This may include installation of DC fast charging stations at key locations, reduced charging fees, and possibly assistance with vehicle leases and/or financing, in partnership with TNCs. This program could also be leveraged to benefit disadvantaged communities and individuals.

5. Continue customer support functions and activities in the following areas:

    a. Maintain Avista's electric transportation webpage with the latest information and tools, including state and federal incentives, utility programs, cost calculators, program information and application links, and FAQs.



Avista's first public EVSE at the Steam Plant in Spokane, WA — in operation since 2010

    b. Promptly respond to customer inquiries via phone calls and email through the call center, with more experienced staff as needed for more detailed questions involving vehicles and equipment, charging options and requirements, utility infrastructure, etc. Increasingly, this may involve inquiries about commercial fleet opportunities.

    c. Support community events such as locally sponsored EV ride and drives during National Drive Electric Week.

    d. Provide informative presentations in a variety of forums, including community events and meetings with local government, industry groups and non-profit organizations, and public webinars.

    e. Promulgate important information about the benefits of electric transportation through various media channels, including earned news and trade media interviews, social media, bill inserts, newsletters and public signage.

Summary – Education and Outreach

- 10% budget target
- By 2023, raise positive customer EV awareness by 500%
- $250 dealer referrals, limited to 100 per year
- EV education and awareness cam-paigns
- Peer-to-peer interest group and TNC support
- Consider informational kiosks, training and certification programs at auto dealerships
- Consider partnering to establish an EV Experience Center, providing education, charging, rental and purchase support
- Continue customer support functions, including online information and tools, call center support, and sponsorship

Community and Low-Income Support

Electric transportation has the potential to deliver improved transportation services to communities and individuals most in need with economic cost savings as well as environmental benefits. Avista is committed to help provide these benefits for the disadvantaged communities and individuals it serves.

According to a United Way report, 47% of Avista's residential customers in Washington are living in poverty or struggling with basic living costs.[46] In 2019, the Spokane Transportation Collaborative was formed, convening area service organizations around the issue of access to mobility resources—recognized as the most serious issue following the lack of adequate housing. Electric transportation can make a difference in alleviating this problem.

The Company believes that programs and strategies benefiting low-income customers are best designed in collaboration with stakeholders, as accomplished both in the EVSE pilot and the development of proposed activities in this TEP. Through traditional low-income assistance and outreach programs over many years, Avista has established strong partnerships with community service organizations throughout its service territory. These partnerships proved to be very valuable in swiftly designing and implementing new and effective programs in the EVSE pilot. The Company will continue to work with established community partners as well as others that may provide access to broader networks as appropriate. In particular, Avista intends to partner with the Spokane Transportation Collaborative, the City of Spokane, and Urbanova to most effectively understand transportation issues and how they may be addressed with future electric transportation and mobility programs supported by Avista in the Spokane area. Recent efforts with these groups helped form a consensus around prioritizing a network of EVSE at public libraries and community centers which may be used to benefit low-income customers, as well as creatively leverage service organization resources—opening the door to increased, low-cost access to electric transportation services and public transportation. Additionally, Avista will work with local government, tribal governments, and other non-profit organizations throughout the region, tailoring programs to their specific needs and opportunities.

Internally, administrative support will be provided by the Consumer Affairs Program Manager who regularly oversees traditional low-income assistance, education and outreach programs, however transportation programs will not compete with resources for established low-income conservation and rate assistance programs.

In the EVSE pilot, Avista successfully collaborated with over 15 local service organizations to educate and discuss electric transportation opportunities in a series of workshops, culminating in selection of two pilot proposals from different community service organizations in Spokane, providing EVs and EVSE utilized for a variety of beneficial purposes including transport to critical medical services, job skills training, shuttle services for overnight shelter and food deliveries. Each organization secured insurance and accepted responsibility for vehicle maintenance and operational costs. In both cases, the volume of transportation services was substantially increased while realizing transportation cost savings of 57% and 82%. Educational and awareness benefits for staff and management may further result in expanded EV adoption for personal and organizational use. Building on the success of the EVSE pilot, a similar approach will be used in partnership with the Spokane Transportation Collaborative and other local government and service organizations in the region.

SPOKANE REGIONAL HEALTH DISTRICT

[46] 2016 United Way Asset Limited, Income Constrained and Employed Report

As the used EV market develops, lower-cost options for reliable and inexpensive electric transportation will grow. The EVSE pilot showed that public EVSE installed in smaller rural towns may be broadly supported by the local community and are felt to provide benefits in terms of public visibility, community access and business development as part of the regional public EVSE infrastructure buildout. In many cases, these EVSE represent the lone public EVSE available for early EV adopters in those municipalities, making electric transportation viable for the first time. Leveraging EVSE infrastructure programs available to all customers, Avista will provide additional installation assistance to low-income communities and service organizations for public, fleet and workplace AC Level 2 EVSE, multiple-unit dwelling installations, and residential customers receiving low-income bill assistance. This can take the form of the utility covering EVSE installation costs that would normally fall under the customer's responsibility in these programs.

Research shows that transportation provided by TNC platforms such as Uber and Lyft are widely used by customers with limited transportation resources.[47] Exploring this opportunity, Avista will deploy a pilot program supporting TNC drivers serving disadvantaged communities through partnerships providing a combination of public EVSE utilized by TNC drivers, EV purchase or leasing, and discounted rides. This effort may also be used to provide easier "last-mile" access to public transportation.

Additional pilots may be designed and implemented with public transportation agencies and school districts that work in coordination with the TNC pilot or in a stand-alone capacity, provide "make-ready" utility investments, and/or maintain EVSE installations for transit fleets serving low-income customers.

Ride-sharing and car-sharing services appear to have some potential but can pose significant administrative burdens that reduce effectiveness.[48] In this area, Avista will consider partnering with an experienced organization such as Envoy to pilot ride-sharing and/or car-sharing services, for example, in a housing development serving customers with limited incomes.

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[47] Brenneis, M. "TNC revolution may improve access for low-income communities." SSTI (2020). https://www.ssti.us/2018/07/tnc-revolution-may-improve-access-for-low-income-communities/

[48] Diaz, A. and Teebay, C. "The Future of Car Sharing: Electric, Affordable, and Community-Centered." Forth (2018).

Summary – Community and Low-Income Support

- 30% budget target
- Collaborate and partner with community stakeholders, local governments and service organizations in the development and implementation of creative programs. Leverage resources together to achieve effective results
- Provide EV and EVSE for community service organizations through collaborative and competitive proposals
- Provide EVSE to disadvantaged communities including rural towns and low-income multi-unit dwellings, and to residential customers receiving low-income bill assistance
- Develop and implement pilot programs with public transit agencies, school districts and/or TNC platforms as early as 2022
- Consider partnering with Envoy and/or other organizations, piloting ride-sharing and car-sharing services

Commercial and Public Fleets

Opportunities to support beneficial electric transportation in commercial and public fleets exist today and will grow in the future. Avista can begin to support this growth with information, tools and consulting services for commercial customers in their consideration of fleet electrification, including vehicle and charging information, utility rates and load management options, total cost of ownership (TCO) comparisons, referrals, and available purchase incentives and tax rebates. This may be provided now for light duty passenger vehicles and lift trucks (forklifts), followed by commercial delivery vehicles, airport ground support equipment and refrigerated trailer units in the future as markets further develop and more knowledge is gathered in these areas. The Company also intends to develop pilot programs working with transit agencies and school districts, in order to better understand the costs, benefits, grid impacts and support that Avista may best provide to help electrify these fleets. This may be accomplished in conjunction with beneficial services to low-income customers.

In addition to fuel and maintenance savings, zero tailpipe emissions, quiet operations, and beneficial utility revenues, commercial and public fleet electrification results in significant reductions in greenhouse gas emissions, as shown in Table 11 below.

According to local distributors and the 2019 Industrial Trucking Association (ITA) annual sales report, despite electric lift truck sales of over 60% of total sales in the U.S., local electric sales are on the order of 36% in Avista's service territory. This presents an opportunity to support increased electric lift truck sales, with resulting benefits for all utility customers. A new program supporting lift trucks is modeled after other successful utility programs in the U.S. The program provides information resources and lift truck (class 1) purchase incentives of $2,000 for buyers, and $250 for dealers. Per lift truck purchase, this will result in avoiding 16 metric tons of CO_2 tailpipe emissions, customer fuel savings of 76%, and $1,500 per year in beneficial utility revenue. Load-management services and consultation on EVSE installations will also be provided. An additional $1,000 purchase incentive is proposed for purchase of

Table 11: Avoided CO_2 reductions from electric transportation, net of grid emissions in the Pacific Northwest (McKenzie, p. 18)

	Avoided Emissions (metric tons CO_2)	
	High grid emissions at 0.5 lbs CO_2/ kWh	Zero grid emissions (100% renewable sources)
Personal Light-duty EV	13	21
Taxi and TNC EV	34	44
Electric Lift Truck (Forklifts)	42	52
Electric Parcel Delivery Truck	62	88
Electric Transit Bus	650	910

Table 12. Proposed incentives for lift truck, ground support equipment, and truck refrigeration unit electrification

Electric equipment type	Additional annual utility revenue per vehicle	Customer purchase cost premium	Customer purchase incentive	Dealer referral incen-tive	Annual fuel savings from electric	Potential for load shifting
Lift truck (class 1)	$1,500	$5,000	$2,000	$250	$2,600	Moderate to High
Lithium-ion batteries	-	$3,000	$1,000	-	-	Moderate to High
Ground support equipment	$2,250	varies	TBD	TBD	varies	Moderate
Truck refrigeration unit	$1,100	$3,000	TBD	TBD	$1,600	Low

Class 1 lift trucks utilizing lithium-ion batteries as opposed to lead-acid. This is based on customer interviews and market research showing that lithium-ion is often needed to make electric lifts feasible for outdoor applications or multi-shift operations, but presents additional upfront cost premiums.[49] Purchase incentives apply to new as well as "first time sales" of lease-return units, as many dealers lease the lifts and then sell them after a few years depreciation.

Fleet managers often choose to convert to electric for economic reasons, since operating an electric lift typically saves over 76% in fuel costs and roughly 40% in annual maintenance costs compared to a gas lift. However, electric lifts have an upfront premium cost of 30% to 40% compared to gas lifts. This premium imposes a market barrier for many organizations that would otherwise benefit from the residual cash flow and employee health benefits of switching to electric over the equipment's lifetime. Purchase incentives and information resources provided by the program are designed to effectively overcome these barriers.

For example, a local foundry served by Avista uses 60 forklifts around the clock on three shifts, all powered by propane. According to this customer, propane-powered forklifts are what they are accustomed to and there is uncertainty as to whether a switch to electric forklifts would be worth the effort and expense. The primary concern in this case is not the additional electricity expense, but rather the upfront cost of the equipment and the operational feasibility and risk associated with making the change. According to a local dealer, an average forklift rated at 5,000 lbs costs between $26,000 and $35,000, compared to an electric forklift that costs between $32,000 and $39,000, plus the cost of the EVSE at close to $3,000 prior to any rebates or incentives. Fuel cost savings vary but can often provide a payback period in a few years; however, many businesses require paybacks in fewer than two years in order to justify capital investments.

From a TCO perspective, an electric lift would have a payback period of approximately two years and over the course of seven years would cost 32% less than a gas lift, and 38% less than a diesel lift, as shown by the TCO comparison tool developed by the Electric Power Research Institute (EPRI).[50] There is also a variety of applications where electric lifts are superior to gas lifts, such as in operating environments that are indoors or have poor ventilation, and where the risk of exhaust contaminants prevents the use of gas lifts. Under regular-use conditions, a gas lift will emit over 16 metric tons of CO2 tailpipe emissions annually. An electric lift produces no tailpipe emissions, resulting in zero local emissions of air pollutants. Even after factoring in Avista's combined emissions from its mix of electric generation sources, an electric lift produces only four metric tons of CO2 annually, a 74% decrease of emissions compared to a gas lift.

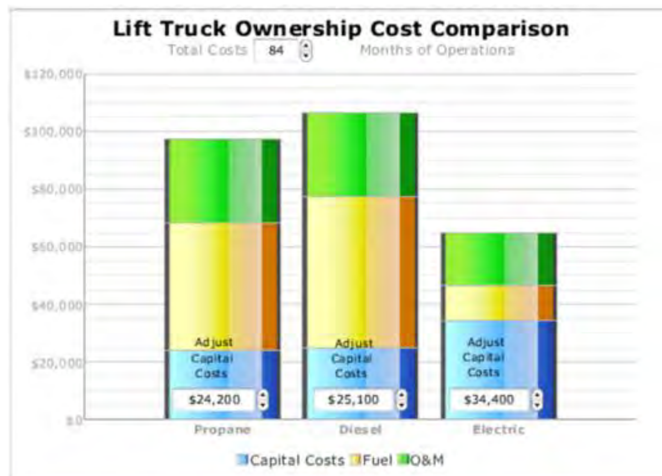

Figure 27: Total Cost of Ownership (TCO) for propane, diesel, and electric lift trucks (courtesy EPRI)

Due to flexible battery capacities, lifts are capable of operating multiple shifts back to back without recharging or swapping their batteries. Fully charged batteries can be swapped into lifts in a process that takes about 15 minutes when downtime needs to be minimized. Batteries can be fast or slow charged using single or three-phase power up to 10 kW, although usually charging is done between shifts at consistent intervals. As a result of this beneficial and often flexible load, the consistency of charging between shifts, reduced carbon emissions, and the ability to model other proven utility programs, electric lift trucks are an ideal candidate for Avista's first fleet electrification program utilizing equipment purchase incentives.

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[49] https://www.refrigeratedfrozenfood.com/articles/98521-allan-brothers-boosts-operation-effectiveness-with-lithium-ion-technology

[50] https://et.epri.com/LiftTruckCalculator.html

One model example is provided by the electric utility JEA serving Jacksonville, Florida. Prompted by the financial crisis of 2009, JEA began searching for new ways to support beneficial load growth, with a forklift electrification rebate as one of the pillars of their industrial electrification program.[51] Since 2015, JEA has helped customers purchase over 3,500 electric lifts through the program, adding over 64,090 MWh of load annually. JEA estimates that 72% of that usage is during off-peak hours. Customer representation is spread proportionally among small, medium and large businesses, with customers reporting benefits including improvements to their working environments and the removal of misconceptions of electric lifts as a result of converting from propane or diesel lifts to electric.

In a second example, the utility CenterPoint Energy headquartered in Houston, Texas has a long-standing industrial electrification program that includes electric forklift rebates.[52,53] The program has been operating since 2008 and has added 17.5 MW of primarily off-peak demand during the five years ending 2019. Key benefits of this program have been the ability to support beneficial electrification while also facilitating an avenue for positive interactions with the utility, increasing familiarity with the benefits of electrification among many customers and stakeholders. Sacramento Municipal Utility District (SMUD) provides another example, with forklift purchase incentives of $2,000 per lift to customers and $1,000 to vendors.[54]

Light-duty passenger vehicles will also be included for fleet electrification support, leveraging available EVSE installation programs as applicable. Similar programs may be proposed for other vehicle types in the future as the market continues to mature and attractive opportunities present themselves. This may include proposals for purchase incentives and EVSE programs as deemed most appropriate and cost-effective.

For both lift trucks and light-duty fleet EVSE installations, the commercial EV TOU rate may be applied with dedicated meter service. Load management consultation services will also be provided as part of the fleet support program.

Table 13: Lift truck market estimates for eastern Washington and Northern Idaho [55]

annual new lift truck sales, not including leases (all classes)	400
average service life (years)	10
total new and used lift trucks in service, not including leased units	4000
additional leased lift trucks in service	1000
total lift trucks in service, including leased units	5000
total lift trucks in service in Eastern Washington	3250
total lift trucks in service in Northern Idaho	1750
electric rider (Class 1) lift truck new sales	105
ICE rider lift trucks new sales	185
electric percent of total rider lift truck new sales	36%

[51] https://www.jea.com/Business_Resources/Rebates_for_Businesses/Electric_Forklifts/

[52] https://www.utilitydive.com/news/enhancing-customer-engagement-a-utility-roadmap-for-the-amazon-era/513195/

[53] https://www.power-grid.com/2016/11/22/utilities-offset-slow-load-growth-with-new-business-ventures/

[54] https://www.smud.org/en/Going-Green/Electric-Vehicles/Business

[55] see the following OSHA website for full descriptions of all forklift classes: https://www.osha.gov/SLTC/etools/pit/forklift/types/classes.html

Summary – Commercial and Public Fleets

- 5% budget target
- Initiate a fleet support program starting with light-duty passenger vehicles and forklifts
- Provide information and consulting services including vehicle and charging information, utility rates and load-management options, total cost of ownership (TCO) comparisons, available incentives, and referrals
- Provide dealer and customer purchase incentives for electric lift trucks to help boost sales, rapidly “paid back” by additional utility revenue
- Enroll participants in the pilot EV TOU rate to encourage off-peak charging
- Consider expanded fleet support services to other vehicle types in the future, including purchase incentives for airport ground support equipment and truck refrigeration units as early as 2022
- Support and possible purchase incentives for emerging medium duty and heavy-duty vehicles may be considered and proposed as the market and technologies develop
- Develop fleet support pilots with mass transit bus and school bus agencies in 2022—2023

Planning, Load Management and Grid Integration

Avista will continue to monitor and document EV load profiles, using a smaller test pool of customers with vehicle telematics connectivity starting in 2021. Updated EV load profiles and adoption forecasts will be integrated on a regular basis with System Planning and the Integrated Resource Plan (IRP). This will be used in conjunction with updated modeling of grid assets and conditions, other load forecasts, and the effects of distributed energy resources (DERs), providing a sound assessment of generation capacity and distribution systems for optimized asset management. More detailed analysis of EV clustering effects on the distribution system may also be performed, as sufficient data and modeling capabilities are developed.

Avista will deploy cost-effective load-management services leveraged with EVSE installation programs. This will initially be accomplished through EV programming and the utilization of low-cost, programmable, non-networked EVSE. Experimentation with new technologies and industry innovations will also be considered, such as the utilization of advanced metering infrastructure (AMI) and other technologies that communicate with EVs and other distributed energy resources, given the potential to optimally manage loads and integrate with the grid at scale. After careful consideration, Avista may elect to support EVSE hardware and software development if the market is slow or unable to deliver needed products and services that are cost effective. Residential TOU rates may also be considered and piloted with groups of customers participating in the EVSE program, starting in 2023. By 2025, the goal is to demonstrate greater than 50% peak load reduction from light-duty EVs than would otherwise occur with uninfluenced charging, thereby achieving grid benefits greater than expenses required to perform load management.

Developing scalable and cost-effective load-management solutions for a large number of light-duty EVs is important over the longer term—particularly as adoption levels reach approximately 30% of vehicles on the road—at which point the distribution system may begin to see material impacts. In the nearer term, the adoption of medium- and heavy-duty EVs for mass transit and other commercial fleet applications could impact local distribution grids much sooner, given power demands greater than 1 MW. As such, Avista will monitor developments closely and work with customers such as STA to better understand operational needs and limitations, as well as opportunities to optimally integrate with local grid conditions in terms of minimizing infrastructure costs.

AC level 2 EVSE site construction in partnership with WSU (Riverpoint Campus, 2017)

Other topics of interest include how expected adoption in each market segment may influence transformer and feeder conductor sizing, as well as feeder dynamics and voltage control requirements. The Company intends to study potential impacts via experimental pilots and solutions on a small scale in order to develop scalable, cost-effective deployments on a larger scale.

Summary – Planning, Load Management and Grid Integration

- 5% budget target
- Collect telematics data and analysis to provide updated light-duty EV profiles
- Leverage EVSE installation programs to continue development of load-management capabilities
- Achieve 50% peak load reduction from light-duty EVs, with net grid benefits by 2025
- Support load management for medium and heavy-duty electrified fleets, such as with mass transit agencies

Technology and Market Awareness

Avista will utilize a deliberate process of monitoring and validation of emerging technologies and market opportunities in electric transportation. During the initial monitoring phase, thresholds may be identified such as when TCO advantages appear feasible, emerging technical innovations, etc, that trigger the development of pilot programs testing technical feasibility, costs and customer experience. Pilots may lead to informed deployments that can scale up over the long term, achieving sustained benefits for all utility customers.

- EV vs. ICE vehicle costs
  - ◊ Up-front purchase
  - ◊ Fuel and maintenance
  - ◊ Total cost of ownership (TCO)
- Model availability and OEM announcements
- Auto dealer lot inventory
- Used market, private-party inventory

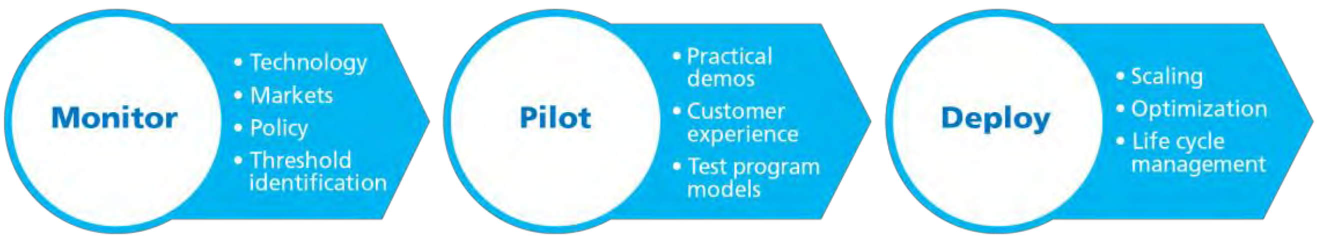

Figure 28: Technology and Market Monitoring and Testing Process

Rapid changes in a number of key areas are expected, as described in the previous Technology and Markets section, which Avista will continue to monitor. These areas include the following:

Batteries

- $/kWh
- Chemistry and thermal management
- Voltages
- Battery life and OEM warranties
- Recycling and second use for grid storage

EVSE

- Power output
- Communications interoperability
- Connector standards
- Inductive charging

Light-duty EV Market and Consumer Preferences

- Light-duty EV % of total vehicle sales
- % online sales

Medium- and Heavy-duty Vehicle Electrification

- Mass transit BEB adoption and TCO
- Electric lift truck % of sales
- Electric school bus TCO and pilot opportunities
- Electric commercial delivery vehicle availability and TCO
- Other electric heavy-duty vehicle availability and TCO
- Electrified truck-stop deployments and results
- Electric refrigerated-trailer deployments and results

Other Technologies and Market Opportunities

- Vehicle-to-home (V2H), -to-building (V2B), and -to-grid (V2G) deployments
- Micro-mobility deployments
- Load-management software platforms and interoperability testing
- Hydrogen-powered fuel cell EVs

Summary – Technology and Market Awareness

- 2% to 5% budget range
- Follow deliberate process of monitor-ing and pilots to validate and design scalable deployments
- Key monitoring areas include:
    - ◊ Battery technology
    - ◊ EVSE
    - ◊ Light-duty market and consumer preferences
    - ◊ Medium- and heavy-duty vehicle electrification
    - ◊ Other technologies and market opportunities

Rate Design

Residential EV Time-of-Use (TOU) Pilot Rate

In the long term, an EV TOU rate for residential customers may be one of the more effective ways to shift peak loads from light-duty EVs, maximizing net benefits for all customers. In this regard, experience with participants in the commercial EV TOU rate as explained below should be helpful in implementing a pilot EV TOU rate for residential customers. This rate may be proposed in 2023 and eventually applied on a larger scale utilizing Advanced Metering Infrastructure (AMI) that is now being deployed in Washington State.

Commercial EV Time-of-Use (TOU) Pilot Rate

Major barriers to increasing commercial electric transportation include high purchase costs of vehicles and charging infrastructure, limited vehicle models and availability, low consumer awareness, and high utility bills driven primarily by demand charges. Although the utility has little influence on vehicle models and availability, it can help address charging infrastructure and low awareness, as detailed in other sections of this Plan. Through new rate designs, it may also address the issue of high demand charges for commercial fleets and DC fast charging sites, while encouraging more off-peak charging.[56]

As an example, consider the case of the Spokane Transit Agency (STA), the main provider of public transit in the greater Spokane metro area. STA is in the process of purchasing four battery-electric buses (BEBs) for a new route serving the Moran Prairie and Monroe Street areas, to be placed in service in 2021 and, if successful, followed by another five to seven BEBs on this route. In addition, another ten BEBs will be purchased and operational beginning in 2022, serving a new central "City Line" connecting the urban core with rapid, zero-emission mass transit. All of these BEBs will be housed in a new depot facility near downtown Spokane. Given the state of current technology, plans are to charge the BEBs for up to ten minutes at one end of the route using a high powered 450 kW overhead charger, and staggered charging at the depot overnight, with additional DC fast chargers each providing 450 kW. Purchase premiums are still very high for electric buses, typically $250,000 or more than the base cost of $500,000 for a diesel bus which may serve most routes in the Spokane area, plus additional EVSE costs, utility service upgrades, and backup generation facilities. STA has estimated these additional costs to serve up to 20 buses at over $2 million, or approximately $100,000 per bus. With lower projected costs for diesel fuel at $2.37 per gallon, STA projects monthly diesel fuel expenses for nine BEBs on the new Moran-Prairie-to-Monroe-St. route at $18,100. This compares to $15,300 monthly electricity bills for BEBs, approximately 45% of which comes from demand charges. With savings of nearly $3,000 per month in fuel costs, payback for the large upfront cost premiums does not occur under current electric rate schedules. Federal and state grants have mostly enabled early electrification plans at STA; however, the business case must be dramatically improved in order to fully electrify the entire fleet of over 140 coaches and many other smaller passenger vehicles.

DCFC site construction at the West Plains Transit Center and Park & Ride—in partnership with Spokane Transit Authority (2018)

The path to full electrification at STA will depend on technology and cost improvements that eventually allow for greatly reduced purchase costs and batteries with sufficient energy to operate a full day without in-route charging. At that point, economical depot charging may occur mostly overnight, without the need for in-route

[56] "Peak Demand Charges and Electric Transit Buses." CALSTART. US Dept of Transportation, Federal Transit Administration (2014).

charging that adds significantly to overall expenses. Additionally, more substantial operational cost savings could be realized by STA if a new rate schedule provides relief from demand charges, while encouraging off-peak charging. This is in fact a necessity to enable an expanded and sustained electrification of STA's fleet.

In another example, the important buildout of DC fast charging infrastructure and investment by third-parties is inhibited by high operating costs, particularly in the early stages of market growth where utilization is low. A DC fast charger with only 2% load factor is effectively billed $0.41/kWh under current rate schedules, making it impossible to recover these costs from competitive user fees of $0.35/kWh, which are roughly equivalent to the alternative of gasoline at $3 per gallon. In addition, as discovered in the EVSE pilot, DCFC typically require $1,500 per year in other operational expenses including site inspections and maintenance, EVSP networking fees, communication fees, and unplanned EVSE repairs.

In a recent study of 51 EV rate options from 21 electric utilities in the U.S., it was found that relatively few rate options were available to commercial customers, and that TOU energy charges without demand charges, combined with monthly fixed charges and seasonal differences were most common.[52] In Washington State, Pacific Power was approved for an optional TOU rate applicable to public DCFC sites with less than 1 MW maximum demand. Pacific Power's Schedule 45 includes a TOU energy charge between 6am and 12pm and 5pm and 9pm in winter, and between 1pm and 8pm in summer. TOU energy charges are gradually reduced and demand charges reinstated over a 13-year period in this optional rate schedule.

Based on these assessments, Avista proposes a pilot EV TOU rate for commercial customers that is essential to support sustainable growth in fleet electrification and public DC fast charging. The proposed rate provides for reasonable recovery of utility costs based on additional time-of-use (TOU) energy charges, while eliminating demand charges that currently inhibit market growth. In this way, it establishes sensible electric billing rates for businesses that invest in electric fleets and public charging, encouraging early and sustained fleet adoption, larger workplace charging facilities, and third-party ownership of public DC fast charging. Through higher on-peak price signaling, it also encourages more off-peak charging, which is beneficial to all customers. The intent is to encourage early commercial EV adoption in the Company's service territory while providing a means to acquire usage and cost data that may be used to conduct more comprehensive analysis and a more permanent EV TOU rate in 2025.

The new EV rate schedules will be made available to commercial customers, provided that EV charging loads are metered separately from other facility loads and peak demand does not exceed 1 MW. Above this threshold, load management may be required, and it must be demonstrated that all reasonable measures are being taken to mitigate impacts and required upgrades to the local distribution grid as a condition of utilizing the pilot rate. The TOU energy charge on the order of $0.05 per kWh is applied in addition to regular energy charges on a seasonal basis, during the hours of 7am to 10am and 5pm to 8pm from November through March, and 3pm to 7pm from April through October. Provisions of existing commercial rate schedules apply other than the removal of demand charges and the addition of on-peak energy charges, and rates will occasionally change slightly in accordance with regular system-wide adjustments.

For DC fast charging sites, assuming 2% load factor, this will result in an all-in rate per kWh of approximately $0.16, in contrast with $0.41 under current rate schedules. Compared to the competitive market-based user fee of $0.35/kWh which approximates $3/gallon of gasoline, the owner of a DCFC may then begin to recover operational costs for electric billing and maintenance costs. In the case of a transit agency such as STA operating 10 BEBs, assuming 19% load factor results in an all-in rate per kWh of $0.09 compared to $0.12 under current rate schedules. This provides for approximately 26% fuel cost savings on an order necessary to initiate pilot deployments of electric buses and the viability of more widespread fleet electrification.

[57] "Review and Assessment of Electric Vehicle Rate Options in the United States." EPRI Report 3002012263 (2018).

Eligible commercial customers may choose to adopt the pilot TOU rate starting in 2021, with open availability through 2025. At that time, the Company intends to propose a more permanent EV TOU rate based on collected data and analysis completed during the 2021-2025 pilot period. Customers that initially participate in the pilot rate may then choose between the new EV rate, or elect to continue with the pilot EV rate for another five years through 2030. Early adopters are thereby given reassurance that the pilot rate may be applied through 2030 when they consider making sizable capital investments in new electric fleet and charging infrastructure with service lives of ten years or more.

A relatively small number of customers is expected to participate in the pilot TOU rate, minimizing risks while providing valuable data to study effects on local coincident loading patterns and impacts on the distribution system, enabling development of a more permanent EV TOU rate schedule.

Utility Fleet Electrification, Facilities and Employee Engagement

Utilities must set a good example for customers in electrifying their own fleets and facilities, as well as encouraging employee engagement around electric transportation. Long term, the utility can greatly benefit from transportation electrification in terms of reduced costs and greater reliability. By 2025, the Company's goal is to expand utility fleet, facility and employee engagement levels by 300%. In addition to realizing fleet and employee benefits, through direct experience in these areas the Company is better able to advise customers. Also, employees who drive electric act as respected ambassadors in the community, raising positive awareness and adoption of EVs in the region.

Avista fleet EV and facility EVSE for fleet, public, and workplace charging — Deer Park, Washington (2018)

Utility Fleets

Every year Avista's fleet of over 700 vehicles drives more than 7 million miles, fulfilling the mission of delivering safe and reliable energy. The mix of vehicles includes Class-1 light-duty passenger vehicles through Class-8 heavy tractors weighing in at over 105,000 pounds.

In 2010 Avista's fleet began the journey of transportation electrification with the purchase of two Toyota Prius PHEV conversions. That effort expanded to bring a Nissan LEAF into the fold when it arrived on the market in 2011. In 2011 we also began to invest in an electric Power Take-Off (ePTO) system. In 2014 Avista joined other utility fleet leaders in the development of Edison Electric Institute's (EEI) Transportation Electrification Initiative. That initiative won the commitment of over 77 investor-owned utility fleets to invest five percent or more of annual fleet spending on electrified transportation alternatives. To date that effort has doubled the goal of five percent with an average investment of over $95 million per year over the last four years.

Since making that commitment in 2014, Avista has invested in an expanding range of technologies aimed at demonstrating and proving out the best possible business cases for electrification in the fleet. These efforts include the expansion of EV, PHEV and range extending PHEV technology in passenger vehicles. Next the Company has looked to the significantly larger fleet of work trucks to identify vehicles where proven technology can meet required duty cycles.

Avista's testing and use of work platform systems has taken a number of forms. On large construction aerials a full ePTO system was used with great success, eliminating over 90% of the vehicle's monthly idle time. However, this system is expensive and packs a significant amount of weight on a unit that has very stringent state weight limits. With this in mind, Avista initiated trials using electrified idle-mitigation technology on small service body trucks and large aerials. Results with this technology have been less than what was modeled by initial analysis, as user adoption and technology gaps have created the most challenges in operating such systems in the fleet. This included issues with getting operators to consistently charge at home even when compensated for the electricity consumption, and to avoid system over-rides when it should have been engaged.

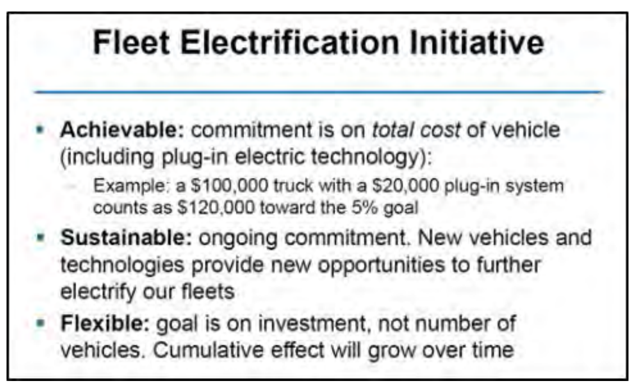

Figure 29: EEI 5% utility fleet electrification pledge

On the positive side, the systems eliminated battery issues on single-battery service trucks. Another lesson learned was the technical difficulty in integrating an idle-mitigation system with a complex cab chassis that already has many other chassis integrations, foremost among these being the starting and stopping of a chassis, and secondary cooling and heat.

The future of fleet electrification is dependent on the development and availability of cost-effective electrified Class-1, -2 and –3 pickup trucks that meet emergency response requirements. Passenger vehicles are the most widely available EV type but make up a small fraction of the company's fleet. At this time there is no cost-effective electric solution available from any of the three domestic truck manufacturers and conversion solutions have many issues. Looking ahead, for large trucks that have mounted equipment such as bucket trucks, the duty cycle of most of that fleet makes sense for electrification. These units, location dependent, tend to have a significant amount of idle time which can be reduced or eliminated. However, cost and weight as well as form factor impact that deployment today.

The good news is that multiple technology advances appear to be near or ready for market. The rollout of both light- and heavy-duty EVs has a future in the market place. However, as a utility fleet our requirements are different from that of a typical fleet operator. We can never forget that our trucks and crews respond to emergencies across our service territory, and in some cases across the nation when assisting other utilities in remote locations. With crews working 16 hours a day during these instances and up to 36 hours initially, we must have power systems that can reliably meet that demand. Our efforts will be focused on enabling our workers to respond day-in and day out-in support of Avista's core mission.

EVSE Facilities

Adequate workplace charging at Avista facilities coupled with effective employee engagement on electric transportation options can make a big difference in employee adoption, which translates to higher awareness and long-term EV adoption in the community.

EVSE installed at Avista facilities throughout the region can provide charging availability for visiting members of the public, as well as for utility fleet vehicles and employees commuting with an EV. This has been successfully demonstrated by EVSE installed at the Company's headquarters in Spokane, Washington, as well as a few other outlying offices. Avista will continue to install EVSE at facilities throughout its service areas at an appropriate level that allows employees commuting with an EV to charge at work, as well as for use by an expanded EV passenger fleet and the public at Company facilities.

Avista EVSE for fleet, public, and workplace charging
— Spokane Project Center (2017)

Employee Engagement

In addition, Avista will provide information and resources for employees to better understand the benefits of EVs and to help make informed transportation choices, similar to education and outreach resources available to customers. EEI provides a wealth of knowledge and resources around the topics of electrification to help utilities in engaging their employees.

Finally, the Company will look to partner with OEMs offering EV purchase discounts to employees. At some point Avista may consider supplementing this with additional purchase incentives funded by shareholders, when EV availability and choices in the market would yield the greatest positive effects.

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Appendix A: Glossary of Terms

Sources: Altas HUB, Alliance for Transportation Electrification, Wikipedia, and from SEPA as adapted from the California Public Utilities Commission (CPUC) Vehicle Grid Integration Communications Protocol Working Group Glossary of Terms (http://www.cpuc.ca.gov/vgi/), 2017. These definitions are "working definitions" and are not meant to be formal or conclusive, with some editing by the authors.

AC, DC: alternating current, direct current. The U.S. electricity grid generally operates on AC. A typical household outlet is 110–120 VAC (volts alternating current). Larger home appliances use 240 VAC. Electric car batteries operate on DC.

AC Level 2 Charger: AC Level 2 (L2) chargers can be found in both commercial and residential locations. They provide power at 220V-240V and various amperages resulting in power output ranging from 3.3kW to 19.2kW.

AFDC: U.S. DOE Alternative Fuel Data Center website containing a wealth of information on alternative fuels and vehicles.

Aggregator: An aggregator is a third-party intermediary linking electric vehicles to grid operators. Increasingly, aggregators are stepping into a role of facilitating interconnections to entities that provide electricity service. Broadly, aggregators serve two roles: downstream, they expand the size of charging networks that electric vehicle (EV) customers can access seamlessly, facilitating back-office transactions and billing across networks; upstream, they aggregate a number of EVs and charging station operators (CSO) to provide useful grid services to distribution network operators (DNO) and transmission system operators (TSO).

AV: Autonomous vehicle is a vehicle that can guide itself without human input. There are various levels of autonomous technology as defined by SAE, from level 0 (no driving automation) to level 5 (full driving automation).

BEV (Battery Electric Vehicle): Battery Electric Vehicle is a vehicle with a drivetrain that is only powered by an onboard battery and electric motor(s).

CAV: Connected autonomous vehicle is an autonomous vehicle that has vehicle-to-vehicle or vehicle -to-infrastructure capabilities.

C2 Device: A telematics hardware device, from FleetCarma, that is capable of logging driving and charging data from electric vehicles.

CCS: The Combined Charging System is a charging method for electric vehicles from the SAE J1772 connector. The plug contains DC and AC options and is also referred to as a combo connector. The automobile manufacturers supporting this standard include BMW, Daimler, FCA, Ford, General Motors, Hyundai, Jaguar, Tesla and Volkswagen.

Charger: A layperson's term for the on-board or off-board device that interconnects the EV battery with the electricity grid and manages the flow of electrons to recharge the battery. Also known as electric vehicle supply equipment (EVSE).

Charge Session: A charge session is the period of time an electric vehicle (EV) is actively charging its battery through the connection with a charger (EVSE).

Charging: Charging is the process of recharging the onboard battery of an electric vehicle.

Charging Level: The terms "AC Level 1", "AC Level 2" and "DC fast" describe how energy is transferred from the electrical supply to the car's battery. Level 1 is the slowest charging speed. DC fast is the fastest. Charging rate varies within each charging level, depending on a variety of factors including the electrical supply and the car's capability.

Charging Station: The physical site where the electric vehicle supply equipment (EVSE) (also known as the charger) or inductive charging equipment is located. A charging station typically includes parking, one or more chargers, and any necessary "make-ready equipment" (i.e., conduit, wiring to the electrical panel, etc.) to connect the chargers to the electricity grid, and can include ancillary equipment such as a payment kiosk, battery storage or onsite generation.

CHAdeMO: “CHArge de MOve” is the trade name of a quick charging method formed by Tokyo Electric Power Company, Nissan, Mitsubishi and Fuji Heavy Industries, and later joined by Toyota.

Connector: The plug that connects the electricity supply to charge the car’s battery. J-1772 is the standard connector used for Level 1 and Level 2 charging. CCS or “combo” connectors are used for DC Fast charging on most American and European cars. CHAde-MO is the connector used to DC fast charge some Japanese model cars.

Demand Response (V1G, direct load management, controlled charging, intelligent charging, adaptive charging or smart charging): Central or customer control of EV charging to provide vehicle grid integration (VGI) offerings, including wholesale market services. Includes ramping up and ramping down of charging for individual EVs or multiple EVs, whether the control is done at the EVSE, the EV, the EV-management system, the parking lot EV energy-management system or the building-management system, or elsewhere.

DER: Distributed energy resource

DERMS: Distributed energy resource management system

Direct Current Fast Charger (DCFC): Direct current fast charging equipment is designed to rapidly deliver direct current to a vehicle’s onboard battery. DCFCs commonly have power ratings of 50kW or higher.

Direct Install Costs: Corresponding to the direct costs associated with the installation of an EVSE. These costs include labor and materials for mounting the EVSE, wiring connections, network connections, signage, EVSE testing, and work to complete required permitting and inspections.

DOE: “Department of Energy” is commonly used to refer to the U.S. energy agency or a state energy agency.

DOT: “Department of Transportation” is commonly used to refer to the U.S. Dept of Transportation or a state transportation agency.

DR: Demand response (see “Demand Response”)

DRMS: Demand response management system

E&O: Education and outreach

Electric Vehicle Service Provider (EVSP): An electric vehicle service provider also known as a network service provider (NSP), provides services related to chargers, such as data communications, billing, maintenance, reservations and other non-grid information. The EVSP sends grid commands or messages to the EV or EVSE (e.g., rates information or grid information based on energy, capacity or ancillary services markets; this is sometimes called an electricity grid network services provider). The EVSP may send non-grid commands (e.g., reservations, billing, maintenance checks), and may receive data or grid commands from other entities, as well as send data back to other entities.

Electric Vehicle Supply Equipment (EVSE): Electric vehicle supply equipment, also often called an EV charger, is stand-alone equipment used to deliver power to the input port connection on an EV. This device includes the ungrounded, grounded and equipment-grounding conductors and the electric vehicle connectors, attachment plugs and all other fittings, devices, power outlets or apparatus associated with the device, but does not include premises wiring.

ENERGY STAR for EVSE: Compliance standards for electric vehicle supply equipment to receive ENERGY STAR certification.

EPA: “Environmental Protection Agency” is commonly used to refer to the U.S. environmental protection agency or a state environmental protection agency

EPRI: Electric Power Research Institute conducts research, development and demonstration projects to benefit the public in the United States and internationally.

EV: “Electric vehicle” is the commonly used name for vehicles with the capability to propel the vehicle fully or partially with onboard battery power and contains a mechanism to recharge the battery from an external power source. EVs can include full battery-electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs).

EVSE: See Electric Vehicle Supply Equipment.

EVSP: See Electric Vehicle Service Provider.

Fleet EVSE: EVSE for use by business owned vehicles.

GGE: Greenhouse gas emissions

GHG: Greenhouse gas

GMS: Grid Management System is based on an architecture and guiding principles to proactively support changing requirements while minimizing disruption to existing operations, consumer commitments and regulatory requirements.

GSE: Ground support equipment is equipment used in airports, such as belt loaders, luggage tags and water trucks.

HDV: Heavy-duty vehicles have a gross vehicle weight above 26,000 pounds.

ICE (Internal Combustion Engine): ICE is an acronym for “Internal combustion engine.” ICE vehicles typify the majority of gasoline/diesel/natural gas vehicles that make up the majority of automotive fleet.

ICCT: International Council on Clean Transportation. ICCT is a research group and has published several reports transportation electrification

IEEE: Institute of Electrical and Electronics Engineers is a professional association whose objectives are the educational and technical advancement of electrical and electronic engineering, telecommunications, computer engineering and allied disciplines.

IEEE 2030.5: IEEE 2030.5 is a standard for communications between the smart grid and consumers. The standard is built using Internet of Things (IoT) concepts and gives consumers a variety of means to manage their energy usage and generation.

IEEE P2690: This standard defines communications between electric vehicle charging systems and a device, network and services-management system, which is typically based "in the cloud" but could also include interfaces to site-specific components or systems (e.g., building energy management systems).

IGP: Integrated grid planning

Interoperability: The ability of devices, systems or software provided by one vendor or service provider to exchange and make use of information, including payment information, between devices, systems or software provided by a different vendor or service provider.

IOU: Investor-owned utility

ISO 15118-1:2013: ISO 15118 specifies the communication between EV and the EVSE.

J1772: also known as a "J plug", is a North American standard for electrical connectors for electric vehicles maintained by the Society of Automotive Engineers (SAE) International, and has the formal title "SAE Surface Vehicle Recommended Practice J1772, SAE Electric Vehicle Conductive Charge Coupler." It covers the general physical, electrical, communication protocol and performance requirements for the electric vehicle conductive charge system and coupler.

L2 Station: See AC Level 2 Charger.

LBEV (Long-Range Battery Electric Vehicles): LBEVs are BEVs (see BEV) that have an average driving range greater than 200 miles for a full battery charge.

LDV: Light-duty Vehicles have a gross vehicle weight at or below 14,000 pounds.

Level 1: Level 1 is part of the charging standard defined by the SAE for charging equipment using standard 120V household electricity.

Level 2: Level 2 is part of the charging standard defined by the SAE for charging equipment using 208V or 240V electricity, similar to the power level used for ovens and clothes dryers.

Load Curve: A load curve or load profile is a graph of electrical load over time. This is useful for utilities to determine how much electricity will need to be available at a given time for efficiency and reliability of power transmission.

Make-ready: Make-ready describes the installation and supply infrastructure up to, but not including, the charging equipment. The customer procures and pays for the charging equipment, which could be funded by a separate rebate or other incentive by the electric company or other entity.

Managed Charging: Managed charging allows an electric utility or a third party to control the charging of an EV remotely. This entity could enable or disable charging, or could control the power level for charging.

MDV: Medium-duty vehicles have a gross vehicle weight more than 14,000 and less than 26,001 pounds.

MUD: Multi-unit dwellings are a type of residence in which multiple housing units are located within a single building or building complex (e.g., an apartment complex, duplex, condos, etc). This is synonymous with a multi dwelling unit (MDU). EVSE at MUDs are intended for use by MUD residents. EVSE located on hotel or motel properties are also included within MUD session data in this report.

NEMA: National Electric Manufacturers Association

Networked EVSE: These devices are connected to the Internet via a cable or wireless technology and can communicate with the computer system that manages a charging network or other software systems, such as a utility demand response management system (DRMS) or system that provides charging data to EV drivers on smartphones. This connection to a network allows EVSE owners or site hosts to manage who can access EVSE and how much it costs drivers to charge.

NGO: Non-governmental organization

Non-networked EVSE: These devices are not connected to the Internet and provide basic charging functionality without remote communications capabilities. For example, most Level 1 EVSE are designed to simply charge a vehicle; they are not networked and do not have additional software features that track energy use, process payment for a charging session, or determine which drivers are authorized to use the EVSE. Secondary systems that provide these features can be installed to supplement non-networked EVSE.

NREL: National Renewable Energy Laboratory

NPV: Net present value is the sum of future cash flows using a discount rate, such that it takes into the account of the time value of money.

OATI: Open Access Technology International, Inc.

OEM: Original equipment manufacturer, commonly used to refer to automobile manufacturers.

OpenADR 2.0b: Open Automated Demand Response (OpenADR) is an open and standardized way for electricity providers and system operators to communicate DR signals with each other and with their customers using a common language over any existing IP-based communications network, such as the Internet.

OCPP: The goal for the Open Charge Point Protocol (OCPP) is to offer a uniform solution for the method of communication between charge point and central system.

PEV (Plug-in Electric Vehicle or PEV): see EV

PHEV (Plug-in Hybrid Electric Vehicle): Plug-in hybrid electric vehicle is a plug-in electric vehicle that can be powered by either or both a gasoline/diesel engine and/or an onboard battery.

Platform: The base hardware and software upon which software applications run.

Port: See Connector.

Premises Wiring: electrical supply panel and dedicated 208/240VAC circuits that suppy electricity directly to EVSE. This includes the protective breaker at the supply panel, wiring, final junction box, receptacle and all attachments and connections.

Proprietary Protocol: A protocol that is owned and used by a single organization or individual company.

Protocol: Set of rules and requirements that specify the business process and data interactions between communicating entities, devices or systems. Most protocols are voluntary in the sense that they are offered for adoption by people or industry without being mandated by law. Some protocols become mandatory when they are adopted by regulators as legal requirements. A standard method of exchanging data that is used between two communicating layers.

Public EVSE: Public EVSE can be found in multiple types of locations including but not limited to business parking lots, public buildings and adjacent to public right-of-way. Public AC Level 2 EVSE have a standard J1772 connector, while DCFC have a CHAdeMO and/or CCS connectors. Tesla vehicles may utilize public EVSE with an adapter; however, other EVs cannot use Tesla EVSE, as no adapters are available.

Residential EVSE: Located within a person's home, most often in a garage, residential EVSE are usually used by one or two EVs intended only for use by the homeowner.

Ride and Drive: Event where individuals are given the opportunity to look at EVs, talk with EV drivers, and ride in or drive an EV.

RPS: Renewable portfolio standard

OCPP (Open Charge Point Protocol): An application protocol for communication between EVSEs and EVSP servers.

Standard: An agreed-upon method or approach of implementing a technology that is developed in an open and transparent process by a neutral, non-profit party. Standards can apply to many types of equipment (e.g., charging connectors, charging equipment, batteries, communications, signage), data formats, communications protocols, technical or business processes (e.g., measurement, charging access), cybersecurity requirements, and so on. Most standards are voluntary in the sense that they are offered for adoption by people or industry without being mandated in law. Some standards become mandatory when they are adopted by regulators as legal requirements.

Standardization: Process where a standard achieves a dominant position in the market due to public acceptance, market forces or a regulatory mandate.

State of Charge (SOC): The level of charge of an electric battery relative to its capacity.

TCO: Total cost of ownership is a financial estimate that accounts for both purchase price and continued, variable operating costs of an asset.

TE: Transportation electrification

Telematics: In the context of EV charging, including managed charging, telematics refers to the communication of data between a data center (or "cloud") and an EV, including sending control commands and retrieving charging session data.

TNC: Transportation network company is a company that connects passengers with drivers via a mobile app or website. Example companies include Uber and Lyft.

TOU (Time of Use) Rate: "Time of use" often refers to electricity rates that can vary by the time of day. TOU rates can also be structured to vary by season.

TRU: Truck refrigeration unit is a device that is installed in a truck to refrigerate a truck's storage compartment.

Use Case: Defines a problem or need that can be resolved with one or more solutions (technical and/or non-technical) and describes the solutions. The use case is a characterization of a list of actions or event steps, typically defining the interactions, describing the value provided and identifying the cost.

Uptime: Defines the amount of time an EVSE is functionally able to provide a charge when requested, as opposed to a faulted state where no charge may occur. Depending on configuration settings, networked EVSE may still be able to provide a charge and maintain uptime status when offline from the network connection.

Workplace EVSE: Workplace EVSE are located on business property, primarily intended for use by employees. However, often the business owner will allow use by visitors or the public if it is located in an accessible location.

V1G: V1G refers to vehicles only capable of receiving power from the electrical grid to the onboard battery. This can also commonly be referred to as demand response for EVs

V2B: "Vehicle-to-building" refers to vehicles capable of sending power from the onboard battery to a building.

V2G: "Vehicle-to-grid" refers to vehicles capable of receiving power to the onboard battery from the electrical grid and vice-versa.

V2H: "Vehicle-to-home" refers to vehicles capable of sending power from the onboard battery to a home.

VMT: Vehicle miles traveled

VPP: Virtual power plant (VPP) is a cloud-based distributed power plant that aggregates the capacities of heterogeneous energy resources for the purposes of enhancing power generation, as well as trading or selling power on the open market.

ZEV: Zero emission eehicle is a vehicle with no tailpipe emissions. The term includes battery electric vehicles and hydrogen fuel cell electric vehicles.

Appendix B: Light-Duty EV Adoption Forecasts

Based on estimates of population and vehicle statistics, the tables below show underlying assumptions and the total number of light-duty registered vehicles (not including motorcycles) as they grow over time in the counties served by Avista electricity in Washington and Idaho.

Table 14: Statistical assumptions for light-duty vehicles

0.757	estimated light-duty highway vehicles per person, excluding motorcycles
2%	annual growth rate of light-duty vehicle registrations
15	average vehicle age (years)
6.7%	annual vehicle stock turnover rate

Table 15: Total light-duty highway registered vehicles in counties served by Avista (not including motorcycles)

Year Ending	Washington	Idaho	Total	Annual Vehicle Stock Turnover
2019	512,297	243,311	755,608	50,374
2020	522,543	248,177	770,720	51,381
2021	532,994	253,141	786,135	52,409
2022	543,654	258,204	801,857	53,457
2023	554,527	263,368	817,894	54,526
2024	565,617	268,635	834,252	55,617
2025	576,930	274,008	850,937	56,729
2026	588,468	279,488	867,956	57,864
2027	600,238	285,078	885,315	59,021
2028	612,242	290,779	903,022	60,201
2029	624,487	296,595	921,082	61,405

Based on state registration data for 2019, total vehicle stock turnover each year, and assumed sales rates through year-end 2029, the following tables show the estimated number of EVs in the counties served by Avista electricity in Washington and Idaho for baseline, high and low adoption scenarios.

In the baseline adoption scenario, average OEM product and strong utility support programs result in a sales rate of 15% by 2030 in Washington, at this level sustainably reaching the early mass market. A damper of 25% is assumed for Idaho in the baseline scenario, given the current state of lower support levels and a more rural, less populated service territory.

Table 16: Baseline EV Adoption Scenario - EVs registered in counties served by Avista electricity

Year Ending	Washington	Idaho	Total
2019	1,331	409	1,740
2020	1,812	569	2,381
2021	2,339	744	3,083
2022	2,951	948	3,899
2023	3,728	1,206	4,934
2024	4,792	1,560	6,352
2025	6,273	2,052	8,326
2026	8,350	2,742	11,092
2027	11,250	3,707	14,957
2028	15,259	5,040	20,299
2029	20,505	6,784	27,289

In the high adoption scenario, strong OEM product is matched with strong utility support programs that result in a sales rate of 15% in 2027, at this level sustainably reaching the early mass market several years earlier than the baseline scenario, and reaching a sales rate of 40% by 2030.

Table 17: High EV Adoption Scenario - EVs registered in counties served by Avista electricity

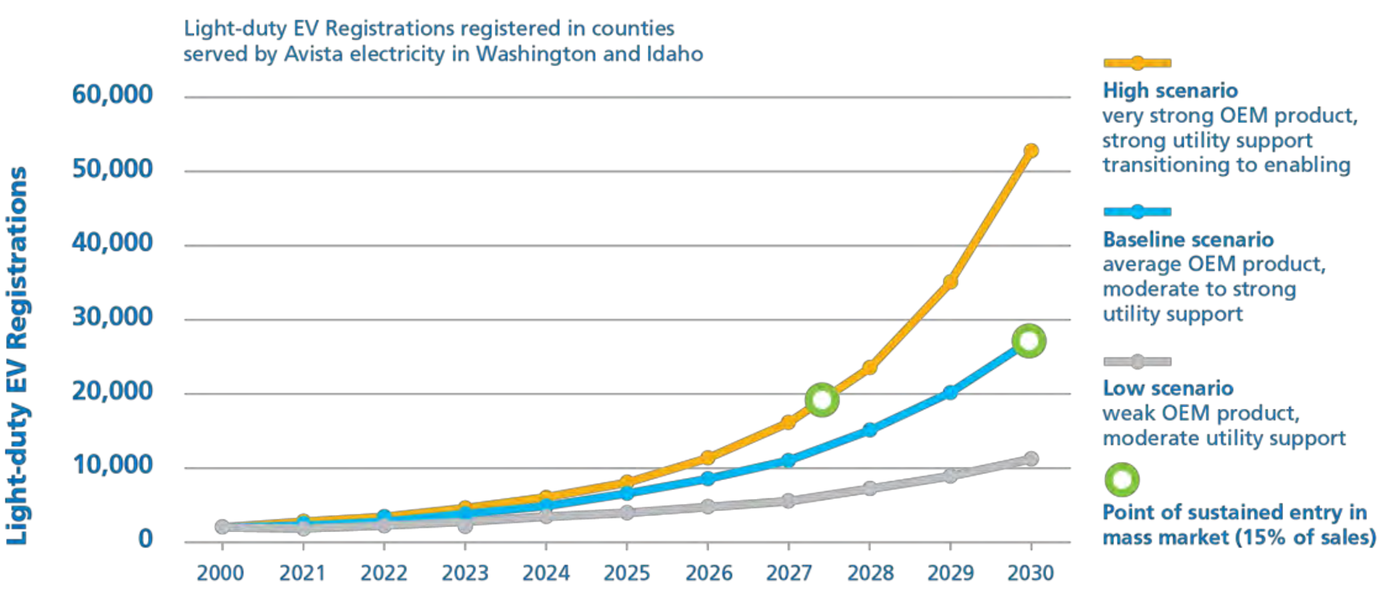
Year Ending	Washington	Idaho	Total
2019	1,331	409	1,740
2020	1,834	564	2,398
2021	2,467	758	3,226
2022	3,271	1,005	4,276
2023	4,418	1,358	5,775
2024	6,114	1,879	7,993
2025	8,624	2,650	11,274
2026	12,335	3,790	16,125
2027	18,013	5,535	23,548
2028	26,701	8,205	34,905
2029	40,610	12,479	53,090

In the low EV adoption scenario, relatively weak OEM product is appropriately supported by scaled-back utility programs, only reaching a 5% sales rate by 2030.

Table 18: <u>Low EV Adoption Scenario</u> - EVs registered in counties served by Avista electricity

Year Ending	Washington	Idaho	Total
2019	1,331	409	1,740
2020	1,455	447	1,902
2021	1,695	521	2,216
2022	2,002	615	2,618
2023	2,396	736	3,132
2024	2,899	891	3,790
2025	3,543	1,089	4,632
2026	4,368	1,342	5,710
2027	5,424	1,667	7,091
2028	6,776	2,082	8,858
2029	8,506	2,614	11,120

These tables are summarized in the chart below for total EVs registered in Washington and Idaho counties served by Avista electricity. An estimate of the number of EVs registered by Avista electric customers may be made by applying an approximate percentage of households served in each county to the total EVs registered. This percentage is currently



Sources: Washington and Idaho registration data; Bloomberg New Energy Finance Electric Vehicle Outlook, 2019 and 2020; "Economic & Grid Impacts of Electric Vehicle Adoption in Washington & Oregon." Energy and Environmental Economics (2017).

Appendix C: Stakeholder Engagement, Comments and Support

Development of the TEP followed from lessons learned during the EVSE Pilot, including insights gained through interviews and online surveys with customers, local stakeholder engagement, and best practices identified through networking at the state and national levels with organizations such as EEI, EPRI, ATE, Forth, leading industry representatives, and other peer utilities. As part of ongoing education and outreach efforts, the Company presents information to local organizations and solicits feedback regarding electric transportation programs in a number of forums and methods including webinars, in-person presentations, newsletters and bill-inserts, and will continue to do so as electric transportation markets and technologies evolve.

Following submission of the EVSE Pilot Final Report in October, 2019, the Company discussed lessons learned and high-level designs for the TEP with members of the joint TE stakeholder group in Washington State, including the Department of Transportation, Department of Commerce, and peer utilities, and presented to the group on November 14, 2019, at an in-person meeting in Olympia. Following submission of the draft TEP on March 10, 2020, a presentation to this group was made on April 1, 2020, soliciting helpful comments and suggestions.

On December 19, 2019, a telephone Townhall was held with local Washington stakeholders including 36 commercial customers and local government representatives. Key points about electric transportation and findings from the EVSE pilot were presented as well as ideas and feedback for the TEP.

Following several meetings with local service organizations in 2018 and 2019, the draft TEP was discussed at a meeting with the Spokane Transportation Collaborative held on April 3, 2020. Next steps with this group include reconvening in the fall of 2020 to solicit specific proposals for electric transportation projects benefiting low-income customers in 2021, in partnership with local service organizations and resources.

In early 2020, several meetings were held with the Spokane Regional Transportation Council (SRTC), the City of Spokane, Urbanova, STA, and other local government representatives in discussions regarding the TEP and the grant opportunity through Washington State's Clean Energy Fund, administered by the Department of Commerce. A workgroup was formed and workshops were held with local stakeholders led by SRTC, receiving strong support from stakeholders including the Spokane Tribe, Spokane International Airport, and the cities of Spokane, Spokane Valley, Cheney, Liberty Lake, and Airway Heights. This culminated in a grant application with a multi-year, regional EVSE buildout plan for Spokane County, including emphasis of innovation, education and outreach, and community and low-income benefits. The grant application proposals are in close alignment with the TEP, utilizing Avista EVSE investments as well as STA electrification investments as matching funds. If awarded, grant funding would provide a significant boost for beneficial EV adoption growth, electrified transit, benefits for low-income customers and learning in the region, and strong working partnerships and collaboration.

Regarding understanding and support for transit bus fleets, Avista and STA have held frequent meetings discussing electric transportation for several years, and Pullman Transit has been consulted as well to ensure the TEP effectively supports electrification of transit buses.

Following the draft TEP submitted March 10, the Company received questions, comments and support letters from a number of stakeholders (attached below). Followup discussions were held regarding these questions and comments with WSU, Climate Solutions, Renewable Hydrogen Alliance, NW Energy Coalition, Public Counsel, and UTC staff. A number of concerns and clarifications were discussed and addressed, including:

- consideration for a residential EVSE lease or rebate program in the future
- integrated management across TEP programs
- more detailed modeling of distribution system impacts as more data and forecasts are gathered, including "clustering" effects

- close ties to the Company's IRP and System Planning
- ensuring continued development of effective load management methods, particularly for residential charging
- more robust reporting requirements
- clarification of costs and benefits, especially as related to the IRP calculations
- consideration of hydrogen-powered EV technology developments
- encouragement to pursue school bus electrification
- strong support for education and outreach
- very strong support for programs benefiting disadvantaged communities and low-income customers, working with public transit in this regard, and the need to actively engage affected communities and groups in development and implementation of programs

In addition to stakeholder engagement in Washington, Avista has received many inquiries and requests from customers and stakeholders in Idaho regarding electric transportation issues and possible supporting programs in the State of Idaho for Avista electric customers. The Company is in the early stages of discussion with policy and regulatory staff in Idaho, in support of the TEP which must have a regional impact including programs appropriately tailored to Washington as well as Idaho territories, in order to be most effective.

May 14, 2020

SPOKANE REGIONAL HEALTH DISTRICT
1101 W. College Ave.
Spokane, WA 99201-2095
509.324.1500 | TEL
509.324.1464 | TDD
SRHD.org

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

Spokane Regional Health District (SRHD) is one of 34 local public health agencies serving Washington state. We have approximately 260 employees and serve a population of more than 500,000 in Spokane County. As a leader and partner in public health, we protect, improve, and promote the health and well-being of all people through evidence-based practices. In 2018, we were granted an electric vehicle (EV) by Avista through their Transportation Electrification program to help serve our clientele. We found that this grant was a great asset in transporting our clientele as well as brought transportation savings to our agency.

SRHD provides services to the people in Spokane County with some regional responsibilities, such as the Breast, Cervical, and Colon Health (BCCH) program and HIV Medical Case Management (MCM) serving 10 counties. We serve low income clients on Medicaid in our Women, Infant, and Children program; Opioid Treatment Services; Nurse Family Partnership; BCCH; MCM; HIV/STD Prevention services; and more. The number of clients served in each of these programs range from 180 up to 8,000 low income individuals.

The primary program using the EV is our HIV Medical Case Management (MCM). This program serves about 400 persons living with HIV/AIDS (PLWHA). The EV makes it possible to transport our clients to their medical and community support appointments, which staff were not allowed to do in their personal vehicles. Clients have household incomes at or below 400% Federal Poverty Level (FPL) with half at or below 138% FPL, who without medical transportation would miss or delay important medical, mental health, and other support service appointments resulting in poorer health outcomes. About 13% of these individuals are unstably housed or homeless. We use the vehicle to transport the clients to search for housing, which has been very successful in assisting clients in a low vacancy market. We also utilize the vehicle to deliver food to homebound individuals. When transporting clients, staff heard from them that this was the first experience they had with an EV.

The EV has produced cost savings for our case management program. The employee mileage reimbursement costs have been reduced by 60%, because staff are not driving their own vehicles for work purposes. Our client Lyft transportation program has a cost savings of over $1,000 a year as we are not having to utilize this program.

In addition, the staff found that charging the EV at SRHD is very convenient and easy to do. Throughout our EVSE grant program, we meet with Avista and other stakeholders quarterly to discuss our findings and the benefits to our agency with having access to the EV. The following year our agency discussed plans on purchasing a second EV because of the great successes we encountered through this grant.

SRHD highly supports Avista's Transportation Electrification Plan. We can successfully support the transportation needs of our low-income clientele, introducing many to an EV for the first time. We found the use of the EV very cost effective, reducing the overall program transportation costs significantly. In addition, SRHD is considering purchasing a second EV, because of the successes we experienced through the Avista grant.

Sincerely,

Amelia E Clark

Amelia Clark,
Administrator

SPOKANE REGIONAL TRANSPORTATION COUNCIL
421 W. RIVERSIDE AVE SUITE 500 • SPOKANE WA 99201 • 509.343.6370 • WWW.SRTC.ORG

May 20, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey WA 98503

RE: Avista Corp. Transportation Electrification Plan

Dear Commissioners:

The Spokane Regional Transportation Council (SRTC) serves all jurisdictions within Spokane County for transportation planning services. SRTC has a federal designation as the Metropolitan Planning Organization and the state designation as the Regional Transportation Planning Organization. Our mission is to coordinate and collaborate across the region on various transportation plans, programs and policies. We strive to bring regional leadership, innovation and inclusiveness in the movement of people and goods in our region.

SRTC believes in a collaborative approach to transportation electrification to aid in market transformation and adoption. The SRTC Board of Directors will consider the goals and objectives outlined in the Transportation Electrification Plan to be adopted into the long-range Metropolitan Transportation Plan for Spokane County.

SRTC is currently working with Avista on a multi-jurisdictional grant application to leverage efforts and bring additional funding for electric vehicle supply equipment to the region. Avista has shown exemplary leadership and innovation in electrification and we look forward to a cooperative and supportive partnership.

Sincerely,

Sabrina C. Minshall

Sabrina C. Minshall, AICP
SRTC Executive Director
sminshall@srtc.org

City of Airway Heights • City of Cheney • City of Deer Park • Town of Fairfield • Town of Latah • City of Liberty Lake
City of Medical Lake • City of Millwood • Town of Rockford • Town of Spangle • Spokane County • City of Spokane
City of Spokane Valley • Town of Waverly • Spokane Airport Board • Spokane Transit Authority
Washington State Department of Transportation • Washington State Transportation Commission

PO Box 218, W 405 California St. | Garfield, WA 99130 | **Phone:** 509.635.1604
Fax: 509.635.1201 | garfield-town@completebbs.com | www.garfieldwa.com

May 7, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

Re: Avista's Transportation Electrification Plan

Dear Commissioners:

We are submitting this letter on behalf of the Town of Garfield in Whitman County. In Garfield we aspire to provide a friendly and peaceful place to reside with a housing market that is economical and diverse. Many of our adult residents who live in Garfield, drive between 20 and 40 miles each way for their daily commute.

Many of Garfield's residents are price sensitive when it comes to commuting to and from work and the cost of fuel in Garfield is typically 10% to 20% higher than fuel purchased in larger towns due to no competition. Once the price of electric cars decreases, there is a good chance that many residents will utilize the cost savings of an electric powered vehicle to get to their in-town destinations and employment. Currently there are 5 electric powered vehicles in this community of 600 people.

Avista has placed a fast charging vehicle electric charging station within the Town of Garfield. We were extremely excited they chose our park location to put this charging station and many residents and visitors express how happy they are to have this service within the town. When Washington State University is having their football games and other sporting events, many out of town tourist come through Garfield and this is a great service to provide them on their back routes to game day.

Avista does a wonderful job of fact finding and seeking out the services their clients need and want, and they put the time and energy into making their research become reality, even for small towns like Garfield. We fully support Avista in moving forward with this Transportation Electrification Plan and recommend approving the plan as presented.

Sincerely,

Jarrod Pfaff
Mayor, Town of Garfield
405 W California Street
Garfield, WA 99130

SPOKANE CITY COUNCIL
808 W. Spokane Falls Blvd.
Spokane, WA 99201-3335
(509) 625-6255

Breean Beggs
City Council President

April 20, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners,

We are writing to you today to formally state our support for Avista's Transportation Electrification (TE) Plan. The City of Spokane and Avista Utilities have had many partnerships over the years and always with the intent to make our community stronger and more resilient. We see this TE plan more as a regional transportation plan rather than simply belonging to one party, and we hope that the UTC will lend its support as well.

Electrifying the transportation sector is a vital step for Spokane in accomplishing both our greenhouse gas reduction targets as well as our 100% renewable energy goals. By partnering with Avista in this endeavor, we will be able to leverage City resources to make important infrastructure investments that are required to promote the adoption of electric transportation.

In light of the COVID-19 emergency response, it may not feel like the ideal time to consider transportation and energy policy. However, if this pandemic has taught us anything, it is the importance of being prepared for a future than looks different than what we are experiencing today. The decisions we make today, will impact the success of our community's collective health and wellbeing into the future. By partnering with Avista and supporting their Transportation Electrification plan, we ensure innovative new technology and renewable energy plays an important part of our economic development in Spokane, and a clean, safe, healthy world exists for future generations.

Sincerely,

Breean Beggs, City Council President

Candace Mumm

Candace Mumm, City Council Member

Lori Kinnear, City Council Member

Karen Stratton, City Council Member

Kate Burke, City Council Member

Betsy Wilkerson, City Council Member

May 8, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

I am writing to express my support for Avista's Transportation Electrification Plan. I represent Transitions, a Spokane based non-profit that works to end poverty and homelessness for women and children in Spokane through the operation of transitional housing sites, childcare facilities, and job training programs. Our actions as an organization are motivated by our four key values of Respect for Human Dignity, Community, Growth and Wellness, and Justice.

New Leaf is a program within Transitions that provides job training in the food service industry for women with barriers to traditional employment. The New Leaf Kitchen & Café programs blend education, hands-on work experience, and supportive services designed to help women gain the self-confidence and professional skills necessary for self-sufficiency. New Leaf has greatly benefited from Avista's transportation electrification program through the acquisition of a Mitsubishi Outlander hybrid vehicle and a vehicle charging station. As a food service enterprise, we are delivering wholesale and catering orders throughout the Spokane metropolitan area on a daily basis, and are making frequent trips to food distribution warehouses and restaurant supply stores to purchase supplies. Having an electric vehicle has reduced our fuel expenses, which allows us to redirect these funds toward our mission of ending poverty and homelessness. Further, we have used the vehicle to provide daily transportation between Hope House (an overnight shelter for women) and Women's Hearth, a day center for women experiencing homelessness. Many of these women are mobility challenged and face safety issues walking to and from these two facilities. The addition of this vehicle has allowed us the capacity to make this daily journey safer and more secure for women experiencing homelessness.

Furthermore, studies have shown that low-income communities disproportionately experience ill-health effects of vehicle emissions, such as asthma, cardio vascular problems and cancer due to living in proximity to busy transportation corridors and/or industrial sites. The transportation electrificaton plan supports the widespread adoption of electric vehicles through investment in infrastructure, encourages the adoption of electric fleet vehicles and lift trucks, and the use of electric buses along transit corridors. All of these steps will benefit the health and wellness of our participants and other low-income individuals throughout the region, in addition to the benefits we have enjoyed at Transitions.

Transitions has been fortunate enough to experience the benefits of vehicle electrification, and can attest to the cost savings that come with a reduced dependence on gasoline. Widespread vehicle electrification will also have immediate and tangible benefits to the health and wellness of the low-income communities we serve, and for these reasons we fully recommend the approval of Avista's transportation electrification plan

Sincerely,

Jamie Borgan

Program Director, Transitions New Leaf
3128 N. Hemlock
Spokane, WA 99205
jborgan@help4women.org
509-496-0396

CITY OF PULLMAN
Pullman Transit and Dial-A-Ride

775 N.W. Guy Street, Pullman, WA 99163
Transit (509) 332-6535 Dial-A-Ride (509) 332-5471
Fax (509) 332-6590 www.pullmantransit.com

May 5, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

Pullman Transit serves the public transportation needs of the City of Pullman, providing nearly 1.5 million rides each year. These services range from quick WSU student campus shuttles to a longer neighborhood commuter service, as well as carrying public school students to our local middle and high schools and a paratransit van service for the elderly and those with disabilities in the community. Until 2011, that service was provided entirely with carbon fueled emission vehicles.

Avista Corporation's Transportation Electrification Plan reflects our shared value of regional resources and in cautious future investments. Their guidance during our lengthy transition from diesel to electric hybrid vehicles has emphasized the benefits of reduced air pollution and greenhouse gas emissions, with lower fuel and maintenance costs as only a perk.

Now, with the administrative and field support of Avista personnel, we are beginning our facility electrical upgrade this summer to accommodate electric bus charging stations. While Pullman hasn't taken the autonomous electric vehicle leap, we did place the order for our first two fully electric buses this spring. This would not have been possible without the support and shared vision of Avista.

Beyond just transit interests, Avista also recently partnered with the City of Pullman for our new electric vehicle charging station/parking lot, strategically located at the WSU Visitor Center. Their major share in the funding of this project was key to its success.

We look forward to our continued work with Avista, and respectfully request approval of their Transportation Electrification Plan.

Sincerely,

Wayne Thompson
Transit Manager

Serving Community Transportation Needs Since 1979

GONZAGA UNIVERSITY | Office of Sustainability

May 22, 2020

Washington Utilities and Transportation Commission

621 Woodland Square Loop SE

Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

Gonzaga University, a Jesuit, Catholic, humanistic University located in Spokane, Washington is a leader in higher education sustainability. Sustainability and care for the planet is infused into our organizational mission, and since 2009, have been working to reduce our greenhouse gas emissions, achieving a 20% reduction in emissions over our baseline. Gonzaga University currently has four electric vehicle charging stations on our campus.

Providing robust electric transportation options for our employees and fleet vehicles is consistent with our missioned call to care for the planet. By encouraging employees to invest in vehicles that do not consume fossil fuels and developing the infrastructure for a future electrified University fleet, we are setting the stage for reduced greenhouse gas emissions and cleaner air for our community. Avista is a leader in transportation electrification, and Gonzaga University has already worked with their team on the installation of a rapid EV charger on our campus.

Avista's transportation electrification plan will help continue to catalyze a sustainable future for Spokane and the Inland Northwest. We recommend that the Commission approve the plan without reservation.

Sincerely,

Jim Simon

Director of Sustainability
simonj@gonzaga.edu
509-313-5571
Gonzaga University
528 E. Boone Ave
AD Box 81
Spokane, WA 99201

The City of Liberty Lake

OFFICE OF THE MAYOR

May 4, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

The City of Liberty Lake, is a small but rapidly growing City in eastern Washington, with a current population of 11,000. "Sustainable Resources" is one of the four pillars of the City's Strategic Plan, and an integral part of our community vision. We recognize the importance of a shift from fossil fuel-based transportation to cleaner, more sustainable transportation infrastructure, from both an environmental and a fiscal sustainability perspective. In 2017, the City of Liberty Lake partnered with Avista to install our first electric charging station in Town Square Park, and the City is currently part of a consortium seeking grant funding to expand the availability of charging infrastructure in the region. Over time, as a City, we anticipate investing in electric vehicle technology to meet our fleet needs.

A critical path to realizing the expansion of electrified transportation in our region is the expansion of Electric Vehicle Supply Equipment (EVSE). The City of Liberty Lake is very supportive of Avista's proactive plans to expand EVSE, and we recommend the approval the draft 2020 Transportation Electrification Plan as a blue print for achieving this outcome.

Please feel free to contact me by phone at (509) 964-1166, or by e-mail at sbrickner@libertylakewa.gov, should you have any questions or require additional information.

Thank you for your consideration.

Sincerely,

Shane Brickner,
Mayor

22710 E. Country Vista Dr., Liberty Lake WA 99019
Telephone (509) 755-6700 Fax: (509) 755-6713
www.libertylakewa.gov

City of Colville
Office of the Mayor
Ralph K. Lane, Jr.
Mayor

May 6, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

The City of Colville was involved in Avista's pilot program to have EV chargers installed in the City. We have two electric vehicle charging stations installed in two of our public parking lots. We have found that the electric charging stations are being used on a regular basis and help meet our City Council and Strategic Plan Goals.

- Colville is a community where people want to live and work.
- Colville effectively delivers services.
- Provide a high level of quality public services to the community.
- Improve the appearance of Colville's built environment.

The City of Colville fully supports Avista's Transportation Electrification Plan and looks forward to working with them in the future.

Sincerely,

Ralph K. Lane, Jr.
Mayor

CC: Randall Farley, P.E., Avista

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May 8, 2020

RenewableH2.org

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ITM Power
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Puget Sound Energy
Red Rocket Creative Design
Renewable Hydrogen Canada
Renewable Northwest
Tacoma Public Utilities
The Warren Group
Toyota Motor North America
TriMet
Vashon Climate Action Group
Warner Hydrogen

To: Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

The Renewable Hydrogen Alliance (RHA) appreciates this opportunity to provide comments on Avista's Draft Transportation Electrification (TE) plan.

Renewable Hydrogen Alliance

RHA is a non-profit 501(c)(6) organization based in Portland, Oregon. Our mission is to advocate using renewable electricity to produce climate-neutral fuels and industrial feedstocks. We engage in lobbying, promotion, and education about the critical role climate-neutral fuels from renewable power have to play in reaching climate goals and reducing dependence on fossil fuels.

Our membership represents gas and electric utilities, clean energy advocacy organizations, developers, consultants, law firms, and manufacturers of equipment related to the production and consumption of clean fuels including hydrogen fuel cell electric vehicles (FCEVs). Members of RHA include several NW utilities including Puget Sound Energy, Tacoma Power, Douglas County PUD, Klickitat County PUD, and NW Natural.

Avista's Draft Plan

RHA applauds Washington State's and Avista's focus on transportation electrification. Decarbonizing transportation is critical to meeting climate goals; in Washington about 40% of all carbon emissions are due to transportation, roughly half from on-road gasoline vehicles, half from diesel and heavy-duty applications. While battery electric vehicles (BEVs) are good replacements for many gasoline vehicles they are not suitable replacements in all transportation applications, particularly those involving high-duty cycles or greater energy densities—e.g., long haul heavy-duty transportation, marine applications, and aircraft.

Where BEVs are not suitable replacements, an equally important pathway for transportation electrification is producing fuels from electricity, principally

RHA Mission:
Promote using renewable electricity to produce climate-neutral hydrogen and other energy-intensive products that reduce dependence on fossil fuels.

(but not solely) hydrogen for use in FCEVs. Battery electric vehicles (BEVs) do have important advantages over FCEVs in some applications, but we urge Avista and the Commission to include FCEV electrification in the TE plan.

Importance of Fuel Cell Vehicles in Transportation Electrification

The absence of power-to-fuels in Avista's draft TE plan does not reflect the current state of development of FCEVs or of hydrogen production from renewable electricity. For example, there are already more than 25,000 hydrogen-powered forklifts in the US, more than 8,000 light-duty FCEVs in California, and about 50 hydrogen transit buses operating in the US. The city of San Bernardino, California, has ordered a hydrogen transit train, and a hydrogen ferry is under construction for San Francisco.

Europe is considerably farther ahead than the US in FCEV deployments. For example, the United Kingdom plans to change out its entire fleet of 100 diesel transit locomotives for hydrogen, Switzerland has ordered 1,000 medium-duty hydrogen trucks, and Denmark is getting 200 hydrogen buses.

Closer to home, Douglas County PUD has ordered a 5 MW electrolyzer—the device that produces hydrogen from electricity and water. That facility will produce enough hydrogen to fuel about 40 hydrogen transit buses. Most exciting is that the PUD intends to use the electrolyzer as an interruptible load that will serve as contingency reserve in place of reserves now held on their hydro project. In other words, this new interruptible load will free up 5 MW of capacity on their hydro system.

A key difference between serving BEV electric loads and FCEV loads is that the FCEV load is completely flexible and typically does not coincide with the time of vehicle fueling. This makes electrolyzer loads potentially very attractive interruptible loads for helping integrate renewable resources. Tacoma Power is considering a special rate for interruptible loads, recognizing the value to the utility of having an option to interrupt loads when system conditions or prices make it advantageous to the utility to do so.

Today, several RHA members have plans to build out hydrogen production and fueling stations in the Northwest, including Washington State. Both Toyota and Nikola Motor Company are eagerly looking to expand hydrogen fueling stations into the Northwest from California and British Columbia. RHA also sees special interest among ports, which are under pressure to reduce emissions and have applications for which FCEVs are particularly suitable.

May 8, 2020

RenewableH2.org

Conclusion

We strongly urge that Avista's transportation electrification plan include electrolytic fuels production. These fuels can electrify transportation markets that battery electric vehicles cannot reach with today's technology, and can potentially provide even greater benefits to Washington ratepayers. RHA is dedicated to bringing both renewable hydrogen and hydrogen transportation to the Northwest in the next one to two years. We look forward to seeing FCEVs represented in utility transportation electrification plans and to working with both the WUTC and Avista toward that end.

Sincerely,

Ken Dragoon

Ken Dragoon
Executive Director
k.dragoon@renewableh2.org
(503) 545-8172
Renewable Hydrogen Alliance
3519 NE 15th Avenue, #227
Portland, OR 97211

May 8, 2020

Avista
1411 E Mission MSC-4
Spokane, WA 99202

Re: Climate Solutions comments on Avista's draft Transportation Electrification Plan

Dear Rendall Farley,

Climate Solutions thanks you for the opportunity to submit comments and recommendations on Avista's Transportation Electrification Plan as proposed. Climate Solutions is a clean energy nonprofit organization working to accelerate clean energy solutions to the climate crisis. The Northwest has emerged as a hub of climate action, and Climate Solutions is at the center of the movement as a catalyst, advocate, and campaign hub.

The transportation sector is responsible for the largest share of both Washington and Idaho's greenhouse gas emissions and other toxic pollutants, making electrification of transportation a critical component of achieving Washington's statutory greenhouse gas limits and addressing climate change and air quality in both states.[1,2] Utilities are uniquely positioned to catalyze electric vehicle deployment through strategic investments in electric vehicle supply equipment and other services that facilitate widespread transportation electrification. Given customers' high trust in utilities, providing programs, education, and resources will also help accelerate the transition to cleaner transportation powered by clean electricity.

Climate Solutions is very supportive of Avista's decision to create and implement this Transportation Electrification Plan. We are excited about its scope and encourage its adoption given that the benefits of implementing this plan will be significant. We also have some suggestions on how to augment or implement programs in the plan which we hope will be considered as the utility creates a final plan for submission to the Utilities and Transportation Commission. These recommendations are described in detail below.

General comments on the plan as proposed

According to numerous greenhouse gas reduction pathways studies (see the "Deep Decarbonization Pathways Analysis for Washington State" and "Meeting the Challenge of Our Time: Pathways to a Clean Energy Future for the Northwest"), on-road transportation must be nearly completely electrified, relying on power from a clean grid, by 2050 in order to meet greenhouse gas reduction goals. In addition to this imperative, the electrification of transportation has numerous health and economic benefits. Currently, over 1,000 Washingtonians die

[1] Washington Department of Ecology, "2017 greenhouse gas data." https://ecology.wa.gov/Air-Climate/Climate-change/Greenhouse-gases/2017-greenhouse-gas-data.
[2] Idaho Department of Environmental Quality, "Greenhouse Gases." https://www.deq.idaho.gov/air-quality/air-pollutants/greenhouse-gases/.

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annually as a result of air pollution—much of which would be eliminated by switching to electric vehicles.[3] And as Avista's plan notes, "if all light-duty vehicles were electric, this would result in regional savings of over $1 billion per year."

As the plan correctly states, due to electric vehicles reaching cost parity in the next few years, we will see accelerated growth starting as early as 2023. Washington already has the second highest rate of electric vehicle penetration, and penetration will continue to grow as we achieve cost parity.[4] It is critical that utilities take a lead role in planning for the transition to electrification in order to maximize customer benefits of electrification and minimize potential impacts to the grid. In order to support high levels of electric vehicle adoption, the groundwork in terms of electric vehicle supply equipment (EVSE), education, demand management strategies, equitable access, and more must be laid now. Avista is rightly focusing on near-term actions to support transportation electrification, and we encourage ambition in order to assure that the region benefits as much as possible from this shift.

Given the rapidly changing technology landscape, we strongly suggest that plans are iterative and can be reevaluated and adjusted during the evaluation for the mid-year reports. A lot can change in five years in the transportation electrification sector, and we want to ensure that Avista's programs and plans can adjust to a changing landscape. Since utility support is so important for the advancement of transportation electrification, we encourage frequent plan iteration and updates to ensure it is updated in alignment with shifting contexts.

Guiding Principles
Climate Solutions is in broad agreement with the guiding principles listed in the draft plan. We would like to specifically emphasize and comment on three of the principles listed.

Grid integration and net benefits
We are glad to see that grid integration that provides net benefits for all customers is listed as a principle. Washington's Deep Decarbonization Pathways Study found that the share of energy coming from the electricity sector could more than double as we electrify current uses of fossil fuels.[5] As Washington moves forward with decarbonizing and electrifying the transportation sector, it is important that utilities are able to manage peak demand and avoid new investments in fossil fuel resources as we transition to a 100% clean energy grid under the Clean Energy Transformation Act. As a part of this transition, utilities will need to work to integrate the variability of renewables and electrification.

In determining the net benefits stemming from programs, and in prioritizing programs, we encourage Avista to look at benefits comprehensively. In addition to evaluating the economic impacts to ratepayers, Climate

[3] Puget Sound Clean Air Agency, "Air Pollution & Your Health." https://pscleanair.gov/161/Air-Pollution-Your-Health.
[4] U.S. Department of Energy Alternative Fuels Data Center, "Electric Vehicle Registration Counts by State." https://afdc.energy.gov/data/10962.
[5] Evolved Energy Research, "Deep Decarbonization Pathways Analysis for Washington State." https://www.governor.wa.gov/sites/default/files/Deep_Decarbonization_Pathways_Analysis_for_Washington_State.pdf.

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Solutions strongly suggests the broader social impacts, the social cost of carbon, and the public interest are considered in order to better select and prioritize projects. The Washington State Legislature, in the Clean Energy Transformation Act, stated:

> *the public interest includes, but is not limited to: The equitable distribution of energy benefits and reduction of burdens to vulnerable populations and highly impacted communities; long-term and short-term public health, economic, and environmental benefits and the reduction of costs and risks; and energy security and resiliency.*[6]

Programs that allow the benefits of transportation electrification to be more widely and deeply felt in environmental, economic, and health terms across populations, and especially by highly impacted communities, should be prioritized and these wide ranges of benefits should be evaluated.

Cost-effective, integrated management

Load management strategies to avoid large increases in peak demand should be a critical component of utility strategies to electrify the transportation sector. As the draft plan notes, Avista found that each electric vehicle without managed charging presents net benefits, but with managed charging, those benefits are 28% greater. Even in cases where an individual utility would experience minimal impacts from increased electrification, well managed loads by one utility will contribute to broader system flexibility and ease regional resource adequacy impacts, as well as showcase overall best practices. Therefore, we strongly agree with including demand management into all program offerings under this plan.

We are extremely supportive of Avista's plan to offer a pilot commercial TOU rate starting next year, and to follow that with a residential TOU rate pilot, among other demand management strategies listed. As the plan notes, demand charges are a noted impediment to electrification, particularly of larger, commercial vehicles and fleets, and replacing these with a TOU rate would greatly assist customers in transitioning their fleet and reducing the pay-back period for electric vehicle purchases. Traditional rates can in fact eliminate financial benefits from electric vehicle ownership, preventing customers from experiencing the potential financial, health, environmental, and social benefits mentioned above. Avista's pilot TOU offering will be a crucial tool in enabling electric vehicle adoption and for studying best rate practices for transportation electric vehicles.

Partner and collaborate with key stakeholders

Working with a variety of different stakeholders that bring unique perspectives will be crucial for achieving widespread electrification of electrification. We would like to particularly highlight the importance of partnering with organizations who have strong community ties, a high level of trust within the community, and those that are identified as highly impacted communities within Avista's service area. The Clean Energy Transformation Act clearly states that all customers must benefit from the transition to clean energy, and it is important that this sentiment also apply to utility transportation programs as well. Therefore, communities should be involved in the

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[6] RCW 19.405.040. https://app.leg.wa.gov/RCW/default.aspx?cite=19.405.010.

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decision-making process for determining what programs that would directly benefit them would look like. We are aware that Avista has already developed strong partnerships with community service organizations in its area and we would strongly encourage these partnerships to be further fostered and expanded. Given that Avista will be spending up to 30% of transportation electrification funding on community and equity-related programs, it is extremely important that these programs are well-designed so they have the desired impact; doing so will require partnerships and collaboration with those who have deep community ties and can advise on what will be beneficial and popular in the community. Obtaining community trust and support is crucial for transportation electrification programs to succeed and provide benefits to all utility customers. After all, if people are wary and have not bought into the program's purpose, and if they do not see how a program will benefit them, they will rightfully be uninvolved or resistant. Everyone should be able to reap the direct and benefits of transportation electrification. Therefore, working with trusted community partners and organizations to ensure that offerings meet community needs and desires is extremely important. We would also suggest that community support is integrated either into this principle or as its own and that a related point is added to the strategic objectives and goals: for example, under the fleet electrification support, working with a determined number of community partners.

Programs and activities

EVSE installations and maintenance

- *Public charging*

Public charging stations play an important role in advancing electric vehicle adoption, not only because they provide a needed resource, but also because they provide more visibility for the technology and assurance that charging is available, alleviating anxiety for potential electric vehicle purchasers. As electric vehicles become more accessible, the infrastructure to support them must as well—especially for those who do not have the ability to charge at home. Experts believe that, as more people utilize electric vehicles, the ratio of these vehicles to public charging stations should be between ten and twenty electric vehicles per station.[7] Polling also indicates that one of the largest concerns about purchasing an electric vehicle is charging infrastructure, with half of drivers worrying about finding a charging station.[8]

Avista should help provide the visible resource of public DCFC fast charging by working with partners as detailed in the plan. We agree that there is a need for some public fast charging in sites that will support both intra-city and longer distance travel, and that Avista-owned chargers should complement those offered by third-parties and thus expand coverage to the benefit of all by provided needed infrastructure and visibility. We would also suggest that gas stations may be an interesting partnership to pursue since siting public chargers at these businesses would provide an element of routine to new electric vehicle drivers, would be a visible site for those who do not currently own an electric vehicle, and would potentially bring customers to partnering businesses.

[7] EVAdoption, "What is the 'Minimum Acceptable' Ratio of EVs to Charging Stations?" https://evadoption.com/what-is-the-ideal-ratio-of-evs-to-charging-stations/.

[8] Green Car Reports, "Poll suggests more Americans might buy an EV—if only they had a place to charge" https://www.greencarreports.com/news/1121698_poll-suggests-more-americans-might-buy-an-ev-if-only-they-had-a-place-to-charge.

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We encourage Avista to explore potential partnerships like this to ensure that DCFC fast charging is accessible to those who need it within its territory, and to more broadly provide visibility for electric vehicles.

Public level 2 charging is also an important resource, for which siting considerations are different than for DCFC fast charging. Listening to customer feedback on where this charging type should be sited will be crucial to ensure that chargers are sited where they will be utilized. We suggest considering siting near multi-family buildings where residents may not otherwise have charging access, especially in buildings that do not have dedicated parking for all residents.

- *Workplace, fleet, and MUD AC level 2 charging*

Offering workplace, fleet, and multi-family dwelling charging access is important to ensure that electric vehicle access isn't limited to those who have the capability to charge vehicles at home. The inability to do so is a significant barrier to electric vehicle adoption. However, many people may not have access to parking where a charger may be sited, or, if they rent, they do not have the ability to install a charger. Although the availability of workplace charging is often viewed as an employee benefit, building owners may be concerned about increased electricity usage. We appreciate that Avista will offer ways of addressing this split incentive by helping cover costs, and that there will be options for utility-owned *or* third-party-owned EVSE. This will provide customers important choices, both of which have benefits, and spur beneficial competition. We are glad Avista will be incorporating demand management into this program as well. We also think this would be an opportunity to partner with affordable housing entities, thereby providing direct benefits of electrification to lower-income residents and helping achieve the plan's goal of up to 30% investment targeting disadvantaged communities and customers.

- *Residential AC level 2 charging*

Avista providing EVSE and partially covering wiring costs will likely support electric vehicle uptake, given reduced costs, provided that this program is well-publicized, including through dealer engagement. We are glad that off-peak charging will be facilitated and other demand management strategies will be tested. It is also important for customers to be offered choices in EVSE and program offerings. We encourage Avista to consider the potential future lease and rebate programs mentioned in the plan, as well as other EVSE ownership options in order to maintain flexibility and customer choice. Utility ownership provides a number of benefits, including technology support and maintenance, but it is also important that customers not be forced into one option.

Education and outreach

Avista has an important role to play in educating its customers about transportation electrification, thereby encouraging uptake of these technologies. Avista already has an established relationship and frequently communicates with its customers. This means the utility has a particular opportunity to educate its customers. Given their importance, we encourage Avista to be ambitious in its education programs.

Engagement with dealers is an important part of education and outreach, and we are happy to see the plan includes this. According to research done by Cox Automotive, the dealer had a strong influence on almost three-

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quarters of decisions to purchase an electric vehicle. At the same time, customers expect dealers to offer support such as detailed cost comparisons, charger maps, and assistance with arranging home charger installation—items that dealerships are rarely offering currently.[9] A recent investigation showed that around a third of dealerships did not provide any information on charging infrastructure and available incentives, and two-thirds of dealerships did not display electric vehicles prominently.[10] There is an opportunity for Avista and dealerships to collaborate on providing customers these resources that will help them feel more comfortable purchasing an electric vehicle. Other utilities in Washington have had success with dealer referral rewards, so we believe these would be successful for Avista as well and are glad to see them in the plan.

In addition to engaging with dealers, the plan includes engagement with customers and the general public. An EV Experience Center as described in the program could provide valuable information for potential purchasers and we would encourage that as much hands-on experience as possible that can be offered, such as ride-and-drives and EV rentals, be included. We also suggest that Avista consider partnering with other companies and organizations that engage in electric vehicle education to expand its reach and impact. The plan also mentions potentially siting charging for on-demand Transportation Network Company (TNC) drivers at such a center; if located in a convenient location, this could provide additional visibility for vehicle electrification. Furthermore, working with TNC drivers to electrify is an important fleet electrification opportunity. Often drivers cannot afford the current upfront cost of electric vehicles, but given the lower cost of fueling electrification and the high mileage of these vehicles, drivers would very quickly recoup costs as long as charging is available to them (there is a clear connection to DCFC fast charging programs mentioned above). Therefore, we are excited that Avista will deploy a pilot program to support TNC fleet electrification, especially since it will lead to amplified benefits given other, complimentary program offerings. We also suggest that demand management strategies and technologies are incorporated into these programs.

We also want to emphasize that in addition to collaborating with dealers, EV Experience Center visitors, and customers as a whole, Avista should make a concerted effort to reach out to community partners and organizations in vulnerable communities. Proactive efforts will need to be made to ensure that information about electric vehicles is heard by everyone, and that the information is communicated in a way that is responsive to community needs and desires—working with trusted community organizations can help ensure this is the case.

Community and equity

Transportation electrification provides significant health and economic benefits that everyone should have access to. It is imperative to ensure that low-income communities and communities of color, who are already

[9] Cox Automotive, "Evolution of Mobility: The Path to Electric Vehicle Adoption." https://d2n8sg27e5659d.cloudfront.net/wp-content/uploads/2019/08/2019-COX-AUTOMOTIVE-EVOLUTION-OF-MOBILITY-THE-PATH-TO-ELECTRIC-VEHICLE-ADOPTION-STUDY.pdf.

[10] Sierra Club, "Rev Up Electric Vehicles: A Nationwide Study of the Electric Vehicle Shopping Experience." https://www.sierraclub.org/sites/www.sierraclub.org/files/press-room/2153%20Rev%20Up%20Report%202019_3_web.pdf.

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disproportionately impacted by air pollution and have fewer resources to mitigate harms, experience both direct and indirect benefits from transportation electrification.[11]

As discussed above, for programs to truly have an impact, they have to address barriers faced by the community and provide options that they want. That is why it is important to work with partners that are trusted by the community. We are glad to see that Avista intends to partner with others including the Spokane Transportation Collaborative and can also build on its previous, successful pilot programs with two community service organizations. Additionally, as already mentioned, helping TNC drivers access electric vehicles is important. It is important to note that not only may drivers serve disadvantaged communities, but many TNC drivers are themselves low-income, and being able to drive a vehicle with lower operation costs would be a tremendous benefit.

We would also like to highlight the importance of medium- and heavy-duty electrification in relationship to its benefits for vulnerable communities. Lower-income communities and communities of color are more likely to live in areas that experience higher air pollution, much of which comes from vehicle travel. Diesel emissions from medium- and heavy-duty vehicles are particularly harmful. Promoting the electrification of these vehicle classes will provide health benefits.

Overall, we urge Avista to consider community and equity not just as a standalone item, but to incorporate it into other programs. For example, when working with transit agencies or school districts, prioritize routes for electrification that go through vulnerable communities and areas with poor quality. Or, when engaging with dealerships, ensure that used electric vehicles are included in their promotion efforts, and that they count toward the referral program.

Commercial and public fleets

As mentioned above, fleet electrification and electrification of medium- and heavy-duty vehicles is a significant opportunity, since these vehicles are one of the largest sources of poor air quality that leads to negative health impacts, particularly in low-income and vulnerable communities. In addition to supporting the near-term electrification of light duty fleets and forklifts followed by commercial delivery vehicles as stated in the plan, we encourage Avista to explore opportunities for electrifying larger vehicles such as garbage trucks. Though some applications are currently more prevalent and achievable than others, it is also reasonable to assume that, given the significant operational cost savings, these vehicle types will become more common. It will be important to be prepared and have the groundwork laid to support their deployment. Utility programs and rate designs tailored towards medium- and heavy-duty electrification will be essential to ensuring broad grid benefits are realized, and utilities avoid unnecessary upgrades to the grid, instead receiving grid benefits from controlled use patterns.

[11] Washington State Department of Health, "Washington Environmental Health Disparities Map." https://fortress.wa.gov/doh/wtn/WTNIBL/.

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Rate structures that effectively encourage off-peak charging may be different for heavier vehicles, compared to light-duty electric vehicles. Alternative components of rate design beyond the price of energy, such as non-coincidental demand charges and line extension policies, often impede large-scale deployment of heavy-duty electrification rather than incentivize it. Climate Solutions strongly supports the pilot commercial and residential TOU programs and other load management experiments listed in the plan that will help determine the best demand management strategies for different contexts, and encourages the utility to continue analyzing innovative rate structures and designs that encourage smart transportation eelctrification. For commercial transportation electrification, research indicates that removing demand charges and implementing TOU rates are effective in promoting off-peak charging and help customers more affordably transition their fleets.[12] Avista's proposed pilot aligns with these best practices. Electrification of medium- and heavy-duty vehicles can provide tremendous benefits to community health and to the grid, if managed well, making such programs important in the short-term so as to achieve long-term benefits.

Just as it is important for Avista to set a good example by electrifying its own fleet and supporting employees in driving electric (under the Utility Fleet Electrification, Facilities and Employee Engagement program), it is also important for municipalities to do the same. For example, the City of Spokane has committed to the purchase, conversion to, and use of electric vehicles.[13] We recommend that Avista partner with municipalities in its territory and assist them with electrifying their fleets and providing the requisite charging infrastructure for operations and for employees who drive to work.

Climate Solutions is excited to see Avista's plans to design and pilot programs for school buses and mass transit. In addition to their climate benefits, electric school buses protect children from harmful air pollution that they are particularly susceptible to given their age. One study found that children inside of a diesel school bus may be exposed to as much as four times the level of toxic diesel exhaust as someone riding in a car ahead of the bus--pollution that puts them at significant cancer risk.[14] There are other benefits as well: for example, bus drivers have credited the quiet electric buses with reducing their stress levels. As Avista works on the school bus pilot, it should utilize the ensuing success stories as an educational opportunity for other districts and entities. Sharing these stories will help others realize the wide-ranging benefits of transportation electrification as well as showcase that the technology is available and within reach today.

Working with transit agencies to electrify their fleet is another important program offering, as well as an opportunity to explore how to best integrate charging of heavier-duty vehicles onto the grid. We encourage Avista to work with transit agencies to determine rate structures and other management techniques that are mutually beneficial as a part of its commercial pilot TOU rate. Climate Solutions is very supportive of Avista's work on this pilot, and we are excited that the utility plans to roll it out next year. As the plan notes, Spokane

[12] Synapse Energy Economics, Inc., "Best Practices for Commercial and Industrial EV Rates." https://www.nrdc.org/sites/default/files/media-uploads/best-practices-commercial-industrial-ev-rates_0.pdf.
[13] Spokane Municipal Code 15.05.050. https://my.spokanecity.org/smc/?Section=15.05.050.
[14] Gina M. Solomon, et al., "No Breathing in the Aisles: Diesel Exhaust Inside School Buses." https://www.nrdc.org/sites/default/files/schoolbus.pdf.

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Transit Agency, which is in the process of purchasing battery electric buses, currently estimates that 45% of associated electricity bills will come from demand charges. In addition, the electrical infrastructure for larger customers will likely often require capacity upgrades or extensions. Avista should be a ready and willing partner in this regard for transit agencies and other medium- and heavy-duty customers.

Conclusion

Thank you again for the opportunity to provide comments on Avista's Transportation Electrification Plan as proposed. Climate Solutions greatly appreciates the efforts of the utility in developing this plan to increase the adoption of widespread transportation electrification and we support its approval. We also recommend incorporation of the above suggestions as programs are being implemented. Specifically we believe the following are important overarching goals:

- Incorporate demand management into all programs
- Closely partner with community organizations to determine community barriers, needs, and desires related to transportation electrification
- Ensure that low-income and vulnerable communities benefit directly and indirectly from programs and play a role in shaping programs
- Support electrification of medium- and heavy-duty vehicles
- Continue providing education and outreach to customers
- Incorporate community feedback and learnings from implementation and pilots into programs as an iterative process and ensure timely updates given the rapidly changing technology landscape

We are excited by the significant opportunity that transportation electrification poses in reducing pollution and maximizing grid efficiencies, and believe utilities will play a significant role in the transformation of our transportation sector. We look forward to further engagement as these programs are implemented and as a part of the mid-period report, program iterations, and future plans.

Sincerely,

Leah Missik
Washington Transportation Policy Manager
Climate Solutions

Kelly Hall

Senior Policy Manager
Climate Solutions

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NW Energy Coalition

for a clean and affordable energy future

May 8, 2020

RE: Avista Transportation Electrification Plan (DRAFT), Request for Stakeholder Comments

Dear Rendall Farley,

The NW Energy Coalition appreciates the opportunity to provide input on Avista's draft Transportation Electrification Plan in advance of filing with the Washington Utilities and Transportation Commission. The Transportation Electrification Plan (TE Plan) includes a wealth of information and strong evaluation of current market conditions. We commend Avista's efforts to advance transportation electrification, especially Avista's plan to achieve 50% peak load reduction from light-duty EVs with net grid benefits by 2025. We believe several components of the plan are designed in a manner to provide long-term benefits to customers and we suggest additional perspective and modifications to help scale Avista's TE portfolio and meet customer needs, as detailed below.

Technology and Markets

Avista's TE Plan provides a detailed overview of the current transportation electrification (TE) market both globally and in Avista's service territory. This section illustratively demonstrates Avista's commitment to monitor market conditions and obligation to serve existing and future customers in a reliable, clean, and affordable manner as well as to support market transformation. In order to do this, we recommend:

1. Avista include a subsection highlighting public charging retail rates, payment options, and fees to better understand what and how customers are expected to pay for electricity through 3rd party providers.
2. Page 29 briefly mentions the opportunity to work with Tesla to provide additional Tesla compatible DCFC. NWEC agrees that Tesla is a popular vehicle choice but recommends caution when investing ratepayer dollars to support Tesla charging networks, infrastructure only available to Tesla drivers. We want to reiterate that investments would need to provide greater utilization, beneficial utility revenue AND support charging for all vehicle types in order to maintain connector interoperability.

Environmental, Economic, and Grid Impacts

Distribution Grid Impacts:

NWEC finds Avista's distribution grid impact analysis interesting in that it is projecting higher costs associated with the need for additional generation capacity but minimal distribution grid impacts from transportation electrification. The distribution grid impacts scenarios are modeled under the assumption that EV adoption will be random and equally disperse across Avista's distribution system, but EVs are typically found in clusters and it is likely that higher power fast-charging at future EV fleet locations will trigger location specific impacts to Avista's distribution system.[1] We recommend Avista conduct a distribution system impact analysis that includes: (1) clustered electric vehicle charging scenarios; (2) targeted locations where large EV fleet and medium- and heavy-duty EV charging of greater than 1 MW is anticipated; and (3) strategies to couple TE demand side management with targeted energy efficiency and demand response. The analysis should be acknowledged in Avista's Analysis and Reporting section (pg. 50) and should be included with Avista's mid-period report.

Downward Pressure on Rates:

E3 and Avista's economic models project net benefits to customers due to incremental revenue from electricity sold to serve new EV load. Can Avista discuss how this is anticipated to interact with Avista's decoupling mechanism and the potential for downward pressure on rates for different customer classes?

Costs and Benefits

The economic and environmental costs and benefits included in the section titled, Environmental, Economic, and Grid Impacts, illustrates both regional and customer costs and benefits. Avista looks at a regional cost-benefit perspective and a customer cost-benefit perspective for light-duty EVs both with and without managed charging. NWEC is supportive of Avista's efforts to pursue managed charging opportunities of reasonable cost to realize the benefits outlined in the TE Plan.

Program Cost-Effectiveness:

Docket UE-160779, Policy and Interpretive Statement Concerning Commission Regulation of Electric Vehicle Charging Services, allows utilities to perform Societal Cost Tests to inform program design. Avista quantifies total cost of ownership savings for customers, GHG emissions savings, and utility costs to serve transportation electrification load. We find this to be very informative in evaluating program costs and benefits and we want to encourage program design that is informed by a comprehensive cost and benefit analysis rather than the sole use of traditional energy efficiency cost effectiveness tests to deem transportation electrification program portfolios cost effective.

Widespread adoption of transportation electrification is facing market transformation challenges. These challenges are similar to those that face new energy efficiency technology, and the rationale behind market transformation programs for energy efficiency – programs that help scale up the market. Utilities should be promoting market transformation for transportation electrification and ensuring that direct and indirect benefits accrue to all utility customers. The early stage of the market means transportation electrification is still an infant industry and traditional cost-benefit tools should not be applied.

Estimated Costs:

Page 46, Table 5 is pulled from the 2020 Electric Integrated Resource Plan and includes values that, to NWEC's knowledge, have not been reviewed by the Washington UTC. This table includes a "clean premium" that is used to estimate Avista's anticipated incremental cost to

[1] https://ieeexplore.ieee.org/document/8732007

comply with CETA in Washington. Can you share what this table was meant to represent in the original IRP, what assumptions were made and how Avista calculated this cost?

Page 47, Table 7 includes customer transportation fuel and maintenance cost savings. What assumptions are made about electricity costs in this calculation?

Avista's plan acknowledges that future updates to the TE Plan will include costs and benefits from other market segments beyond light-duty EVs. NWEC understands certain TE markets are still in early stages in Avista's service area and we strongly encourage Avista to include medium- and heavy-duty EV costs and benefits, including considerations for port, off-road, and agricultural applications, in the mid-period report, additional program filings, and future updates to the TE Plan.

Analysis and Reporting

NWEC is comfortable with Avista's proposal to re-issue the TE Plan every 5 years with the understanding that new program filings and program filing updates may and should be submitted on an on-going basis and that the mid-period report will provide comprehensive updates. We support the proposed metrics to monitor and report and strongly recommend adding:

- Stakeholder engagement – utility performance related to outreach to and participation of vulnerable populations in highly impacted communities as defined in the Clean Energy Transformation Act, low-income service providers, community-based and community service organizations, non-profit organizations, small businesses (particularly minority and women owned businesses), and tribes related to TE.[2]
- Direct and indirect benefits to low-income customers. Direct benefits mean a low-income customer or an entity directly serving low-income customers participated in a utility program and it resulted in cost savings, access to electric transportation technology, and an increase in reliable and affordable mobility due to utility TE investments. Indirect benefits mean low-income customers experience better air quality due to avoided GHG pollution and downward pressure on rates associated with utility TE investments.

Programs and Activities

EVSE Installations and Maintenance:

Public DCFC and AC Level 2 –

- NWEC is supportive of Avista's proposal to own and operate 30 public DCFC or half of the anticipated public DCFC needed to meet customer needs and 12 new AC Level 2 sites per year through 2024. Avista should not exceed 50% of the DCFC need and should ramp down public charging commitments if 3rd party ownership ramps up.
- We recommend Avista adapt their public charging retail rate to include an on-peak charging price to help shift load to off-peak periods and reduce the need for additional generation capacity (Portland General Electric uses an on-peak charging price for utility owned public charging, Schedule 50).[3]

[2] http://lawfilesext.leg.wa.gov/biennium/2019-20/Pdf/Bills/Session%20Laws/Senate/5116-S2.SL.pdf?q=20200506110601

[3] https://www.portlandgeneral.com/our-company/regulatory-documents/tariff

- We strongly support the inclusion of credit-card readers at public charging stations and encourage the use of multiple payment options to help support accessibility.
- We encourage Avista to work with city and county planners and stakeholders to prioritize public charging locations in areas that are not conveniently accessed by public and active modes of transportation.
- Avista should not use or allow time-based rates at AC Level 2 sites as older EVs often have lower capacity on-board chargers and therefore certain drivers pay more for electricity. Utilities should use the EVSE rules in the California Code of Regulations (4002.11. Electrical Vehicle Fueling Systems. (3.40.)) as guidance in developing unit prices and methods for communicating prices.[4]

Workplace, Fleet and MUD AC Level 2 –

- NWEC is supportive of Avista's efforts to support workplace, fleet, and MUD AC Level 2 charging. We are interested in the potential benefits of evaluating fleet incentives separately. Due to a more predictable use case for fleets, Avista could create fleet categories that correspond with anticipated incremental revenue from TE fleet investments in specific fleet categories. Avista could then develop incentives for fleet categories commensurate with the benefits they are expected to provide.

Residential AC Level 2 –

- NWEC is generally supportive of residential programs, particularly ones that support managed charging, but we request Avista provide an explanation for why utility ownership is the best model for this program.
- We are very concerned that Avista intends to install non-networked EVSE as it does not support flexible, future load management program design. Avista reported in their Electric Vehicle Supply Equipment Pilot Final Report that switching EVSE manufacturers resulted in "greatly improved connectivity" and demonstrated an aggregated "49% drop in peak demand compared to the uninfluenced load profile." [5] This pilot demonstrated successful outcomes and we cannot support this element of the plan unless it includes networked charger installation so the utility can remain flexible with future demand side management program options.

Education and Outreach:

We are supportive of utility investments in education and outreach, especially efforts that are designed to educate customers on beneficial charging behavior, and would like to raise the follow comments and questions:

- How is Avista justifying $250 incentives to dealers (limited at 100 referrals per year)?
- NWEC is supportive of Avista deploying informational kiosks.
- Continued installs of public charging has the co-benefit of increased TE visibility but should not be relied on as a primary means of education and outreach.

[4] https://govt.westlaw.com/calregs/Document/IE46E6433D170468DA724522E70EC6F01?viewType=FullText&originationContext=documenttoc&transitionType=CategoryPageItem&contextData=(sc.Default)

[5] See UTC docket UE-160082, Electric Vehicle Supply Equipment Pilot Final Report, pp. 82-83

- Can Avista provide data on the beneficial outcomes of investing in an EV Experience center?
- NWEC sees value in providing financing assistance to transportation network company (TNC) drivers to increase access to EVs and reduce costs. In considering any TNC programs, Avista should seek input directly from TNC drivers and organizations representing the interest of TNC drivers.

Community and Equity:

Avista has a long and trusted history serving communities throughout eastern Washington. We encourage Avista to leverage these relationships to develop more equitable TE programs that align with Avista's commitment to dedicating 30% of program funds to low-income TE on an aspirational basis.[6]

NWEC appreciates the inclusion of this section but feels it is crucial that Avista demonstrate clearer intent to achieve this goal. Identifying a range of 10% to 30% of the total portfolio budget range is not sufficient and we recommend:

- Avista expand the second objective identified on page 65. Avista should reach out to community based and community service organizations, low-income service providers, and those representing vulnerable populations in highly impacted communities to develop programs that provide direct and indirect benefits to low-income customers. Avista should resource these organizations for their time spent and expenses incurred in guiding the development of equitable TE programs. In addition, we encourage Avista to look at Puget Sound Energy's Low-Income program portfolio for scalable program ideas and to do further outreach to tribes to identify areas of opportunity.
- Avista initiate a more proactive approach to support Spokane Transit Authority (STA) and other transit agencies to help accelerate battery electric bus and shuttle adoption. Avista can further provide direct and indirect benefits to low-income customers by supporting; (1) the prioritization of transit route electrification in communities experience the greatest environmental health disparities as indicated in Washington's Environmental Health Disparities Map and (2) transit agency's efforts to expand service hours and routes due to sustained fuel and maintenance costs savings from TE.[7]
- Providing EVSE and car-sharing programs to disadvantaged communities does not necessarily provide direct and indirect benefits to low-income and rural communities if additional barriers to adoption exist. We strongly recommend working with community members to identify mobility needs and design relevant and affordable program solutions.
- Selected projects should not compete with weatherization, efficiency or bill assistance programs and should provide sustainable benefits to customers even in the event a pilot or program is terminated.

[6] See UTC docket UE-190334, et. Al, Partial Multiparty Settlement Stipulation, pp. 11-12

[7] https://fortress.wa.gov/doh/wtn/WTNIBL

Avista's detailed EVSE proposals demonstrate Avista's ability to develop strong programs. NWEC would like to continue working with Avista to support equitable program design and increase access to TE that distributes benefits to all of Avista's customers.

Commercial and Public Fleets:

We are very interested in the potential benefits of supporting lift truck electrification. We are supportive of the proposed program design that would result in net benefits to customers due to the anticipated additional annual utility revenue per lift truck. However, Avista is justifying the program based on a total cost of ownership (TCO) comparison between diesel, propane, and electric lift trucks. Has Avista also evaluated the TCO of hydrogen fuel cell lift trucks? Since Avista is projecting increased costs due to additional generation capacity needs, it would be interesting to evaluate viable alternative fuel options. If renewable hydrogen were to be produced in Avista's service area, it could provide additional benefits from increased sales and flexible load that provides system reserves and frees up capacity.

Planning, Load Management and Grid Integration:

NWEC appreciates that load management is integrated throughout the plan. We encourage Avista to pursue proactive demand side management measures and to match demand side management with increased and targeted energy efficiency and demand response. Please refer to comments throughout this document encouraging more distribution system planning and transit electrification.

Rate Design:

Residential EV TOU Pilot Rate –

- In concept, NWEC finds value in residential EV TOU rates. We feel more detail will be important to determine if a residential EV TOU rate is beneficial to Avista's customers. For example, is Avista planning to install a submeter and would there be an additional monthly fixed charge to utilize this rate?

Commercial EV TOU Pilot Rate –

- NWEC is supportive of efforts to reduce the burden of demand charges on customers that include price signals to help shift load to off-peak periods. We would like to note that STA's new bus depot facility could exceed 1 MW of maximum demand. We encourage Avista to included STA charging sites in targeted distribution system impact analysis and to consider rate structures that take into account the unique type of load presented by these utility customers.

Utility Fleet Electrification, Facilities and Employee Engagement:

NWEC is supportive of Avista's efforts to lead by example. As a trusted part of eastern Washington's communities, Avista has the opportunity to demonstrate the value of TE and reduce operation and maintenance costs.

Conclusion

NWEC appreciates Avista's works to develop this plan and we look forward to engaging in the development of Avista's future TE programs. We encourage Avista to undertake a proactive strategy to effectively enable efficient grid and resource management, increase access to transportation electrification for vulnerable populations in highly impacted communities, advance integration of clean energy resources, and expand programs to accelerate TE market transformation.

Thank you for your consideration of NW Energy Coalition's comments.

Sincerely,

Annabel Drayton
Policy Associate
NW Energy Coalition

WASHINGTON STATE UNIVERSITY

Office of
VP for Finance and Administration

May 26, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

Washington State University (WSU) is the land-grant institution for the state of Washington with over 31,000 students enrolled across six campuses and supported by over 6,700 faculty and staff.

WSU relies on Avista to provide major utility services and often partners with Avista to invest in infrastructure improvements at the Pullman and Spokane campuses. In the summer of 2019, WSU Facilities Services took advantage of the Avista Electric Vehicle Supply Equipment (EVSE) pilot program to install four dual port charging stations on our Pullman campus. Three of the stations are now being used for fleet charging and one for residential charging at the University President's residence. These electric vehicle (EV) charging stations were installed as a response to Washington State's recent mandate to add EVs to our fleet.

WSU has reviewed Avista's 2020 Draft Transportation Electrification Plan and supports their proposal to work with industry partners, community leaders, policymakers and regulators to innovate and create a better future for all. We are excited to continue a collaborative partnership with Avista.

Sincerely,

Stacy M Pearson

Stacy M. Pearson,
CFO and Vice President for Finance & Administration

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May 7, 2020

Washington Utilities and Transportation Commission
PO Box 47250
Olympia WA 98504-7250

RE: Avista's Transportation Electrification Plan

Dear Commissioners,

I write to you today on behalf of Forth, a nonprofit trade association that advocates for the advancement of electric, hydrogen, shared, smart, connected, and autonomous mobility. Forth has more than 180 members, including auto manufacturers, electric vehicle charging suppliers, industry partners, utilities, local governments, and non-profit environmental organizations.

Today, emissions from traditional internal combustion vehicles represent Washington's single largest contributor to greenhouse gases. At the same time, electric vehicles (EVs) have quickly gained attention in Washington by providing consumers with the ability to choose clean non-polluting transportation coupled with extremely low fuel and operating costs. In fact, electrically fueled vehicles help lower energy costs for all utility customers by providing improved utilization of the grid primarily during non-peak hours.

Forth has reviewed Avista's Transportation Electrification Plan and finds it to be both insightful and practical. We believe that the guiding principles used in the Avista plan (in particular, the program focus areas: EVSE infrastructure, customer education and outreach, community and equity, fleet support, and grid integration/load management) represent best practices for utilities working to provide their customers with clean and affordable transportation. As transportation electrification continues to increase, we would also recommend that Avista recognize the potential and importance of fuel cell electric vehicles in its future transportation electrification plans.

In closing, because of its numerous economic and environmental benefits, transportation electrification represents a unique value proposition for both EV drivers as well as non-EV drivers across the Avista service territory. Thank you for the opportunity to submit our letter in support of Avista's Transportation Electrification Plan.

Sincerely,

FORTH

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June 22, 2020

Washington Utilities and Transportation Commission
621 Woodland Square Loop SE
Lacey, WA 98503

RE: Avista's Transportation Electrification Plan

Dear Commissioners:

Spokane Transit Authority (STA) provides public transportation to thousands of workers, students, and other community members throughout Spokane County on a daily basis. In 2019, STA provided over 10 million rides on Fixed Route and Paratransit buses and vans.

Within STA's comprehensive plan, the agency has established a policy goal to pursue battery electric bus technology for our fixed route fleet as it becomes financially practicable and effective. To that end STA has recently completed a study evaluating both the timeline and costs of a zero-emission fleet transition, as well as an analysis of the probable performance and requirements for the first 20 battery-electric buses the agency expects to operate. At this time, 14 of those buses are on order for delivery over the next 18 months. Avista has played an important role in supporting our evaluation of the technology and requirements. This included regular consultations between the STA team and Avista staff, and several updates to Avista executive leadership in the course of planning and evaluation work.

Avista's Transportation Electrification Plan supports STA's efforts and aligns with our goal of providing cost effective and sustainable public transportation for the Spokane region.

Spokane Transit supports Avista's efforts in developing a vision and a roadmap to transportation electrification in the region, and we recommend approval of this plan.

Sincerely,

E. Susan Meyer

E. Susan Meyer
Chief Executive Officer

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Alliance for Transportation Electrification

June 28, 2020

Rendall Farley, Manager
Electric Transportation Manager
Avista Utilities
1411 E. Mission (MSC-4)
Spokane, WA 99202

Re: Avista Transportation Electrification (TE) Plan 2020

Dear Mr. Farley:

The Alliance for Transportation Electrification (ATE) wishes to express our strong support for your transportation electrification (TE) plan that you will submit to the Washington UTC, and the accompanying programs and tariffs over a five-year period. Your pilot programs have been innovative and well designed, and we agree with you that it is time to move now toward larger scale based on a portfolio approach of multiple use cases.

Overall comments

Your pilot programs, albeit modest, were one of the first to market among utilities in the country and have been nationally recognized for their scope and design. We believe you have learned a good deal about the early EV adopters in your service territory, and how their deployment and use of the charging infrastructure and behavior may be impacted by rates and program design. Furthermore:

- ATE supports and advocates in other States for the portfolio approach which tested out several use cases was sensible and prudent. These early pilot programs have provided you with valuable information on specific use cases in this nascent stage of market development.
- Your ownership and operation model, working on a turnkey basis with EV service providers, was consistent with the 2015 legislation that stipulated that utilities should play a primary role as a catalyst in market transformation.
- ATE is a strong supporter of open protocols and interoperability, and you have demonstrated that the use of open protocols (such as OCPP as a back-end communication protocol) has both been useful in working with vendors and helped to avoid stranded assets. We are pleased that you will continue with this support of open standards.
- We believe that a strong stakeholder process is essential to the ultimate success of utility-funded EV infrastructure programs, and you have established a robust stakeholder process by yourself, especially with community and equity groups, as well as supporting and participating in the UTC Stakeholder Process.

- We appreciate your projections of market growth of the EV market through 2025 and 2030, and the development of a baseline scenario as well as high and low. The Alliance recognizes that 2019 and now 2020 with the Covid-19 pandemic and recession have not been stellar years for EV sales and adoption. But we are inclined to express our support for a higher "High Scenario" projection by 2030 and believe 15 percent to be conservative. The Alliance would urge Avista and the Commission to adjust these numbers upwards during the next five years depending on technology, vehicle availability, and market trends.

Comments on specific program components

Public DC fast charging (DCFC) development:

The Alliance supports your approach of moving to hybrid model that supports both utility O&O (ownership and operation) as well as a make-ready investment approach with EV service providers (EVSPs), third party developers, and host sites. We believe this growing market is large enough for both types of market development, and neither works to the exclusion of the other; they are complementary. The utility make-ready investment, for example, is an enabler of the business model of the EVSPs and their unique strengths in siting and developing DC fast charging sites. The overall goal of 60 sites for development, over a five-year period, seems reasonable and will be split between Avista and the EVSPs.

We urge you, and the Commission, to stay focused on a couple of specific issues as these programs are implemented. The first is the maintenance and repair of all of these DCFC facilities and ensuring an adequate EVSE uptime – your goal of greater than 99 percent is appropriate. The second is ensuring that all members of the public who own an EV may have reasonable access to the infrastructure, or what is called public accessibility, while recognizing that certain market segments may wish to place the charging infrastructure (such as commercial fleet infrastructure) in depots and such.

Public AC Level 2 sites:

The Alliance strongly supports your approach to public Level 2 investments, which continues the program design principles adopted in the Phase 1 pilots. The cost-sharing requirements with the customers are reasonable and putting the program on a first-come first-served basis makes sense for the 10 sites per year. We agree that you should continue largely with the O&O model for this market segment with a path for make-ready investments as well.

Education & Outreach (E&O)

We also strongly support a robust utility program in educating consumers about all aspects of the EV experience: the large and growing number of vehicle types; comparison of petroleum prices to electricity (kwH prices), types of charging infrastructure and so forth. The Alliance works in many States across the country, and in all jurisdictions, including California, the market surveys indicate there is still a significant gap in awareness in this early stage of market development. ATE supports a reasonable budget to be allocated to these activities, and for you to engage in multiple activities with key players in the growing market. We also recognize the challenge of working with many traditional auto dealers that require a physical visit and presence to finalize the sales. But many of the OEMs, and other national web-based automobile firms, are experimenting successfully with "no-touch" sales of vehicles using Web-based tools. Especially in this era of the Covid-19 pandemic, we would urge both you and the

Commission to monitor these developments as well, and perhaps take advantage of these innovations both in technology, marketing, and adoption practices.

Community and Equity:

The members of ATE support a strong approach to equity, diversity, and low-moderate income communities and recently formed an internal task force to address these issues. We fully support your approach in this area and emphasize the need to work with community action agencies, neighborhoods, and others in your service territory on these issues. An aspirational goal of 30 percent is good. But we also wish to emphasize the importance of flexibility and changing community and market conditions here as well. For example, in its Phase 1 pilots, Southern California Edison (SCE) in the Los Angeles area started with a 10 percent goal for DACs, but actually achieved something closer to a 40 percent level of investment.

Commercial and Public Fleets

The Alliance believes that you have addressed some of the key issues affecting fleet electrification in your plan. The interest in medium and heavy-duty EV use cases has expanded dramatically over the past 12 or 18 months among utilities, bus and trucks OEMs, off-road electric lifts, and NGO stakeholders. The Alliance is pleased to see this as an essential part of this portfolio approach developed by Avista. The opportunities for commercial fleet operators are substantial for the medium and long term through a lower TCO (total cost of operations) for the fleet, but the relatively higher upfront costs of the vehicle and charging infrastructure can be impediments. At the same time, we urge you and the Commission to monitor the continuing positive trends in public transit and school buses during this period and be able to move quickly through the stakeholder and flexible regulatory process.

Load management, planning, and integration

The Alliance supports a variety of approaches to manage these loads more flexibly, including both the use of advanced technologies as well as more innovative rate design approaches cited above for commercial fleets. Avista has traditionally been a leader in advanced technologies in energy efficiency, load management, grid modernization, and moving toward consideration of transactive energy approaches. The specifics of these load management strategies are diverse and well balanced and will use the technologies built into the OEM telematics, the EVSE equipment itself, as well as focusing some attention on the non-networked EVSEs to understand consumer behavior better. Moreover, we agree with Avista's approach to move more gradually and begin such dynamic rates for certain EV owners/customers in 2023. In summary, the Alliance supports the overall goal of using these multiple strategies to demonstrate a greater than 50 percent peak load reduction from EVs.

Rate design

As stated above, the normal demand charge in a standard C&I rate class schedule can be a substantial barrier to the development of commercial and government fleets. Similar constraints apply to host sites and operators of DC fast charging sites as well. Accordingly, Avista's proposal to eliminate or mitigate these demand charges in the early stage of development, for both types of customers, makes great sense and should be supported. The Commission and the parties will review the details included in the program and tariff proposals, but it is sensible to require a meter for these EV TOU rates, and to put a cap (less than 1 MW) on their use. As is done in jurisdictions such as Hawaii and Colorado for fleets and battery electric buses, a substantial price penalty is imposed if the customer violates the terms of the tariff and charges on-peak compared to the off-peak rate.

Therefore, the Alliance supports these changes in rate design, and the considerations given to the "early adopters" among commercial customers to take advantage of these EV rate designs. Avista, the Commission, and the stakeholders should continue to monitor the progress of these new customer rates during the initial period of 2021 to 2025, and then allow the early adopters to continue to use these for a longer period of time until 2030. From its work in other States, the Alliance has learned that the fleet operators and customers of utilities are especially sensitive to both transparent pricing, as well as certainty in pricing structures over the longer term as they switch from diesel fuel to kwH-electric fuel.

Budget:

The Alliance finds the proposed budget levels in the TE Plan to be reasonable and well grounded. Compared to other programs in States across the country, the $2 to $4 million in both capital and operating expenses for a broad portfolio suite of programs is certainly on the more modest size. However, we recognize the relatively lower number of EVs in your service territory today, and given the current difficult economic circumstances, the need to plan carefully. We would urge Avista, and the Commission, and the stakeholders to reassess the market conditions on a regular basis through the stakeholder process, the EV planning process, and its integration in to the IRP process for loads and resources. The Commission should allow some flexibility to adjust these overall budget numbers, and their specific allocation in these categories, as technology and market conditions change over the next five years. Moreover, the increasing ability of EVs and EV infrastructure to have flexibility at the edge of the grid, including e-mobility, may offer significant system benefits as the scale of the EV transformation takes place. While some of these benefits and costs may not always be easy to quantify using traditional methods, the utility and the Commission should refine these methodologies so that this information can be used for both cost-effectiveness and broader public interest tests.

In summary, the Alliance strongly supports the TE Plan developed by Avista in this docket, and the associated programs, tariffs, and budgets over the relevant five-year period. We urge the Commission to give prompt and favorable consideration to this TE plan and its specific programs. ATE stands ready to offer further comments and provide any guidance on best practices in other jurisdictions in the months ahead. We will continue to stay engaged in the Washington Transportation Electrification stakeholder group in the future, including a proposed meeting in late August.

Sincerely,

Philip B. Jones

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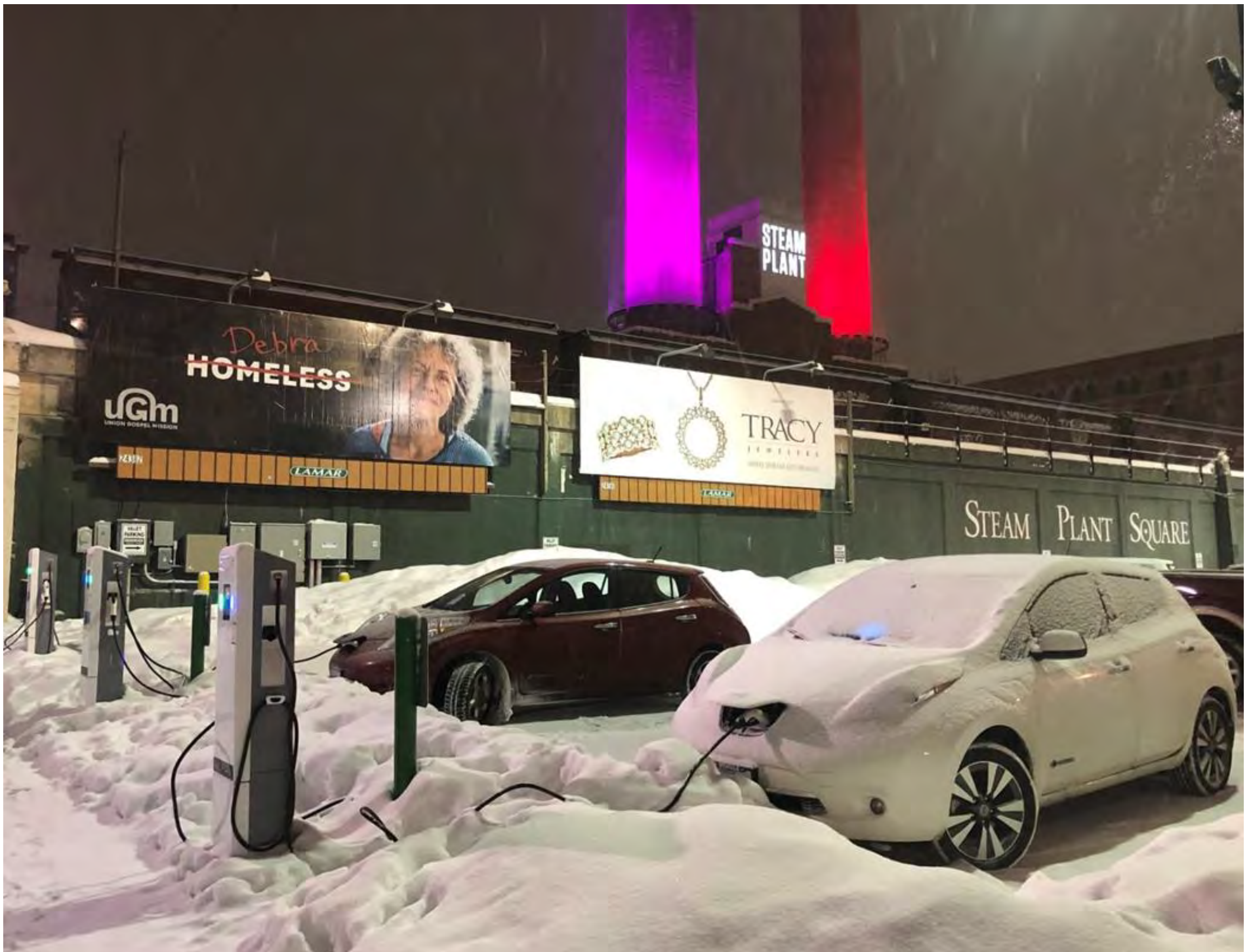

Public AC Level 2 EVSE at Steam Plant Square in downtown Spokane (2018)