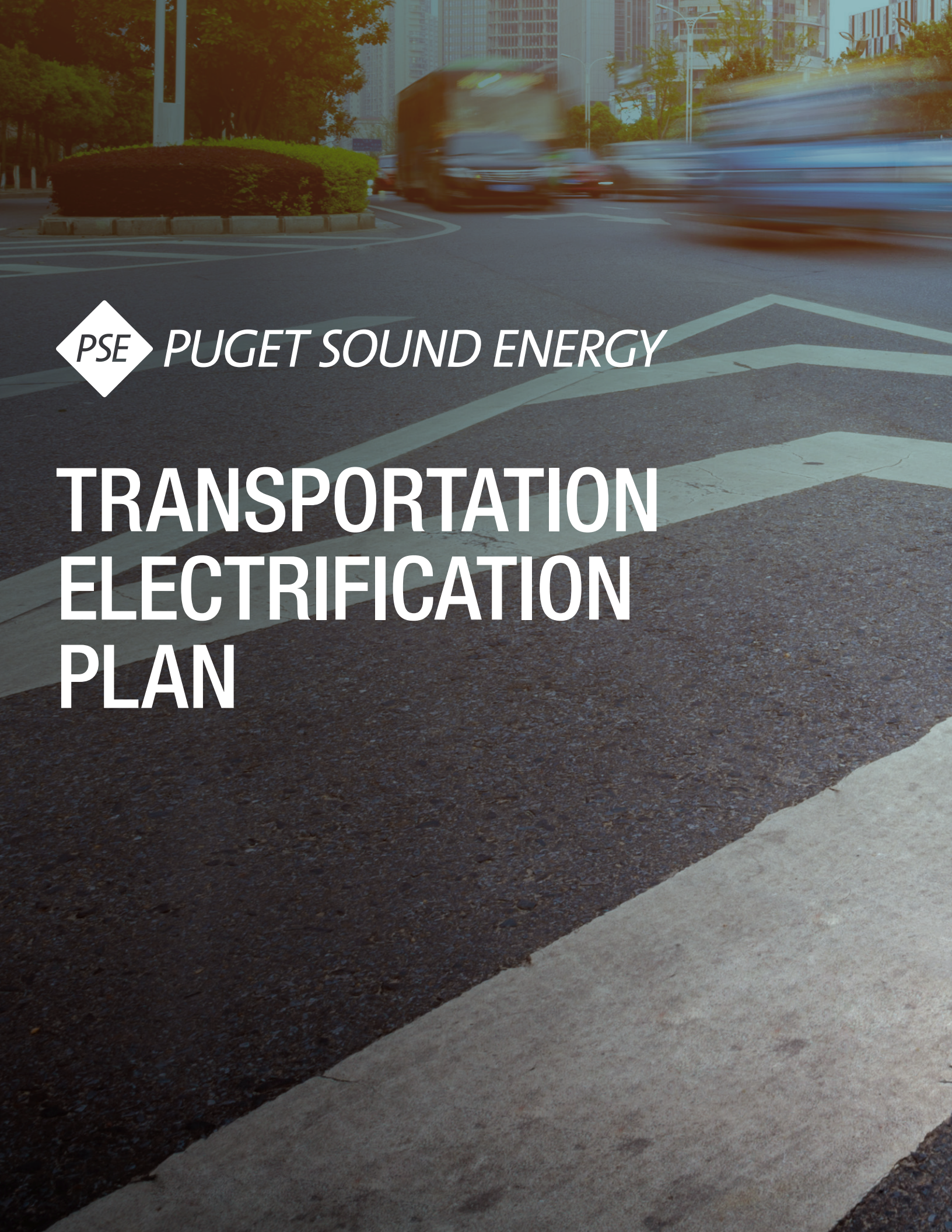


PUGET SOUND ENERGY

TRANSPORTATION ELECTRIFICATION PLAN

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

AMI	Advanced Metering Infrastructure
BEV	Battery Electric Vehicle
BIPOC	Black, Indigenous, and People of Color
CETA	Clean Energy Transformation Act
DA	Distribution Automation
DCFC	Direct Current Fast Charger(s)
DER	Distributed Energy Resource(s)
EV	Electric Vehicle
EVCI	Electric Vehicle Charger Incentive Program
EVSE	Electric Vehicle Supply Equipment
GHG	Greenhouse Gas
HDV/HD	Heavy-Duty Vehicle
HEV	Hybrid Electric Vehicle(s)
ICCT	International Center on Clean Transportation
ICE	Internal Combustion Engine
IRP	Integrated Resource Plan
LCFS	Low-Carbon Fuel Standard
LDV/LD	Light-Duty Vehicle
L2	Level 2
L3	Level 3
MDV/MD	Medium-Duty Vehicle
MF	Multi-Family
MPG	Miles Per Gallon
MPGE	Miles Per Gallon Equivalent
NREL	National Renewable Energy Lab
OEM	Original Equipment Manufacturer
PEV	Plug-in Electric Vehicle(s)
PHEV	Plug-in Hybrid Electric Vehicle(s)
TCO	Total Cost of Ownership
TE	Transportation Electrification
TOU	Time of Use
V2G	Vehicle to Grid
VGI	Vehicle Grid Integration
WSDOT	Washington State Department of Transportation
WSF	Washington State Ferries
WUTC	Washington Utilities and Transportation Commission
ZEV	Zero-emission Vehicle(s)

EXECUTIVE SUMMARY

Puget Sound Energy (PSE) is committed to creating a better and cleaner energy future as we proactively work to do our part to support Washington state's clean energy goals. This includes transforming our electricity supply to become carbon-free by 2045. In PSE's "Beyond Net Zero Carbon" goal, PSE seeks to partner with customers and industry to reduce carbon in other sectors, including advancing the market's transformation to electrified transportation. Transportation emissions currently account for approximately 45% of our state's emissions. Accelerating widespread transportation electrification is vital to Washington state achieving its carbon reduction and clean air goals. Furthermore, our customers increasingly want utilities to provide electric vehicle (EV) programs, while also building the enabling charging and utility infrastructure that can support them. By advancing transportation electrification, PSE can reduce emissions, manage EV charging loads, and better serve our customers.

However, PSE cannot take this journey alone; close collaboration with policymakers, customers, environmental groups, social justice advocates, and business leaders will be required to successfully electrify the transportation sector and make our communities better places to live and work. To that end, PSE's Transportation Electrification Plan outlines the necessary steps and investments to achieving an electrified future.

A RAPIDLY EVOLVING MARKET

There has been significant growth in the U.S. EV market since the first mass-market model was introduced in 2010, and that trend is poised to continue. In recent customer research, PSE found that 68% of our residential customers plan on buying or leasing an EV[1], and it is estimated that by 2030 there will be over 200,000 EVs in PSE's service area. In addition, our commercial and fleet customers are increasingly adopting EVs and are forecasted to continue to grow.

This increase is driven by growing customer interest and concern about climate change, favorable federal and state-level policies, decreasing battery costs, improved technology, and financial incentives. These advancements underscore the opportunity for fuel savings, and urgency for deploying charging infrastructure that is fast enough, and sufficiently widespread, to meet growing energy needs and customer expectations.

Moreover, the Puget Sound region is growing and thriving, with major employers including Microsoft, Starbucks, Amazon, Costco, and REI, and a population that is expected to rise steadily. This growth has led to unprecedented demands for energy and significant increases in traffic throughout the region. Therefore, a safe, efficient, and reliable energy system is essential to the area's quality of life, economic backbone, and transportation infrastructure. As growth continues, mobility and infrastructure improvements will need to complement efforts to improve air quality, protect the local environment, and reduce overall greenhouse gas (GHG) emissions as well as localized pollutants to address climate change.

PSE'S ROLE IN TRANSPORTATION ELECTRIFICATION

While customers are the ones who ultimately choose to go electric, utilities play an important role in driving transportation electrification—not only by providing the grid infrastructure to supply and deliver energy to electric vehicles and managing the associated loads, but also by transforming the market and expanding Transportation Electrification (TE) benefits to more customers.

To support our vision for an electrified transportation future and align with the 2017 UTC EV Policy Statement, PSE has established a set of guiding principles that provide the framework for this Transportation Electrification Plan (TE Plan). These principles shape our approach and complement our broader utility-scale initiatives to achieve clean, reliable, and affordable energy for our customers. PSE seeks to enable all customers to experience the benefits of electric mobility—from cleaner air to the conveniences of advanced technology.

PSE is developing new programs and services to advance the adoption of electric transportation, boosting resiliency and modernizing the grid to enable it, and partnering with key stakeholders to develop a robust EV ecosystem. This ensures that everyone, regardless of income and geographic location, can participate in transportation electrification and experience the benefits of electric mobility—from residential customers with personal vehicles to larger, commercial customers with medium- and heavy-duty fleets. As adoption continues to grow, PSE is proactively monitoring EV load and designing load management mechanisms to promote EV charging during off-peak periods.

However, utilities alone cannot expedite transportation electrification. We require partnerships with state and local governments, environmental agencies and advocates, mobility service organizations, vehicle manufacturers, and EV charging equipment providers. This collaborative effort, coupled with PSE's investments in a modernized grid, will support increased customer adoption of EVs and the infrastructure required to charge them.

PSE'S APPROACH: ADDRESSING CUSTOMER AND MARKET BARRIERS

Four overarching goals have guided the formation of our TE Plan, as well as the design and launch of our existing transportation electrification products and services. They are designed to create a robust, customer-centric electrified transportation future, which we further discuss in Section 3.

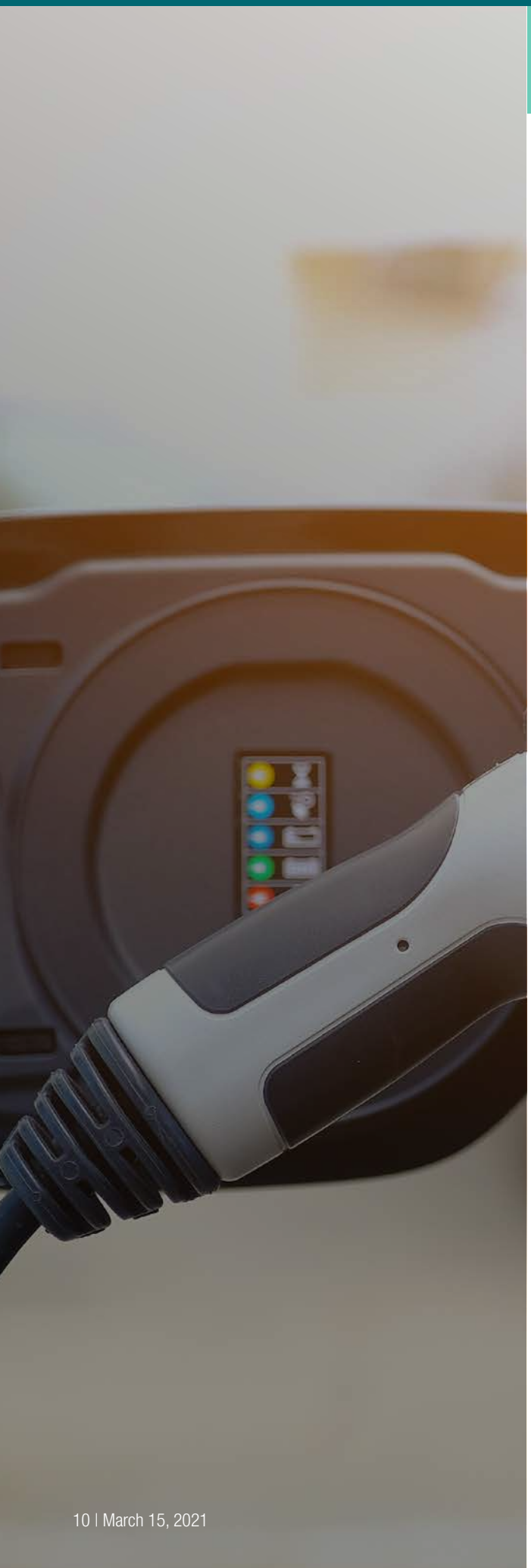
Supporting and enabling market transformation	Addressing charging infrastructure gaps	Planning and managing electric loads	Furthering energy equity and inclusion

PSE has already taken significant steps to meet these goals and support Washington's decarbonization efforts, from investing in electric vehicles and charging infrastructure throughout the region, to developing greener fueling alternatives for buses, ships, ferries, and trains. PSE launched its first customer-facing EV program in 2014, and our current program, Up & Go Electric, includes developing products and services that support charging availability, making electric fueling more affordable, increasing EV accessibility for low-income and disadvantaged communities, and promoting overall awareness of transportation electrification. Our efforts to date have focused on light-duty vehicle electrification. But as the transportation electrification sector continues to expand with more vehicle options and higher customer adoption rates, PSE recognizes that our TE Plan needs to serve a wide range of customer segments, including single- and multi-family residential customers, workplaces, commercial fleets, governments, and community providers across various light-, medium-, and heavy-duty vehicles.

Looking to the future, and despite projected growth and opportunities, significant barriers to EV adoption are expected to remain across all customer segments. Therefore, PSE's transportation electrification strategy seeks to identify and address these barriers, which fall into three major categories.

- Market and Consumer Education—the relative newness and uniqueness of the transportation electrification market can make it more difficult for customers to make informed decisions that match their needs.
- Participation and Ownership—unique EV-specific challenges exist that can prevent customers from purchasing EVs or participate in transportation electrification programs.
- Availability of Charging Infrastructure—charging infrastructure needs to be more readily available to make customers feel more comfortable making an EV purchase or participating in EV programs.

We also intend to remove barriers related to equity and inclusion with offerings that provide electrified transportation access to as many customers as possible—while supporting additional customer values like better air quality, less noise pollution, and cost savings. Providing greater access to EVs positions PSE to directly and indirectly improve the lives of low-income and disadvantaged communities.



WHAT WE'RE BUILDING TOWARD

More than simply adding electric vehicles to Washington's roads, and the infrastructure to charge them, PSE is committed to creating an ecosystem capable of supporting an electrified transportation future. This means ensuring that all our customers can benefit from transportation electrification by removing equity barriers and increasing EV options. It also means establishing a plan for achieving our collective clean energy objectives and modernizing PSE's grid with the four aforementioned goals in mind.

PSE has an immediate need to support our Commercial and Fleet customers, and we plan to file new customer programs after the approval of this TE Plan. The commercial market has evolved rapidly since the 2018 launch of Up & Go Electric and represents a significant portion of the region's emissions. PSE is currently designing programs to serve this customer segment need and we will also continue to build on learnings from our light-duty programs as we design the next phases of our customer offerings. We will use a portfolio-based approach to design a variety of products, services, and programs for our customers, each one addressing unique barriers and supporting our overall transportation electrification vision.

In the existing Up & Go Electric program, PSE has been collecting EV charging data and testing incentives for off-peak charging. Load management strategies will continue to be a priority for new customer programs to mitigate incremental system costs. Aligning EV load with off-peak times of the grid can efficiently increase grid utilization. This creates downward pressure on electric rates and the ability to offer new EV programs to benefit all customers.

Realizing our transportation electrification vision will require proactive partnerships among agencies, local governments, and the private sector. From our first customer-facing pilot program in 2014, to the proactive and collaborative approach we're pursing now, PSE is charting an exciting, aggressive course for advancing transportation electrification throughout the region—and creating a better, cleaner energy future for us all.

HOW TO USE THIS DOCUMENT

PSE's Transportation Electrification Plan is intended to be an overarching strategic framework for how we approach transportation electrification. It provides context on what policies, legislation, customer choices, technical feasibility, and market factors influence and guide our decision-making—and a roadmap for electric vehicle products and services in the coming years.

This document is intended to be refreshed every five years, and to be updated as the market and our strategy evolves. PSE will file discrete programs and the associated tariff sheets following the acceptance of this document. Given the nascence of the transportation electrification market, this document is meant to guide our strategy, while leaving flexibility for our programs to evolve with market needs. In between refreshes of this document, PSE will provide updates biannually to the UTC stakeholder group in the form of a report filed directly to the UTC. The biannual TE Plan report will include an update on the program's achievements to-date, customer participation and adoption metrics, and program budget. The report will also discuss marketplace trends and PSE's recommendations on any program adjustments that are needed to react to these trends.

1. PSE'S TRANSPORTATION ELECTRIFICATION VISION

Our region continues to undergo rapid changes, and similarly, the electric power and transportation industries are experiencing a dramatic transformation. Electricity will be the fuel of the future. Consumer preferences are also changing. As such, utilities are uniquely positioned to respond to market needs. This means that PSE needs to manage electric vehicle charging with a grid that is reliable, resilient, flexible and modernized to safely respond to the changing transportation industry.

BUILDING A CLEAN ENERGY FUTURE

PSE is committed to creating an ecosystem that supports an electric transportation future. The transportation sector is evolving toward electrified, shared, and autonomous options. By 2040, over half of all global vehicle sales are likely to be electric.[2] This includes personal light-duty vehicles as well as other modes of transportation like buses, freight trucks, other public and private fleets, and ferries. This transition requires developing affordable and convenient charging options while planning for and managing the associated electric loads.

PSE wants all customers to experience the benefits of electric mobility—from cleaner air to the conveniences of advanced technology. PSE is focused on ensuring that all our customers can participate in, or benefit from, transportation electrification by removing barriers that prevent their adoption. This holds true for customers at all income levels in both urban areas and rural communities.

The execution of this Transportation Electrification Plan will also create economic opportunities throughout our customer base. By designing electric vehicle programs and solutions to minimize incremental system costs through efficient grid utilization, PSE, as a utility, is best positioned to leverage the benefits of downward rate pressure to provide economic benefits to all customers. This cycle of innovation will spur continued investment in EVs that will advance transportation electrification. Electrified mobility will also bring the prospect of new jobs, training programs, and workforce development to support the ecosystem we are building.

PSE'S SIX GUIDING PRINCIPLES FOR THE ELECTRIFICATION OF TRANSPORTATION

To support our customers and build a vision for an electrified transportation future, PSE has established a set of guiding principles that are the framework for this Transportation Electrification Plan. These guiding principles help shape our approach to transportation electrification and complement our other utility-scale initiatives.

ADVANCING CLEAN MOBILITY

Forecasts predict that worldwide, 58% of light-duty and 31% of medium-duty commercial vehicle sales will be electric by 2040.[3] That's 56 million electric vehicles globally, and over half a million light-duty vehicles forecast in PSE's service area. In the U.S., the Puget Sound region has been a service area leader in this transition to EVs and that regional growth is expected to continue as the State Energy Strategy sets GHG reduction targets of 45% below 1990 by 2030 and 95% below 1990 levels by 2050.[4]

In preparation for this new electrified mobility future, PSE is actively planning and building the enabling infrastructure and ecosystem to support our customers' choices. We see ourselves playing a key role in advancing the conversion to EVs and transforming the market in Washington state. There are significant cost savings and social and climate benefits associated with switching to EVs, and PSE is helping our customers understand them.

It is incumbent on us to ensure that all customers can participate in transportation electrification, and we are inclusive in our program planning. We are exploring almost every mode of transportation and are taking steps now to plan for the system-wide increased demand for electricity. We are also creating programs that encourage managed charging and vehicle-grid integration of this new electricity demand.

CUSTOMER-FOCUSED

PSE's customers and communities are essential partners for achieving Washington's carbon reduction and transportation electrification goals. As we pave the way to a better energy future, we also want to empower customers and electric vehicle drivers with simple and impactful actions they can take to reduce greenhouse gas (GHG) emissions and lower their carbon footprints. Consumer interest in energy issues continues to grow[5], and PSE plans to partner with our customers on that journey. As EV adoption advances, our customers look to PSE as an advisor and partner in providing resources and solutions.

In keeping with efforts to be our customers' clean energy partner of choice, we are also building toward a transformed customer experience. We have taken on major projects like Get to Zero, which uses innovative tools to improve customer service, and are deploying advanced meter infrastructure (AMI), which will support a more automated and individualized customer experience and provide a foundation for our transportation electrification work. Our customers have an expectation that PSE will continue to innovate and deliver creative products that provide clean energy solutions. PSE intends to keep pace with these expectations.

SOCIAL EQUITY AND ENVIRONMENTAL JUSTICE

We're committed to designing our programs so they are equitable and inclusive and reaching customers that may be underserved by traditional programs. Our service area is diverse and heterogeneous—what may work for one community, may not work for another. We strive to design our programs so they are affordable, accessible, efficient, reliable, and safe for all customers.

We are designing programs that reverse the impacts that transportation emissions have placed on communities of color and low- and moderate-income households. Data shows that people who live near transportation corridors experience higher rates of asthma and lung and heart disease due largely to breathing toxic vehicle emissions. Our programs aim to provide direct, meaningful, measurable, and assured benefits and reduce health and financial burdens for low-income and disadvantaged communities.

CREATING A RESILIENT AND MODERN GRID

PSE's grid modernization strategy provides a holistic approach to creating a smart, flexible, safe, and resilient system to meet our customers' evolving needs. Transportation electrification is a critical piece in this transformation. At PSE, we feel it's imperative to continue investing in the grid of the future. This is an ongoing and dynamic undertaking that will deliver a better customer experience and drive operational efficiencies while integrating the benefits of electric vehicles into our grid.

A modern grid also means developing new infrastructure capable of accommodating and optimizing more distributed energy resources, like battery storage, solar, wind, and EVs in customer homes and businesses. PSE is continuously developing and launching products and services that explore ways to manage distributed energy resources and invest in capabilities that enable EVs as a grid resource. Our grid modernization strategy addresses our system, with initiatives that range from cutting-edge smart technology to infrastructure improvements that support overall function and resiliency. Managed charging and vehicle-grid integration of EVs is an important component of our modern grid vision that uses customer price signals to encourage charging during ideal times of excess supply.

CONTRIBUTING TO STATEWIDE CARBON GOALS

Reducing carbon from the transportation sector is an essential part of Washington state's energy strategy. By advancing transportation electrification, PSE will help Washington achieve its climate goals. Electric vehicles provide a pathway toward significantly reducing carbon emissions. Transportation currently accounts for over 45% of Washington's GHG emissions. Even today with our current generation mix, an EV charged on PSE's electric system cuts carbon emissions by over 80%.[6] Each additional EV aids in continuing this carbon reduction trajectory, which benefits air quality throughout our state as well as our service area.

PSE is planning for a future that achieves 100% clean electricity by 2045, in accordance with Washington State's Clean Energy Transformation Act (CETA). This includes milestones of being coal free by 2025, having a carbon neutral electric system by 2030, continually

acquiring new clean energy sources that meet the region's growing needs, and reducing our GHG emissions. In January 2021, PSE set a "Beyond Net Zero Carbon" goal that extends beyond the CETA goals to partner with customers and industry to identify programs and products that cost-effectively reduce carbon across our region and state.[7]

Decarbonizing our electricity supply is not enough to achieve the state's climate goals. Our customers' continued adoption of EVs will be increasingly important as we advance toward a deeply decarbonized economy, powered by carbon-free energy. They share our desire for clean energy and new technology options. PSE has been an early leader in these efforts, investing billions in renewable resources and energy efficiency throughout our region. Our mission today is transforming our electricity supply to meet CETA's objectives and achieving deep decarbonization; electrifying the transportation sector and powering it with clean energy is critical to meeting these goals.

COLLABORATION & PARTNERSHIP

Partnership and market participation are crucial for creating an electrified transportation ecosystem. This means partnering with the private sector, governments, non-profits, and state agencies to collaborate on programs, and brainstorming ways to meet our shared objectives. PSE can't accomplish transportation electrification alone. We understand the importance of building a coalition and coordinating our efforts.

We see our customers as critical partners in that collaboration, with their voices guiding the way. We maintain active communication with our customers about their decisions to electrify, and we remain committed to accompanying them on this unfolding journey. As the market continues to evolve and transform, we will do the same.

Working with partners, customers, and communities throughout our region, we are creating a better, cleaner energy future—together.

ACHIEVING OUR TRANSPORTATION ELECTRIFICATION VISION

These six principles will serve as important building blocks for a future where our region's transportation needs are electrified. We will support this by offering electric vehicle products and services to our customers that help them to make that transition. PSE is aligned with statewide transportation electrification goals, and we will continue to build upon each success. There is still significant work to be done to meet impending customer demand and plan for an electrified future.

The rest of this document lays out the current transportation electrification market, customer barriers, and how PSE is designing programs to address their needs. In Section 2 we cover the current state of the transportation electrification industry. Section 3 details customer and market barriers around transportation electrification and PSE's role in mitigating them. In Section 4 we lay out planning considerations for transportation electrification and how PSE is responding to the coming wave of EV adoption. In Section 5 we describe how PSE plans to meet our customer needs through our transportation electrification programs, and how they form our future EV roadmap and provide a solid foundation for future TE initiatives.

Author's note: For the purpose of this document, we talk about "EVs" as a whole, even though they are comprised of two sub-segments—battery electric vehicles (BEVs) and plug-in hybrid electric vehicles (PHEVs). The industry is trending toward BEVs, which make up 75% of current sales volume. All references to EVs in this document assume BEVs are the primary focus.

2. TRANSPORTATION ELECTRIFICATION BACKGROUND

The U.S. electric vehicle market has grown significantly since the introduction of the first mass-market EVs in 2010, reaching a cumulative 1.5 million vehicles sold through the end of 2019. Automakers continue to commit to EV investments.[8] As of April 2020, automakers have committed more than $370 billion to transportation electrification globally[9], and in the U.S. alone companies either spent or raised nearly $23 billion for EV production and development in 2020.[10] Moreover, automakers are increasingly focused on and investing in electrification of buses, trucks, and other medium-duty (MD) and heavy-duty (HD) vehicles. EV adoption is poised for rapid acceleration due to a confluence of several factors: improving technology and falling costs, favorable policies and financial incentives, rising consumer and commercial interest, and growing desire to reduce environmental impacts and fuel costs.[11]

Likewise, EV battery range has improved significantly, battery costs continue to drop, just as electric models of more vehicle types including pickups and long-haul freight trucks have been introduced.[12] This technology advancement and market adoption requires significant support and buildout of charging infrastructure including electric vehicle supply equipment (EVSE), particularly those with higher (faster) power delivery capabilities. As EV battery range improves and larger vehicles are introduced, there is an increased demand for deployment of direct current fast chargers (DCFC). Based on the vehicle and technology deployment, it is anticipated that light-duty vehicles will require charging at power levels up to 350 kilowatts (kW), and heavy-duty EVs may charge at power levels up to 1.5 megawatts (MW).[13]

While COVID-19 may have an impact on 2021 sales volumes, industry commitments have not shifted and federal policy, such as mandates that all new federal fleet purchases are electric, is rapidly supporting EV growth.[14] Many forecasts continue to show favorable consumer and commercial confidence to adopt EVs. In order to plan and meet this demand, far more charging infrastructure must be deployed. Although the number of chargers has grown rapidly, there is still a gap between the predicted EV adoption and the number of stations available. Charging infrastructure deployed over the next several years will need to cover a range of charging locations including multi-family, workplaces, public charging, and schools, as well as urban and highway corridor charging hubs to support the anticipated EV market growth. One study by The International Council on Clean Transportation (ICCT) estimated that the greater Seattle area only has 31-40% of the required charging needed to meet the 2025 demand.[15]

This section explores transportation emissions and the associated environmental impact. It also provides an overview of EV technology, the types of vehicles becoming available to consumers, and their respective energy and charging infrastructure requirements. This section concludes by providing the Washington state policy context that has shaped vehicle electrification to date.

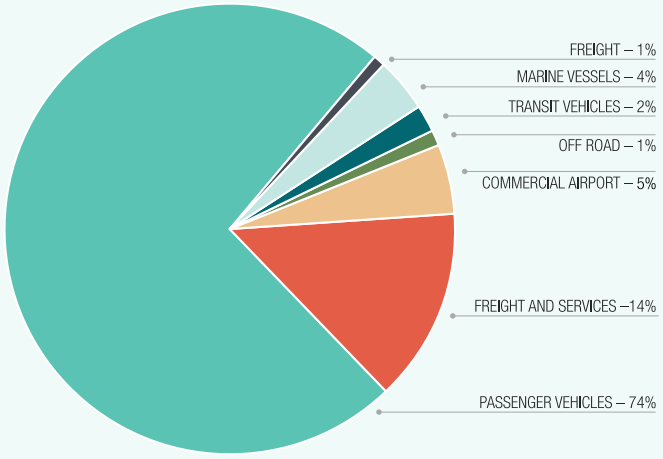
TRANSPORTATION EMISSIONS AND ENVIRONMENTAL IMPACT

Transportation is the largest source of GHG emissions in the U.S., accounting for 29% of the nationwide total. Since Washington's current electricity mix is cleaner than most states due to its carbon-free hydroelectricity, Washington's transportation sector represents a larger portion of GHG emissions, contributing around 45% of total emissions.

In the Puget Sound area, light-duty passenger vehicles are the largest contributor to GHG, which comes from the sheer number of vehicles on the road and the higher rate of personal vehicle ownership. However, on a per-vehicle basis, medium- and heavy-duty vehicles lead to a disproportionate share of GHGs in comparison to passenger vehicles. This is due to higher vehicle miles (VMT) and energy needs associated with medium- and heavy-duty vehicles. Figure 1 shows the types of transportation emissions throughout the greater Puget Sound region.

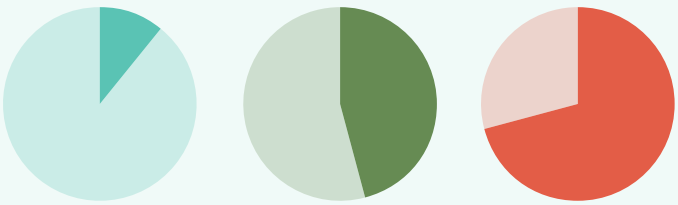
Washington's legislature has set a target to reduce emissions to at least 45% below 1990 levels by 2030, and reach Net Zero GHG emissions by 2050.[16] Reducing transportation emissions is an important part of achieving these goals, primarily because of 1) the high potential to reduce carbon and impact climate change, and 2) the role of transportation emission on air quality. This not only means light-duty vehicles, but also emissions from medium- and heavy-duty vehicles, since traditional freight fuel consumption and GHGs are forecasted to grow four-fold through 2050 without progress on electrification of this class.[17] Despite being relatively small in number, heavy-duty vehicles (HDVs) represent a disproportionate share emissions, as shown in Figure 2.

Figure 1 – Source of Regional Transportation Greenhouse Gas Emissions[18]



SOURCE: PUGET SOUND CLEAN AIR AGENCY GREENHOUSE GAS EMISSIONS INVENTORY

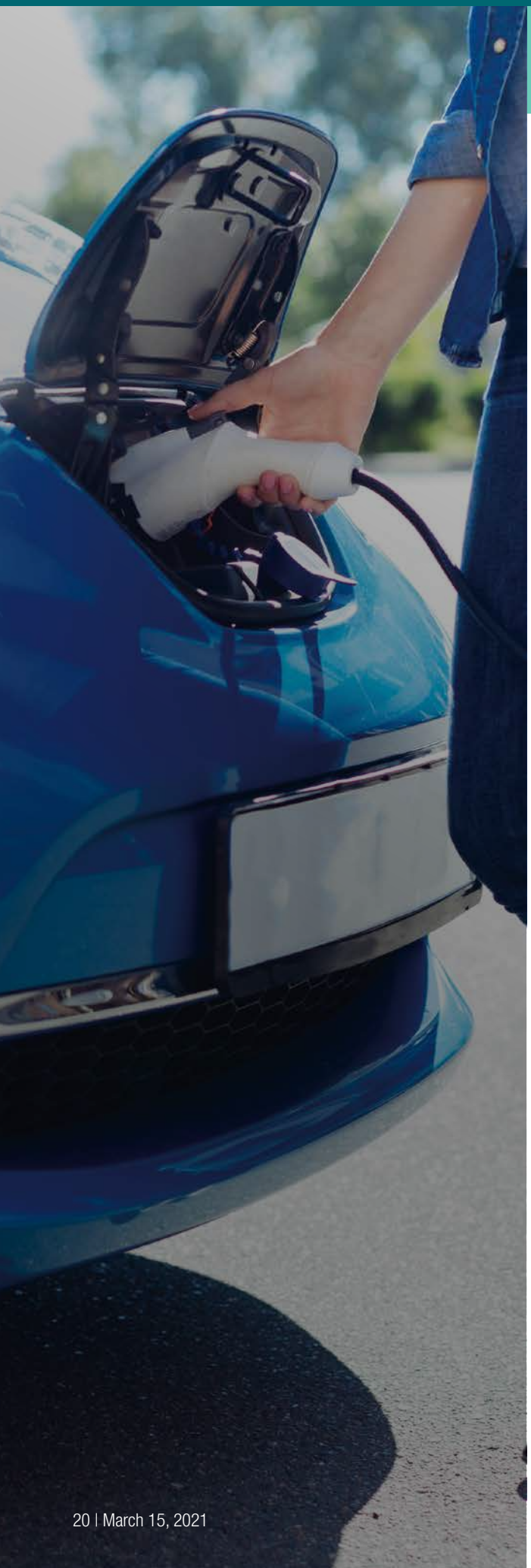
Figure 2 – On-road climate pollutants from heavy-duty vehicles[19]



11% OF VEHICLES ON THE ROAD ARE HEAVY DUTY

46% OF CO_2 EMISSIONS ARE FROM HEAVY-DUTY VEHICLES

71% OF VEHICLE PARTICULATE EMISSIONS ARE FROM HEAVY-DUTY VEHICLES



Electrifying all classes of vehicles can greatly reduce emissions when paired with a clean energy generation mix. Fully electric vehicles do not emit tailpipe emissions, and the electricity that fuels them can be significantly less carbon intensive than gasoline or diesel. Local air quality is also improved without tailpipe emissions. While PSE's electricity generation does currently produce emissions, the emissions from EVs charging off the PSE grid are lower than those produced by an average gasoline car. Approximately 40% of PSE's electricity fuel mix comes from clean energy resources, primarily hydroelectric and wind resources. The remainder of the electricity is supplied by coal and natural gas. However, as PSE transforms its electric supply to meet the goals of CETA, the electricity fuel mix will become increasingly clean. By 2025 PSE will retire all coal from our electric portfolio; coal currently supplies over a third of PSE's generation and produces approximately two-thirds of PSE's emissions. As PSE's grid rapidly becomes more reliant on renewable energy, the emissions associated with EVs will be even further reduced and are on-track to be carbon neutral by 2030 to achieve the CETA targets.

This reduction of emissions is also important to PSE's transportation electrification strategy as it relates to environmental justice. Urban regions suffer the worst impacts of air pollution—especially those around transportation corridors, which disproportionally impacts communities of color. Asian American, Black, and Latinx communities are exposed to substantially more air pollution from cars, trucks, and buses than other demographic groups.[20]

Widespread transportation electrification will improve air quality in transportation corridors and help reduce burdens to highly impacted communities.

TYPES OF ELECTRIC VEHICLES & CLASSES

There has been a steady uptick in market and customer interest in electric vehicles over the past decade, with even more rapid growth in the past 2-3 years.[21] EVs are now available in every type of vehicle class, although the level of EV availability differs across subsectors of the market. Passenger EVs have been commercially available since 2010, and electric transit buses have also seen wide-scale commercialization. Electric school buses are also becoming more widely available. While freight and delivery electric truck models are just now entering the market, this sector has experienced recent upticks with announcements from Ford, GM, Daimler, Tesla, Rivian, Nikola, and others around plans to bring new medium-duty and heavy-duty EV models to market. Table 1 shows the breakdown of vehicle classes and commercialization levels.

For each of these vehicle classes, the battery capacity and charging requirements vary. This becomes increasingly important since larger battery sizes need more kilowatt-hours (kWh) for a daily charge. In addition, depending on vehicle usage, the charging speed becomes crucial. Delivery vehicles that operate for a majority of the day may require faster charging options, while school buses have flexibility to charge mid-day and/or overnight. In addition, there are several charging standards for light-duty vehicles that are currently in use throughout the U.S.. Light-duty vehicles primarily use Level 1, Level 2, and Direct Current Fast Charge (DCFC). Medium- and heavy-duty vehicles use faster DCFC speeds, although they can use Level 2 for overnight charging. An explanation of EVs and charging standards is provided in Appendix A.

Table 1 – Vehicle Classes, Customer Uses, and Charging Speeds Table[22, 23, 24, 25, 26]

VEHICLE USE CASES		CUSTOMER USE	WEIGHT CLASS	EV AVAILABILITY	TYPICAL EV CHARGING AND SPEED
	Long-haul freight	Commercial fleets	Heavy-duty class 8 (>33,000 lbs.)	Demonstration/ prototype	DCFC (> 350 kW)
	Freight truck	Commercial fleets	Heavy-duty class 8 (>33,000 lbs.)	Limited availability	DCFC (>150 kW)
	Transit bus	Municipal fleets	Heavy-duty class 7 (26,000-33,000 lbs.)	Available	Level 2, DCFC (> 50 kW)
	Refuse truck	Municipal and commercial fleets	Heavy-duty class 7 (26,000-33,000 lbs.)	Limited availability	Level 2, DCFC (> 250 kW)
	Shuttle bus	Commercial fleets	Heavy-duty vehicles (Class 7-8)	Limited availability	Level 2, DCFC (> 50 kW)
	Delivery truck	Commercial fleets	Medium-duty class 3-6 (10,000-26,000 lbs.)	Limited availability	Level 2, DCFC (> 150 kW)
	School bus	School district fleets	Medium-duty class 6 (19,500-26,000 lbs.)	Limited availability	Level 2, DCFC (> 50 kW)
	Light truck	Residential, commercial fleets	Light-duty class 2 (6,000-10,000 lbs.)	Limited availability	Level 2, DCFC (> 50 kW)
	Passenger vehicle	Residential, commercial fleets	Light-duty class 1 (0-6,000 lbs.)	Available	Level 2, DCFC (> 50 kW)
	Other non-road	Commercial/municipal fleets	Varies	Limited availability	DCFC, Varies (> 1 MW)

In addition to these on-road vehicles, there are many non-road and off-road options. These include construction and industrial vehicles (e.g., forklifts), yard trucks, and other non-road transportation, like ferries. Washington State Ferries (WSF), the world's second-largest ferry operator, has already begun electrifying its fleet.[27] Moreover, WSF has been approved to invest $35 million in hybrid electric vessels to replace their Mark II ferries, the largest ferries in the WSF fleet.

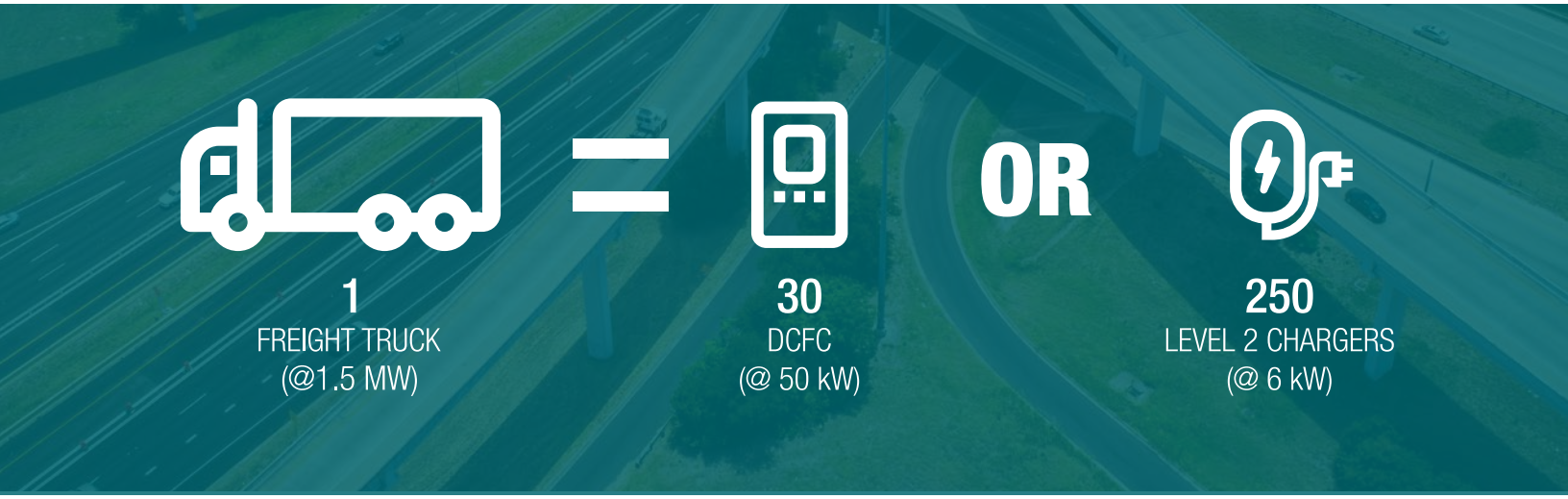


Figure 3 – Charging power requirements and equivalency charger types. Vehicle type and charging speed have a significant impact on charging power requirements. One freight truck with rapid charging requires the same amount of power to charge as 30 delivery trucks between shifts with DCFC or 250 school buses charging overnight with Level 2 chargers.[28]

INDUSTRY & TECHNOLOGY TRENDS

The number of electric vehicle offerings has increased significantly since 2018 due to the rising popularity of battery electric vehicles (BEVs). BEVs accounted for almost 75% of U.S. EV sales in 2019 compared to plug-in hybrid electric vehicles (PHEVs).[29] Falling battery prices and lower production costs have coincided with major commitments to electrification from automakers around the globe. These lower battery costs also make it more economically feasible to increase EV driving ranges. Most vehicles being released in 2021 will have a battery range over 300 miles, compared to 100-200 miles of range for those in the mid-2010s. Bloomberg New Energy Finance predicts that EVs will reach price parity with internal combustion engine vehicles by the mid-2020s in most vehicle segments.[30] A summary of EV sales volumes in the U.S. is shown in Appendix A.

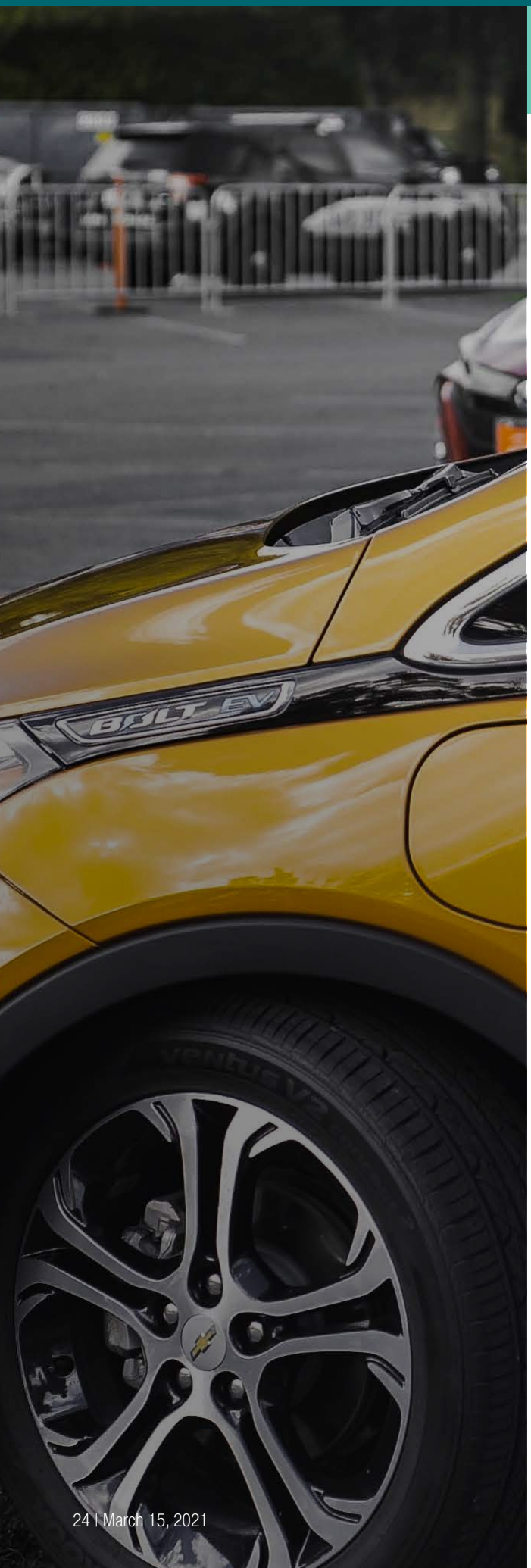
Automakers are investing billions of dollars in Evs, which is expected to increase availability in the U.S. At the end of 2019, there were 44 models available for sale across the country, with wide variations from state to state.[31] American automakers, including General Motors, Ford, and Tesla have pledged to make substantial electrification investments and are among the leading automakers in terms of global commitments to electrification. Appendix A highlights investment commitments both globally and within the U.S. While overall vehicle sales volumes have been reduced by the COVID-19 pandemic, most automakers have maintained their commitment to manufacture EVs.[32]

As community partnerships and buy-in are essential to building a comprehensive electrification plan, many non-profit organizations and low-income service providers have suffered great losses in budget and personnel headcount as a result of the pandemic.[33] These organizations cannot simply afford to support citizens as they previously did and may be even more hesitant to contribute dollars to ongoing capital investments.

CUSTOMER FEATURE: KING COUNTY METRO

King County Metro (KCM) is committed to a 100% zero-emissions fleet by 2040. Over the next 20 years, KCM expects to have approximately 2,200 battery-electric and electric trolley buses. A zero-emissions fleet benefits the community, riders, and employees by eliminating greenhouse gas emissions and improving air quality. Additionally, the program aligns with broader King County equity and social justice goals around the King County Strategic Climate Action Plan.

Currently, Metro operates 185 zero-emission buses, which includes 11 battery-electric buses with charging stations at the Bellevue Campus and Eastgate Park-and-Ride. KCM will phase 120 zero-emissions buses into operations, starting in 2021 at the interim base at South Campus and followed by 250 buses at the South Annex base in 2025. Metro's newest base, which will be built in south King County (PSE service area) and is scheduled to open in 2030, will house, operate, and maintain 250 zero-emissions buses.



COVID-19 has also greatly impacted the public transit sector. In data from an April 2020 survey conducted by the Transit app, 92% of app users are using the app to commute to work; including healthcare, food service, and maintenance jobs; and more than half of total commuters are African-American or Hispanic.[34] Furthermore, 85% of these riders depend on public transit as their only mode of transportation to get from destination to destination. And for many, public transit proves to be a more cost-efficient option than ridesharing; 70% of riders surveyed make under $50,000 a year. Although overall transit ridership has decreased, communities of color and lower income areas will continue to depend on public transportation as the country endures lasting impacts of the COVID-19 pandemic.

Medium- and heavy-duty sector electrification is increasing in the U.S., with California currently leading the way. To date, truck and bus deployment has been limited by several factors, including high upfront costs and low commercialization for truck and bus categories (other than transit buses). Announcements are expected from close to 50 manufacturers about new medium- and heavy-duty vehicles coming to market over the next five years.[35]

Falling battery prices and reduced EV costs at scaled mass production, coupled with continued commitment from automakers to produce EVs, will certainly aid market growth. In turn, consumer confidence will increase as EVs become more mainstream and a wider variety of models are available.

WASHINGTON POLICY CONTEXT

Transportation electrification is an area of growing interest, globally and locally, primarily because of its potential to lower emissions and improve public health. This includes reducing air pollutants, especially particulates that can disproportionately affect low-income communities and other highly impacted communities and vulnerable populations. Washington's legislature has set a target that, by 2030, overall emissions will be reduced by at least 45% below 1990 levels; transportation electrification will play an important role in meeting this target.

In addition, in 2015, Washington state committed to putting 50,000 electric vehicles on the road by 2020[36]—a goal aligned with the Washington State Department of Transportation's (WSDOT) 2015 Electric Vehicle Action Plan. Since then, Washington has surpassed this goal, with approximately 66,500 EVs on the road as of January 2021. The state's policies related to EV adoption are outlined by Washington's Department of Commerce State Energy Office. These include policies for vehicle adoption, incentives for vehicle adoption, policies for use of EVs in state business, and legislative authorization for charging pilot programs for WSDOT.[37] In Washington's 2021 State Energy Strategy, electrifying vehicles is a priority with goals to set ambitious statewide targets, improve planning and oversight of BEV charging infrastructure, and accelerate the market for BEVs. These statewide targets set important thresholds for stakeholder alignment, including PSE.

A brief background of legislation and policies is shown in Figure 4.

LOW CARBON FUEL STANDARD (LCFS)

LCFS is a market-based policy designed to reduce carbon intensity in fuels. Organizations that deploy electric vehicle charging infrastructure can benefit from LCFS by receiving credits for switching from high carbon (e.g., diesel or gasoline) to less carbon-intensive fuel (e.g., electricity). The most prominent example today is the LCFS Program in California, which allows EV charging infrastructure owners to earn credits for offsetting gasoline and diesel usage and subsequently trade them in a special market. Revenue generated from LCFS credits is a significant benefit to program participants in California, and can also be reinvested into expanding EV charging infrastructure or providing other incentives to customers.

The Washington state legislature considered a similar bill (HB 1110) in the 2020 session, but it failed to make it out of the committee. However, this is being reconsidered in the 2021 session under HB 1091. Puget Sound Clean Air Agency has also been considering a regional Clean Fuels Standard, although it was paused during the 2020 Washington state legislative session.

Figure 4 – History of transportation electrification legislation and policies in Washington state

- **2005 HB1397:** Adopts California's more protective low emission vehicle standards (excluding ZEV program regulations)
- **2007 HB1303:** Allows and incentivizes EV charging at state facilities.
- **2009 HB1481:** Promotes EV use and infrastructure investments by local jurisdictions of a certain size.
- **2015:** Governor Inslee sets Washington state goal of 50,000 EVs on the road by 2020.
- **2015 HB1853:** Requires the Washington Utilities and Transportation Commission (WUTC) to encourage EV charging infrastructure.
- **2016 Volkswagen Diesel Emissions Settlement:** Washington state received $141M in settlement funds, managed by WA Department of Ecology
- **2017 WUTC Final Policy Statement:** Outlines how the WUTC would regulate EV charging as a regulated electric utility service and policies to promote fair competition in the provision of EV charging services.
- **2018 Executive Order 18-01:** Prioritizes leasing and use of battery electric vehicles in state fleets.
- **2019 HB1512 & HB2042:** Allows utilities to adopt an electrification of transportation plan, and other EV incentives. Also includes provisions for EV sales tax exemptions, alternative fueling along highways, low-income EV adoption, and EV registration fees.
- **2019 SB5116 Clean Energy Transformation Act (CETA):** Commits Washington to an electricity supply free of GHG emissions by 2045. CETA applies to all electric utilities serving retail customers in Washington and sets specific milestones to reach the required 100% clean electricity supply.
- **2020 HB5811:** Requires automakers to sell zero-emission vehicles (ZEVs). The bill takes effect in 2022 and utilizes a credit system to ensure that about 6% of their new cars sold in WA are ZEVs.
- **2021 Washington State Energy Strategy:** Provides a strategic decarbonization roadmap and comprehensive assessment of major emissions segments including Transportation, Industry, Electricity, and Buildings. The state energy strategy outlines various actions towards meeting the state's GHG emission limits of 45% below 1990 levels by 2030, 70% below 1990 levels by 2040 and 95% below 1990 levels with net zero-emissions by 2050.

3. PSE'S APPROACH TO TRANSPORTATION ELECTRIFICATION

As part of our commitment to being our customers' clean energy partner of choice, Puget Sound Energy is dedicated to ensuring that transportation electrification plays a major part in reducing GHGs and pollutants throughout Washington. Currently, on-road vehicles account for over 45% of GHG emissions throughout Washington state.[38] By using electricity as a transportation fuel, PSE, together with our customers, can more effectively reduce those emissions, accelerate Washington's efforts to meet environmental goals, improve community health outcomes, and better support our customers' desire for lower-carbon options.

While customers ultimately make the decision to go electric, utilities play a role in advancing transportation electrification by delivering energy to electric vehicles, ensuring grid reliability through load management, transforming the market, and expanding benefits to broader segments of customers. However, utilities alone cannot expedite transportation electrification. They require partnerships with state and local governments, environmental agencies and advocates, mobility service organizations, vehicle manufacturers and dealers, and charging providers. This collaborative effort, coupled with PSE's investments in a modernized grid, will support increased customer adoption of EVs and the infrastructure to charge them.

PSE has actively worked to develop transportation electrification solutions that meet customer needs. We launched our first customer-facing EV program in 2014 and, ever since, have helped our customers realize the value and benefits of going electric. We have been creative in our approach to mobility, recognizing the importance of environmental justice and the implicit burden that traditional transportation places on low- and moderate-income households. All of the Up & Go Electric program includes products and services that support charging availability, electric rates designed for EV charging affordability, EV accessibility for low-income and historically unrepresented communities, and overall awareness of transportation electrification.

This section begins by providing an overview of our peer utilities' vehicle electrification programs. This section continues by describing PSE's transportation electrification goals and discussing customer and market barriers to EV adoption and PSE's role in addressing them. Finally, we discuss opportunities to partner and collaborate to further reduce market barriers.

UTILITY TRANSPORTATION ELECTRIFICATION PROGRAMS

Throughout the U.S., utilities have become increasingly involved in transportation electrification. Their strategies vary based on state priorities, legislation, and utility strategic operations. Their areas and degree of involvement in vehicle electrification have ranged widely. California was an early leader and continues to make the most significant investments.

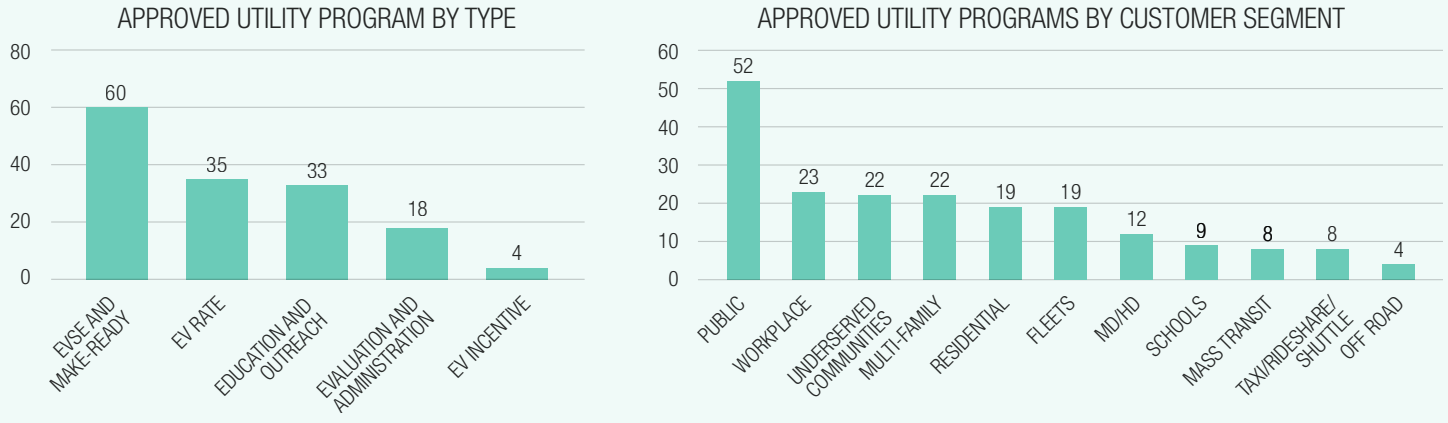
Generally, most utility programs are designed to address market education and charging infrastructure barriers. Electric utilities have been approved to offer incentives for charging station purchase and installation, as well as direct utility ownership of charging infrastructure in some cases. In other states like California and New York, a majority of their program funding goes toward "make-ready" infrastructure. Make-ready is where the utility funds the enabling infrastructure to support the installation of a customer charger. This concept is explored further in Section 5.

Many of these programs include management of electric vehicle" loads, including off-peak EV charging rates across a range of customer segments. Utilities' regular channels of communication with customers also provide a unique opportunity to share resources and information about the benefits of transportation electrification. This includes direct outreach to low-income and disadvantaged communities and other segments that are not always prioritized in other programs.

These utility approaches help inform our own program design and ways we can provide meaningful impact for our customers. Likewise, we collaborate with our peers across the country, and draw on lessons learned, to continuously refine and improve our offerings.

A summary of the utility program types and customer segments served is displayed in Figure 5 below.

Figure 5 – Number of Approved Utility Transportation Electrification Programs by Type of Program and Customer Segment[39]



Note: There are overlapping customer segments for certain approved utility programs.

SUMMARY OF PSE TRANSPORTATION ELECTRIFICATION PROGRAMS

PSE has supported Transportation Electrification Programs for over five years, with the most recent launch of Up & Go Electric. This program was created in response to customer demand and has proven to be very popular with our customers. Below displays a summary of our transportation electrification programs.

2000s

EARLY EV STUDIES

PSE conducted early assessments to determine impacts and risks associated with electric vehicle adoption.

2014–17

EV CHARGER REBATE PROGRAM

In 2014, PSE introduced the EV Charger Incentive (EVCI) program that offered customers $500 rebates toward the purchase of a residential EV charger. PSE's goal was to better understand the impacts of EV charging on the electric system. Overall, 1,993 customers participated in the program and completed surveys about their driving and charging habits while also allowing PSE to monitor their home energy usage through meter data. This helped PSE understand charging behaviors, how load shapes align with our peak demand times, ways to integrate renewable resources into our energy planning process, and customer charging needs. This initiative and the insights gained provided the foundation for PSE's transportation electrification roadmap.

2018–PRESENT

UP & GO ELECTRIC PILOT PROGRAM (2018 – PRESENT)

Based on the data and insights collected through the EVCI program, PSE's Up & Go Electric program was designed to take a multi-faceted approach to removing current adoption barriers and boosting charging infrastructure. The current portfolio of programs and pilots includes:

- Education and outreach to raise awareness about electric transportation and help customers make informed decisions about EV options. Since 2018, the Up & Go Electric Program has:
  - Tallied 583,684 customer engagements on EV education and awareness
  - Increased annual customer engagements by 93%
  - Had 11,553 engaged conversations with customers about EVs
  - Enabled 1,000 customers to take an EV test drive

- Residential charging and off-peak programs to increase customer knowledge around off-peak charging benefits, offer incentives to charge at off-peak times, and inform PSE's off-peak charging strategy. Up & Go Electric's home charging pilot saw rapid customer enrollment and builds capabilities around EV load management.
    - Word of mouth in the EV community drove demand for the home charger pilot when it opened for applications in 2019 – we received nearly 800 applications for 500 available chargers.
    - Up & Go Electric chargers have been installed in 500 customers' homes to test different incentive methods to encourage off-peak charging.
    - Early data suggests that performance-based payment incentives are driving off-peak charging behavior in pilot participants.
- Public charging to increase the supply of, and infrastructure for, reliable public charging stations in the region, beyond what's offered by the private market and public sector.
    - First of eight Up & Go Electric public charging stations opened in September 2020 in Lacey, WA.
    - EV drivers are finding the public charging station via charging apps like PlugShare and usage has grown organically month-over-month since launch.
    - The Up & Go Electric public charging network will expand across our service area, with seven more stations to open over the next two years, including locations in Kent, Renton, Kirkland, and Bellingham.
- Workplace and fleet charging to increase customers' access to charging options and their knowledge about EVs—and help PSE build a best practices toolkit for installation, system support, and charging load management.
    - With many employees working remotely due to COVID-19, siting and installations have slowed in 2020. Remaining installations are expected to be complete in 2021, bringing the total to 40 sites.
- Multi-family charging (MF) to increase charging access in multi-family and apartment buildings and help determine the ideal placement and servicing for these types of systems while better understanding charging load patterns.
    - Up & Go Electric chargers have been installed in 21 multi-family properties across our service area
    - 14% of multi-family installations are at properties housing low-income residents, thereby expanding access to electric transportation to an underserved market
- Low-income customer pilots to find new, scalable models to bring EV services or benefits to customers who may not have access to electric mobility, as owners or via public transit.
    - Low-income service provider pilots were designed to promote equitable access across low-income and disadvantaged communities to electric mobility and the distribution of resulting environmental, social, and economic benefits. Pilot use cases were co-created with local mobility stakeholders.
    - Pilots are underway for low-income and weatherization service provider, tribal transportation, and community car share use cases at five locations.
    - Pilots are under development for an electric school bus, non-emergency medical transportation, and additional low-income weatherization service provider use case.
    - PSE will evaluate benefits across the areas of service expansion, total cost of ownership, carbon abatement, education and outreach, as well as additional social and safety benefits.

PSE'S TRANSPORTATION ELECTRIFICATION OBJECTIVES

Consistent with WUTC's 2017 Policy Statement, we have taken a portfolio-based approach in designing and launching our transportation electrification products and services. Our portfolio of offerings is informed by customer input, supports our overall objectives and prioritizes customer needs. Over the past five years our customers have increasingly asked PSE to offer electric vehicle products and services.[40] We also recognize the importance of collaborating with the private sector and stakeholders to keep pace as technology matures. As each initiative and program is launched, it contributes to market transformation and helps us identify additional transportation electrification programs moving forward.

Our current goals fall into four high-level categories designed to create a robust, customer-centric electrified transportation future. They are also supported by statewide policy and legislation, as well as past program experience.

TE Program Goals

SUPPORTING AND ENABLING MARKET TRANSFORMATION:

We help customers understand the benefits of electrified transportation through market education, awareness, and technical advisory services. This includes ensuring that all customers have access to the benefits of transportation electrification. PSE also acts as a coordinator, providing a consistent customer experience throughout our service area and collaborating with a variety of partners to ensure that infrastructure and electrified activities are deployed efficiently and effectively.

ADDRESSING CHARGING INFRASTRUCTURE GAPS:

We are developing and enabling charging infrastructure, or electric vehicle supply equipment (EVSE), that supports charging needs and helps customers—from residential to large fleet operators—to feel more confident about making an EV purchase. This includes considerations such as location, equity, market availability, clean energy, and costs.

PLANNING FOR AND MANAGING ELECTRIC LOADS:

As EVs become more mainstream, and market transformation continues, PSE is planning for and will manage the forecasted load increases associated with EVs. This means studying different vehicle models, charging infrastructure, and customer use cases, as well as adopting pricing signals and structures that encourage ideal charging times.

FURTHERING ENERGY EQUITY AND INCLUSION:

It is our goal to provide equitable services to all customers, including those impacted by financial burdens and environmental and societal disparities. PSE aims to create innovative and intentional programs and strategies to engage our low-income and disadvantaged communities population with the intent to increase participation and benefits of an electrified transportation future.

OUR APPROACH TO PROGRAM DESIGN

Our approach to designing and implementing transportation electrification programs includes gathering feedback from our customers and the market and building on the success of our past programs and pilots. When launching new products and services, we strive to remove barriers to electric vehicle adoption and achieve measurable impacts. We also want to address barriers to equitable access and inclusion with offerings that provide electrified transportation availability to as many customers as possible and co-benefits like saving time or money. This includes supporting other customer values like improving air quality, reducing carbon, increasing cost savings, and reducing noise pollution.

Although every product and service is unique, our underlying methodology focuses on serving customers and the EV market by:

- **Building an understanding of customer barriers and needs:** We gather early input from our customers through various channels, including conversations based on our current offerings, outreach efforts, and quantitative research (customer surveys). These inform our understanding of customer needs and how PSE can best address them.
- **Tracking the transportation market and technology:** We proactively monitor, track, and engage in market activities, while also collaborating with industry partners. This informs our transportation electrification efforts and supports our grid modernization investments.
- **Aligning around program design:** We study existing market needs and barriers and determine what aligns with our own strategy and regional policy and provides value for our stakeholders.
- **Seeking out partnerships:** We look for opportunities to collaborate with stakeholders throughout Washington and the broader industry and with our customers. We believe these collaborations result in better outcomes.
- **Testing, gathering feedback, and iterating:** Since transportation electrification is still developing, we will continue to analyze the data we gather and share what we learn with our partners. This approach allows us to be more flexible and responsive as the market evolves.
- **Managing EV charging to support grid reliability:** PSE incorporates load management strategies in our programs, increasing the efficient utilization of the grid to benefit all customers.

PSE'S LOW-INCOME PROGRAM METHODOLOGY

For PSE's Up & Go Electric Low-income Customer Pilot, we conducted a mobility stakeholder workshop and held individual conversations with approximately 20 nonprofits, government agencies, community service organizations, and private mobility organizations to better understand their daily operations, fleet needs, benefits and barriers associated with electrification, and lessons learned from similar pilot programs.

Based on those discussions, we created a decision matrix to assess various use cases. This matrix helped prioritize projects by category. These include scalability, replicability, projected benefits, agency resources, implementation timeframe, electric vehicle availability and cost, and overall project viability.

More details about this methodology are included in Appendix B.

CUSTOMER FEATURE: HOPESOURCE

As part of our low-income pilot project, we provided HopeSource in Ellensburg, Wash., with funding to offset the cost of a new 2020 Kia Niro EV and installed a dual port L2 charging station to reduce any financial or infrastructure barriers to electric vehicle ownership.

"We are excited to have HopeSource participate in our pilot project so that they and the communities they serve can benefit from electric vehicles," said Will Einstein, Director of Product Development and Growth. "This project is part of our work with multiple service providers across Washington state to improve access to electric mobility for underserved customers and better distribute the environmental, social, and economic benefits of electric transportation."

The new EV has a range of more than 200 miles on one charge and will be used by all departments at HopeSource to provide client services in an economical and earth-friendly way. The vehicle has the slogan "Empowering a greener future" emblazoned on the side and will be zipping around Kittitas County powered solely by electricity.

"For years Puget Sound Energy has been a steadfast partner with HopeSource in providing services to low-income Kittitas County residents," said Susan Grindle, HopeSource CEO. "The grant from PSE to purchase the electric car and charging station is further evidence of the company's commitment to the community and the environment."

CUSTOMER AND MARKET BARRIERS TO ELECTRIC VEHICLE ADOPTION

The first step in our program design process is building an understanding of barriers that exist in the market and for our customers. From our experience and current conditions, we have grouped these barriers into three categories.

MARKET AND CONSUMER EDUCATION

The relative newness and rate of change of the transportation electrification market can make it more difficult for customers to be aware of their electric vehicle options and make informed decisions that address their needs.

PARTICIPATION AND VEHICLE OWNERSHIP

A variety of barriers can prevent customers from purchasing EVs or participating in transportation electrification programs.

CHARGING INFRASTRUCTURE

Until there is more widespread charging infrastructure, some customers may not feel comfortable making an EV purchase or participating in EV programs.

Customer needs vary across different use cases (e.g., personal vs. fleet, charging location, driving patterns). For the purpose of this document, we have identified barriers that impact all customers, as well as two key customer segments. Later in this section, we will outline specific use cases and how we are designing products and services for each of them.

All customers: This cuts across all customer classes and addresses ways to remove barriers that may disproportionately prevent some customers (e.g., those in low-to-moderate income ranges) from participating in transportation electrification.

Personal light-duty vehicle customers: These are primarily residential customers who use light-duty passenger vehicles (e.g., sedans, SUVs) for their personal use. They typically charge these vehicles at home (single-family or multi-family), work, or public charging stations.

Commercial and fleet customers: These customers typically have larger vehicle fleets that range in size from light-duty (e.g., passenger vehicles) to medium-duty (e.g., delivery trucks and shuttle buses), to heavy-duty (e.g., school buses, transit buses, and freight). This could also include community service organizations (e.g., food banks and housing authorities) that operate a fleet of vehicles.

A hybrid of the above classifications includes the growing segment of shared mobility. Shared-use vehicles, such as ride-hailing platforms like Uber and Lyft, generally have higher utilization than private-use passenger cars. Recent public announcements from these ride-hailing companies indicate a growing commitment toward electrifying shared mobility,[41] which will likely have significant impacts on future EV charging infrastructure needs.[42]

In the next three tables, we identify the primary market barriers that exist for our customers. Later in this section, we address PSE's role in overcoming these barriers. In Section 5, we outline how our programs will be designed to bridge these market gaps. For reference, more details about vehicle classes and their uses are included in Section 2. We also expand more about operating considerations for Fleet & Commercial customers in Appendix A.

MARKET AND CONSUMER EDUCATION

Barrier	Personal light-duty vehicles/ residential customers	Commercial and fleet customers
Customer awareness	Customer awareness of EVs is higher in PSE's service area than it is nationally. Sixty-eight percent of PSE customers said they would likely buy an EV,[43] although this has not yet materialized into an actual purchase. Current sales volume of EVs throughout WA still hovers around 6%.	Commercial and fleet operators are familiar with conventional gas/diesel operations and their associated operational and budget considerations. Often, fleet managers are not yet aware of the latest available EVs options and their respective benefits.
Information and technical advisory	Information & Technical Advisory Information about EVs can come from multiple sources and is not widely available compared to conventional vehicles. Automotive sales channels (e.g., dealerships) still have limited training and incentive to sell an EV over a conventional gas vehicle.[44] Customers also need a better understanding of charging options, including home installation and other public charging options.	Commercial customers typically have larger electric loads associated with their conversion to EVs. This requires more robust planning, by both the customer and the utility. Early partnership and alignment helps mitigate later issues related to design, costs, construction, and load management.

PSE'S ROLE IN MARKET AND CONSUMER EDUCATION

Market education is an area where PSE can add significant value and help customers better understand their options and the technical requirements for adopting electric vehicles, including charging costs and operations. PSE's current efforts with Up & Go Electric primarily focus on light-duty vehicles, although we are increasingly addressing the needs of our commercial and fleet customers. As our programs evolve, we will continue building technical advisory capabilities that better serve commercial and fleet customers. Many municipal fleets and community service organizations also help expand access to low-income and disadvantaged communities. Transit buses, for instance, are considered heavy-duty fleets capable of providing broad access to customers across all income levels. PSE has ongoing collaboration meetings with transit agencies (e.g. King County Metro) in our service area to align around priorities and activities.

PARTICIPATION AND VEHICLE OWNERSHIP

Barrier	Personal light-duty vehicles/ residential customers	Commercial and fleet customers
Vehicle costs, initial and Total Cost of Ownership (TCO)	While more affordable electric passenger vehicles are becoming available, their upfront costs are still higher than their non-electric counterparts. Light-duty EVs are estimated to reach price parity with conventional vehicles in the mid-2020s.[45] Until then, the primary consumer benefits result from fuel and maintenance savings, which are not enough to sway all customers.	Upfront costs of medium- and heavy-duty EVs are a significant barrier to increased market adoption. Electric transit buses are roughly twice as expensive as diesel alternatives.[46] While upfront costs are still higher, the TCO for many medium- and heavy-duty electric vehicles is lower than current diesel alternatives and will continue to decline.[47]
Lack of used vehicle market	In the U.S., around 60% of current vehicle purchases are pre-owned models. However, because most electric models are less than 10 years old, the market availability for used EVs is still very limited.	Although a used EV market could benefit commercial customers, especially for light-duty fleets, it likely won't be an option for the next five to 10 years.
Model availability	Model availability has been inconsistent over the last several years, although major commitments from automakers are expected to significantly expand the number of available EV options. Automaker electrification plans also include an increased focus on SUVs and pickup truck electrification throughout 2021,[48] giving consumers more choices.	The medium- and heavy-duty market is still in its infancy, although major manufacturers brought new freight trucks to the North American market in 2019. More models become available each year, with electric school bus and electric transit bus markets dominated by a handful of companies.[49]
Model features—battery and range	Range continues to be a primary consideration influencing consumer choices and EV demand, even though the national average driving distance is approximately 39 miles daily.[50] The five highest-selling all-electric vehicles in 2019 had a range greater than 200 miles, and sales for similar EVs are expected to grow steadily through 2030.[51]	Medium- and heavy-duty vehicles require larger battery packs due to heavier vehicle weights and payloads, while maintaining customer range expectations. The battery cost is a major influencing factor for the significantly higher vehicle prices in this market.
Cost/price signals (when to charge)	Customers (and PSE) are interested in ways to save money while also optimizing charging patterns that benefit the grid and all customers. Customers have shown a willingness to respond to price signals and manage charging during certain off-peak periods during the day.[52]	Commercial and fleet operators are looking for rates and rate structures that support electrified transportation options. Often, these loads can be multiple megawatts. Both PSE and its customers are interested in managing these loads for both grid benefits and cost savings.
Equitable access	Not all customers have access to electrified transportation options and their associated benefits. Likewise, there are uneven opportunities to participate in electrified transportation. These barriers can include light-duty vehicle costs, public transportation availability, or access to shared-mobility vehicles and services.	

PSE'S ROLE IN PARTICIPATION AND VEHICLE OWNERSHIP

For participation and ownership barriers, there are certain areas that **we won't** be able to address. This includes model availability, model features, and the used vehicle market. While PSE does continue to coordinate with automotive original equipment manufacturers, we have limited influence over how they release vehicles or how quickly. Therefore, we will not address these particular barriers in our current programs but will incorporate this information into our education and awareness initiatives that inform our customers.

The participation and ownership barriers we can address are equitable access, total cost of ownership, and cost/price signals. PSE has a role in addressing these barriers and how they are incorporated into program design. Currently, through our Up & Go Electric Low-Income Programs, we are offsetting the incremental cost difference of electric vehicles and conventional vehicles for local community service organizations. Looking ahead PSE will also explore employing new tactics such as commercial ride and drive events that will help educate commercial fleet owners on the total cost of ownership benefits of EVs and rental programs that eliminate the up-front cost barrier to utilizing EVs.

CHARGING INFRASTRUCTURE

Barrier	Personal light-duty vehicles/residential customers	Commercial and fleet customers
Consistent charging experience	Charging across locations, use cases, and speeds can vary significantly across charger equipment. To aid in market transformation, it is important that the user experience is consistent with charging equipment, that stations are maintained and meet customer expectations, and deployed infrastructure is interoperable between networks.	
Lack of charging locations	Limited access to charging remains a barrier to increased EV adoption. Currently, the Puget Sound region is only at 31-40% of the required levels of charging infrastructure required to meet demand by 2025.[53] One of the main barriers to increasing access to DCFC charging is the challenging business case for public charging infrastructure, and lower charger utilization can impact viability.	Interstate partnerships are emerging as one method to address the challenges facing freight electrification. Commercial fleets will be a major source of EV energy demand and require specific charging infrastructure solutions—either at private facilities (such as vehicle depots or distribution centers where vehicles are charged while goods are loaded and unloaded) or in shared charging plazas.
Charging installation	As much as 85% of EV charging occurs where a vehicle is parked overnight.[54] Installation costs can vary widely for homeowners and be a barrier for those in multi-family (MF) dwellings where charging access is limited. MF dwellings have additional challenges, including the variety of property styles, high capital costs, and lack of incentive or motivation for landlords to install charging stations. Estimates show that the cost of installing a Level 2 charging station at a MF unit can be three times higher compared to a single-family home.[55] Public and workplace charging can help fill the gap for drivers who lack off-street parking or are otherwise constrained from charging at home.	The speed at which fleet managers will electrify their fleets depends on operational constraints, the Total Cost of Ownership (TCO), and the parameters of their existing facilities. Often, charging infrastructure requires trade-offs between parking spaces and route planning/charging, which can impact installation planning and construction. This can make conversions from a gas to electric fleet more complicated than a typical fleet replacement turnover.
Charging maintenance	Maintaining infrastructure can be an operational burden that is often not accounted for when installing charging. Landlords may abandon apartment charging or network operators and owners may not be able to maintain publicly-available charging sites that meet driver expectations.	Fleet managers need to account for charger maintenance in their ongoing operations. Because this is often a new technology, it requires internal training and a point-person overseeing charger maintenance.
Charging speed/power requirements	Charging speed can be a barrier to adoption in some cases. The charging speed required for LDV residential customers is largely dependent on location and how much time is available. Overnight Level 2 (~ 2 – 19 kW) charging works well at the home, while faster speeds of 150 – 350 kW are required en-route, likening it to a gas fill-up.	Similar to LDV, MD and HD vehicle charging speeds are aligned by use case. Often, these charging speeds start at 50-150 kW and can be in multiple MW for large off-road vehicles (like ferries). The speeds can require significant power draw if there are multiple vehicles charging at the same time.
EVSE investment	Studies have shown that the business case for hosting charging stations remains challenging for many potential site hosts. Data show that station utilization exceeding one session per day, and access to public funding, were core factors increasing the chance of profitability for charging stations.[56]	Charging infrastructure costs and lost revenue due to charging downtime were the primary factors leading different types of electric trucks to have higher operating costs than diesel trucks.[57] Fleet operators have reduced costs and improved the business case for investing in this technology by leveraging grant programs and electric utility investment, along with thoughtful charging strategies.
Talent and workforce	To support a healthy electrified transportation ecosystem, there needs to be a trained technical workforce to support the transition. Currently, there are some technical assistance training programs, but very limited talent pipelines exist to support installation, operations, and maintenance of EVs and EVSE.	It is expected that EVs and charging infrastructure will continue to create opportunities for engineers, construction managers, electricians, planners, programmers, technicians, and specialized automotive technicians. There is also an opportunity to leverage training programs from Washington's Department of Commerce.

PSE'S ROLE IN CHARGING INFRASTRUCTURE

PSE can play a significant role in overcoming charging infrastructure barriers. Our approach varies by charging type and customer segment, and we tailor our programs and offerings to specific customer needs and business model strategies. There is an important relationship between the availability of charging infrastructure and consumer confidence. It's frequently been found that the deployment of public charging infrastructure is linked to greater electric vehicle uptake.[58] Ensuring that charging networks are maintained and meet customer expectations is also crucial to building that confidence and support.

Additionally, ensuring the interoperability of EV chargers will maximize EV drivers' access to public chargers. Continued collaboration with existing organizations such as Greenlots and Enel X leaves room to address ongoing customer concerns and challenges on maintenance. As the market stands today, EV infrastructure deployment is promising, but the rollout has been uneven and has not always kept pace with the anticipated demand. More details about our approach to deploying charging infrastructure are outlined in Sections 4 and 5.

PSE'S ROLE IN ADDRESSING MARKET BARRIERS

Guided by customer needs, PSE strives to make the greatest impact on market transformation and drive healthy competition. We have evaluated the barriers listed above to help determine our responses based on customer type. To date, the customers participating in Up & Go Electric, and the associated charging infrastructure PSE is providing, still represent a relatively small percentage of what is required to meet the need of electric vehicles in our service area.

PSE's current Up & Go Electric programs are primarily focused on the personal light-duty market, with a few exceptions targeting workplace fleets and low-income segments. An increasing number of commercial customers have begun electrifying their fleets, and many more customers are evaluating the feasibility. PSE is collaborating with these customers and developing offerings that address their needs. Table 2 outlines each customer segment's primary market barriers and PSE's role in mitigating these challenges while supporting healthy market growth.

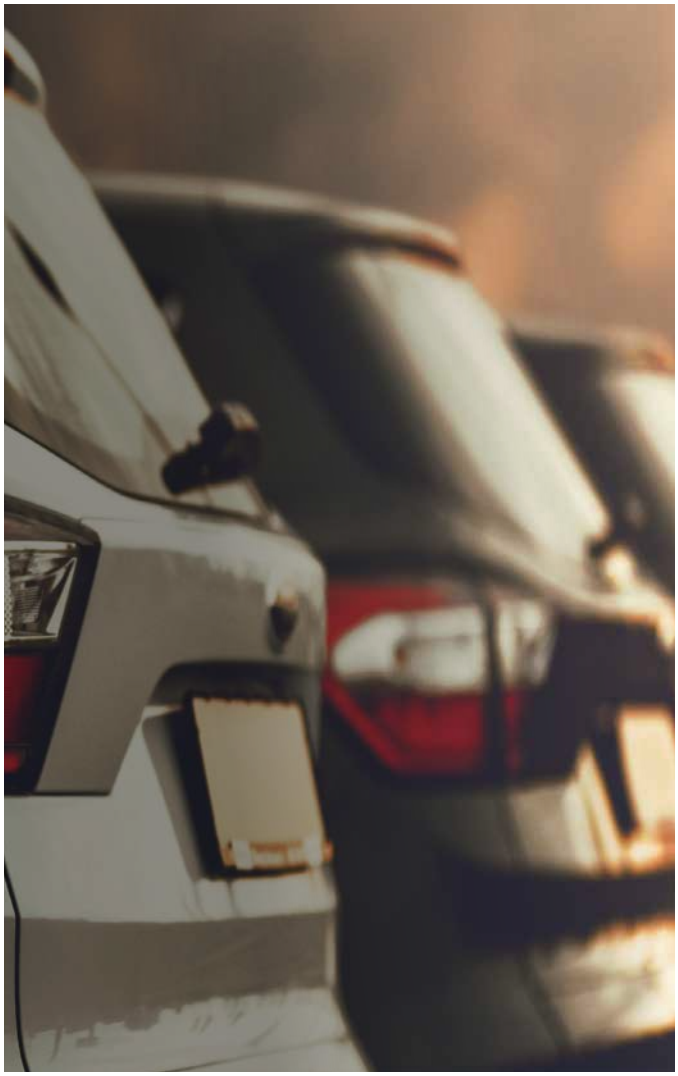
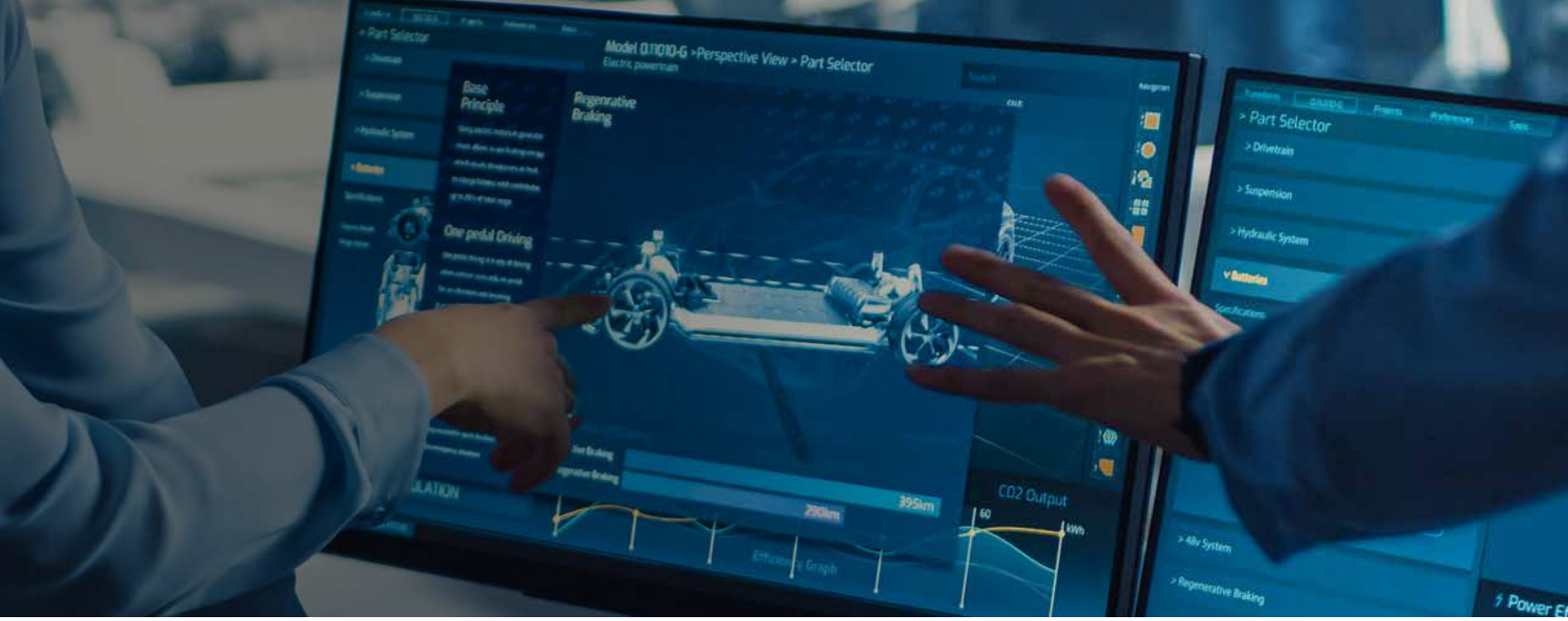


Table 2 – PSE's Program Design in Addressing Transportation Electrification Barriers

Customer segment/ use-case	Types of vehicles	Primary market barrier(s)	PSE's role in addressing barriers and market transformation
All customers		• Customer awareness • Information and technical advisory • Consistent charging experience • Talent and workforce	• Educating customers about transportation electrification and vehicle types that best match their needs • Raising awareness about transportation electrification and the associated benefits • Acting as an advisor to customers, helping them navigate their decision to choose transportation electrification • Supporting a transportation electrification ecosystem by creating expertise and workforce development
Low-income and Disadvantaged Communities		• Equitable access • Vehicle costs • Lack of used EV market	• Ensuring that all customers have the opportunity to benefit from transportation electrification • Engaging with low-income and disadvantaged communities to identify program opportunities that increase adoption and use of EVs. • Accelerating the adoption of electrified transportation across a range of income types, demographics, and geographies • Creating partnerships that support multiple modes of electrified transportation • Offering technical/job training services to communities for support of infrastructure to increase exposure and education
Residential stand-alone	LDV	• Cost/price signals • Charging installation	• Increasing customer access to reliable charging • Managing the associated electric load from residential charging
Residential multi-family (MF)	LDV	• Lack of charging locations • Charging installation • Charging maintenance • Cost/price signals	• Increasing customer access and ease of acquisition of reliable charging • Managing the associated electric load from residential charging
Public charging	LDV Multi-Modal	• Lack of charging locations • Charging maintenance • EVSE investment • Charging speed/power requirements	• Increasing customer access to reliable charging, identifying and filling existing gaps • Developing local best practices and playbooks for installing charging infrastructure and coordinating its deployment • Coordinating infrastructure deployment and planning for larger charging requirements and system upgrades • Exploring multi-modal charging options and charging "hubs" for different usage like ride-share, shuttles, etc. • Understanding charging patterns by location type and how they impact PSE system loads
Workplace (employer/ employee)	LDV	• Charging installation • Cost/price signals	• Increasing customer access to charging • Managing the associated electric load from workplace charging
Commercial fleet (e.g. freight, local delivery)	LD fleet MD fleet HD fleet	• Cost/price signals • EVSE investment • Information and technical advisory • Charging speed/Power Requirements	• Providing advice and expertise as customers electrify their fleets • Planning for larger charging requirements and system upgrades • Understanding charging patterns at various location types, how they impact PSE's system planning, and proactively managing charging loads • Developing programs that are responsive to customer needs
Transit, government, and community agencies	LD fleet MD fleet HD fleet	• Information and technical advisory • Vehicle costs • Cost/price signals • EVSE investment • Charging speed/power requirements	• Making vehicle conversion more accessible • Providing advice and expertise as customers electrify their fleets • Planning for larger charging requirements and system upgrades • Understanding charging patterns at various location types, how they impact PSE's system planning, and proactively managing charging loads • Developing programs that are responsive to customer needs



STATEWIDE ACTIVITIES AND PARTNERSHIPS

PSE's approach to offering transportation electrification programs is informed by and done in coordination with other investments made by Washington state. Likewise, commitments to transportation electrification throughout the state benefit from many interagency partnerships as well as a high level of collaboration with private sector companies. In Washington's 2019 and 2020 legislative sessions, many state agencies received funding to advance transportation electrification, which also aligns with PSE's priorities.

Washington has continuously demonstrated leadership in transportation electrification investment; only California and New York have committed more to electric vehicle adoption and EV charging. While this is encouraging, there are still more opportunities to support the transition to EVs, and almost half of the state's Volkswagen Settlement allocation remains. Plus, even more investment will be required to reach climate and clean transportation goals.

VW SETTLEMENT FUNDS

In 2016, the US Government and Volkswagen (VW) resolved allegations that VW violated the Clean Air Act. Through that settlement, VW will provide approximately $3B to remediate excess, illegal air pollution by funding projects to reduce diesel emissions. As part of this settlement, VW also established Electrify America a subsidiary of VW directed to invest $2 billion in ZEV charging infrastructure throughout the country. Washington state was allocated $141M in settlement funds, which is being managed by the Department of Ecology. These funds are dedicated to projects that support WA's transition to zero-emissions transportation systems. More than $60.3M has been invested statewide through the settlement, including $35 million to convert three of the state's largest ferries to hybrid-electric engines.[59]

Bus electrification efforts are a priority, with transit agencies served by PSE in King, Kitsap, Whatcom, and Pierce counties receiving funding to invest in electric buses. Across all government grant programs, transit agencies in PSE's service area have been awarded more than $26 million to support transit bus electrification.[60] School districts are also increasingly interested in bus electrification, and the Department of Ecology made an initial investment of $12 million to bring 40 new electric school buses to Washington using Volkswagen settlement funds.[61] We are working closely with our transit agencies and school districts to support their charging needs as they convert to electric buses.

WSDOT is currently working with state agencies, electric utilities, and organizations in Oregon and California to develop the West Coast Electric Highway, a network of light-duty charging infrastructure along transportation corridors throughout the region. WSDOT leveraged more than $2.5 million through their Electric Vehicle Infrastructure Partnerships Program between 2017 and 2019.[62] The Washington Department of Commerce runs the Electrification of Transportation Systems Program through the Clean Energy Fund, which has competitive grant funding.[63] Table 3 provides a snapshot of statewide transportation electrification activities.

Table 3 – 2019-2020 Statewide Transportation Electrification Activities

Organization	Priorities	TE Segment Focus	Estimated Funding
Department of Commerce	Charging infrastructure, project finance, vulnerable communities	Government fleets, public transportation, workplace, multi-family units	$10M
Department of Ecology	DCFC charging along corridors/ highways	Light-duty vehicles	$4M
Department of Ecology	Workplace charging	Light-duty vehicles	$2.3M
Department of Ecology	School bus procurement	School districts & buses	$12M
WSDOT	Public transit vehicles, equipment, and infrastructure	Transit agencies	$12M
WA State Ferries	Vehicle conversion	Off-Road	$35M
Electrify America	DCFC charging	Light-duty vehicles	~ 60 DCFC in PSE service area
Private Charging Companies	Varied	Light-duty vehicles	~ 84 DCFC in PSE service area

In 2020, PSE participated in the West Coast Clean Transit Corridor Initiative. This year-long study, conducted by nine electric utilities and two agencies representing more than two dozen municipal utilities, recommended adding electric vehicle charging sites for freight haulers and delivery trucks at 50-mile intervals along Interstate 5 and adjoining highways. The study also provides research information on the transportation electrification market landscape (e.g., regulations, policies, programs, and technology trends) in California, Oregon, and Washington and makes recommendations for starting long-term planning to accommodate new charging needs.

Finally, PSE regularly coordinates with private sector investment in transportation electrification. This includes charging station providers, original equipment manufacturers, software developers, and other agencies. This collaboration becomes increasingly important as we build an ecosystem for positive EV experiences throughout Washington.

PSE'S PROGRAM FOCUS MOVING FORWARD

The barriers, market needs, and current stakeholder investments we've outlined are important tools for shaping PSE's plans and programs. Up & Go Electric's Light-Duty Vehicle programs are a good first step to help our customers adopt electric vehicles and create an ecosystem that supports transportation electrification. However, Up & Go Electric currently addresses just a fraction of what the growing market will require. In subsequent sections of this document, we address the adoption forecasts and power requirements projected for the future.

We will also continue to build on learnings from our light-duty programs and begin to craft our next phases of customer offerings. Our focus will be on key market barriers for our customers and the areas we can impact and influence the most. Commercial and Fleet customers contribute about 46% of the carbon emitted in the transportation sector. Additionally, diesel vehicles dominate the heavy-duty vehicle segment.

PSE has an immediate need to support our Commercial and Fleet customers. This market has evolved rapidly since the 2018 launch of Up & Go Electric, and PSE is currently designing programs to serve this market. These customers hail from the private sector, tribes, public transportation, school districts, mobility providers, and municipalities. Their fleets also range in vehicle types between LDV, MDV, and HDV. Our customers are adopting these vehicles at a rapid pace, and we want to support this conversion and ensure that the appropriate charging infrastructure and load management is in place.

CUSTOMER FEATURE: AMAZON

Amazon is taking dramatic steps to change their logistics business. Shipment Zero is Amazon's vision to make all Amazon shipments net zero carbon, with a goal of delivering 50% of shipments with net zero carbon by 2030. A Shipment Zero order will be transported in a zero-emissions delivery vehicle from a fulfillment center powered by 100% clean energy. Zero-emissions delivery vehicles are 100% battery electric or hydrogen-fueled, in addition to electric bikes and electric three-wheelers.

To support Shipment Zero, Amazon ordered 100,000 electric delivery vehicles from Rivian, a U.S. electric vehicle manufacturer. This is the largest order ever of electric delivery vehicles. Amazon plans to start using these new vehicles from Rivian to deliver packages to customers by 2021, with 10,000 new vehicles on the road as early as 2022 and all 100,000 vehicles on the road by 2030.

We expand on these programs in Section 5. Our high-level focus for **Commercial and Fleet customers** targets:

MARKET EDUCATION

We aim to help these customers assess the benefits and tradeoffs of electric conversion and align our education and technical advisory efforts to best serve commercial customers' needs.

PARTICIPATION AND OWNERSHIP CONSIDERATIONS

Aligned with our market education efforts, we want to make fleet conversion easier. Since charging patterns will vary by customer, we want to understand those patterns and their associated loads and adapt our rates and price signals to help reduce customer charging costs as well as improve load and grid management for PSE.

CHARGING INFRASTRUCTURE

This will be the most significant area of development. Commercial and Fleet customers have large power requirements which, in turn, will require infrastructure planning on PSE's part to meet that need. In addition, our commercial customers have varying business objectives that PSE will need to consider when bringing charging offerings to the market.

LOAD MANAGEMENT

We plan to build upon the existing Up & Go Electric Pilot that tests different incentive methods to encourage off-peak charging to increase overall grid utilization and minimize growth in local distribution and system peaks. Additionally, we plan to explore the opportunity for EVs (especially medium- and heavy-duty fleets) to deliver power to the grid (vehicle-to-grid) during peak times through innovative technology pilots.

In subsequent sections, we will provide more detail about vehicle adoption and load requirements across sectors and vehicle types, including PSE's approach to designing future programs and filings. Given the speed at which commercial and fleet customers are adding vehicles on the road, we anticipate our next program filing closely following the submission of this TE Plan.

PSE'S INTERNAL FLEET ELECTRIFICATION GOALS

As stated in PSE's Beyond Net Zero Carbon goal, PSE is committed to decarbonizing its utility fleet through electrification and other means while reducing the mileage driven to serve our customers. These efforts will result in valuable learnings and insights that we will incorporate into our customer electric vehicle programs and enable PSE to better assist customers in their own transition. To accomplish this, PSE has set forth the following goals:

- 100% of Light-duty vehicles electrified by 2030
- 80% of Medium-duty vehicles electrified by 2030
- 50% of Heavy-duty service trucks electrified by 2030
- For vehicle types that cannot be converted to electricity as a fuel source, PSE will pursue the use of lower carbon fuels
- PSE plans to deploy EV charging infrastructure to serve 100% of electrified fleet vehicles at PSE facility locations by 2025. This will include a mix of fast charging (DCFC) and Level 2 charging, depending on vehicle type and use case
- For forklifts, PSE is targeting electrification of 100% of its units by 2030
- PSE will further explore technological advancements, particularly for heavy-duty use, through industry associations and our industry knowledge as an energy company

4. PLANNING FOR TRANSPORTATION ELECTRIFICATION

The data pertaining to electric vehicle forecasts, energy and load increases, and system impacts presented in this section provides an important snapshot for how PSE is planning for the future and designing programs to meet customer needs. As more EV models are introduced to the market, consumer interest and confidence will continue to grow, resulting in more EVs in PSE's service area.

PSE will need to plan for this forthcoming demand and ensure enough chargers are available to meet driver's needs—across all vehicle classes and customer segments. This will require continued planning with state agencies, charging network operators, and the private sector to coordinate deployment and adequately address market gaps.

PSE must also play a critical role in managing the impending EV load. As vehicles with larger battery capacities come online, and customer preferences trend toward faster charging speeds, PSE will need to ensure it is balancing these demands with overall system load requirements. This will require proactive planning and load management strategies that address increased vehicle adoption. As the next section will show, this increased adoption can provide benefits to all customers and become a grid resource when properly managed. These are important factors in PSE's program design and future EV program filings.

ELECTRIC VEHICLE MARKET ADOPTION

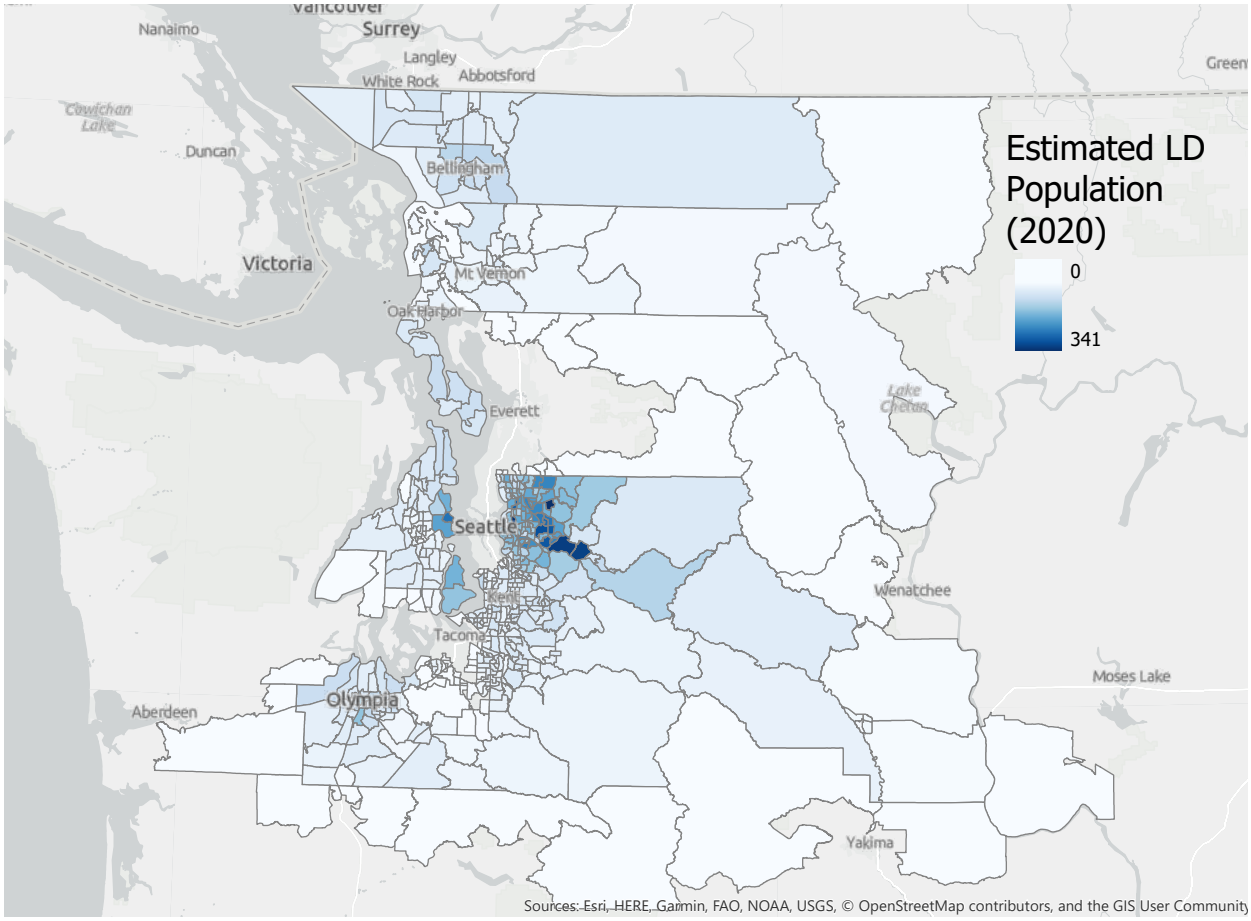
Sales for U.S. passenger electric vehicles have experienced considerable growth in the two years prior to COVID-19 (2018-2019), trending notably upward compared to the early days of the market (2010-2017). Cumulative EV sales surpassed the 1 million vehicle threshold in 2018 and will likely exceed 2 million sales in the next two to three years. This also holds true for medium- and heavy-duty sales. Some projections have estimated approximately 50,000 commercial and fleet EVs on U.S. roadways today.[64]

Estimates from early in 2020 showed the U.S. passenger EV market growing at least 6% annually through 2050, and medium-duty commercial vehicle sectors are expected to grow by 31% through 2040.[65, 66] These projections were made prior to COVID-19 and will likely be modified once the pandemic's impacts are better understood. While short-term market impacts are expected, recent trends and customer demand indicate that longer-term impacts of COVID are not likely to be significant.

REGIONAL EV ADOPTION

In Washington, individual consumers and fleets are increasingly purchasing electric vehicles. As of January 2021, Washington had more than 66,500 registered light-duty vehicles on the road, making it the third largest market in the country, after California and New York.[67] Both all-electric and plug-in hybrid vehicles accounted for an estimated combined 4.3% of total vehicle sales in Washington in 2020.[68] This exceeds the 2020 national EV sales volume of 2.1%.[69] Currently, more than 50% of all EVs on the road in Washington are registered in ZIP codes with electricity served by Puget Sound Energy.[70] Figure 6 shows the concentration of light-duty EVs throughout our service area.

Figure 6 – Electric Vehicle Registration Concentration in PSE Service Area



Beyond the passenger vehicle industry, Washington also leads in transit bus electrification with the second largest state fleet in the country. More than 211 electric buses were either purchased or in operation in Washington as of October 2019,[71] primarily led by King County Metro's commitment to bus electrification. In addition, school districts in Washington have 40 new electric buses coming online thanks to Department of Ecology funding, with 17 of these buses in PSE's service area.[72]

REQUIRED CHARGING INFRASTRUCTURE TO MEET MARKET DEMAND

As more long-range electric vehicles are introduced into the market, there will be a significant customer need for higher power levels and DC fast charging. In addition to offering faster charging speeds, the location of these charging stations becomes important to provide convenient charging options. Currently, most fast charging stations are around 50 kW, although Electrify America and Tesla have stations that range from 100 kW to 350 kW.[73] While 50 kW is significantly faster than overnight home charging, it can still take upwards of one hour to recharge longer-range car batteries. When DC recharging speeds reach between 150 and 350 kilowatts, it begins to mirror the refueling experience of a conventional gas vehicle.

Most of the fast charging networks throughout the U.S. can be attributed to Tesla and Electrify America, although Tesla's system is proprietary for their vehicles. Overall, charging infrastructure deployment continues to expand, through both utility investment and the private market. The port count for Level 2 and DC charging, combined, increased by over 30% between 2018 and 2019, although there are still significant infrastructure gaps (see Author's Note below). It is estimated that in 2020 there were approximately 93,000 publicly available charging locations throughout the U.S.. Edison Electric Institute estimates that in the U.S. about 1.1 million publicly available charging stations, or 9.6 million total charge ports (including home charging), will be needed to support the 18.7 million EVs projected to be on the road in 2030. The mix of charge ports by location is shown in Figure 7.[74]

Figure 7 – Nationwide Estimate of EV Charging Infrastructure Required by Location in 2030

Author's Note: A charging station or EVSE is the physical piece of infrastructure that is installed. A "port" or "handle" is the connection point for providing power. In non-residential settings, there is often one to four ports per station.

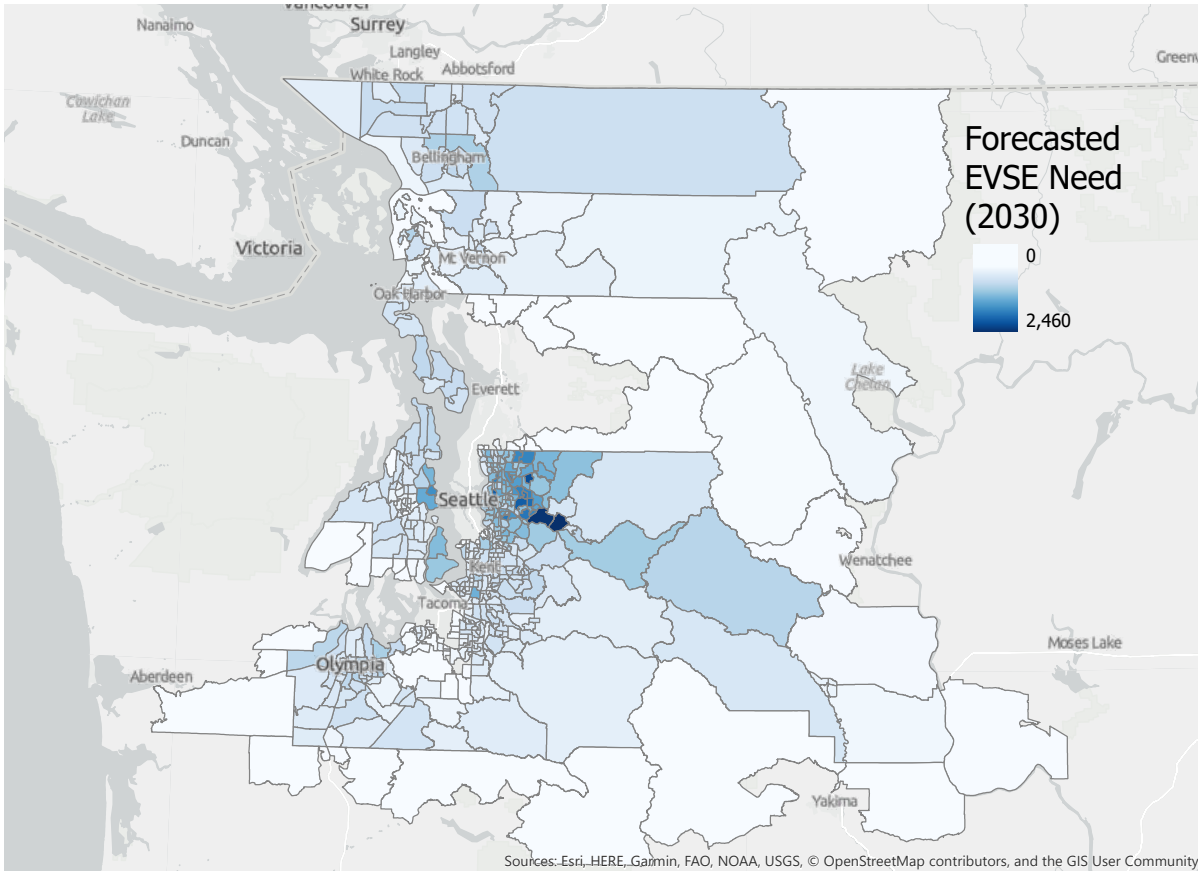
As of early 2021 in Washington state, there are approximately 3,300 public charging stations, which are predominately Level 2 chargers (2,764 ports).[75] The majority of fast chargers in Washington are Tesla and Electrify America stations, although this number is expanding with other third-party investments. Guidehouse (Navigant) estimates that there are 32,515 total chargers in PSE's territory, inclusive of home charging. Since the charging market is rapidly developing, siting for many current stations in Washington may not align with future market needs.

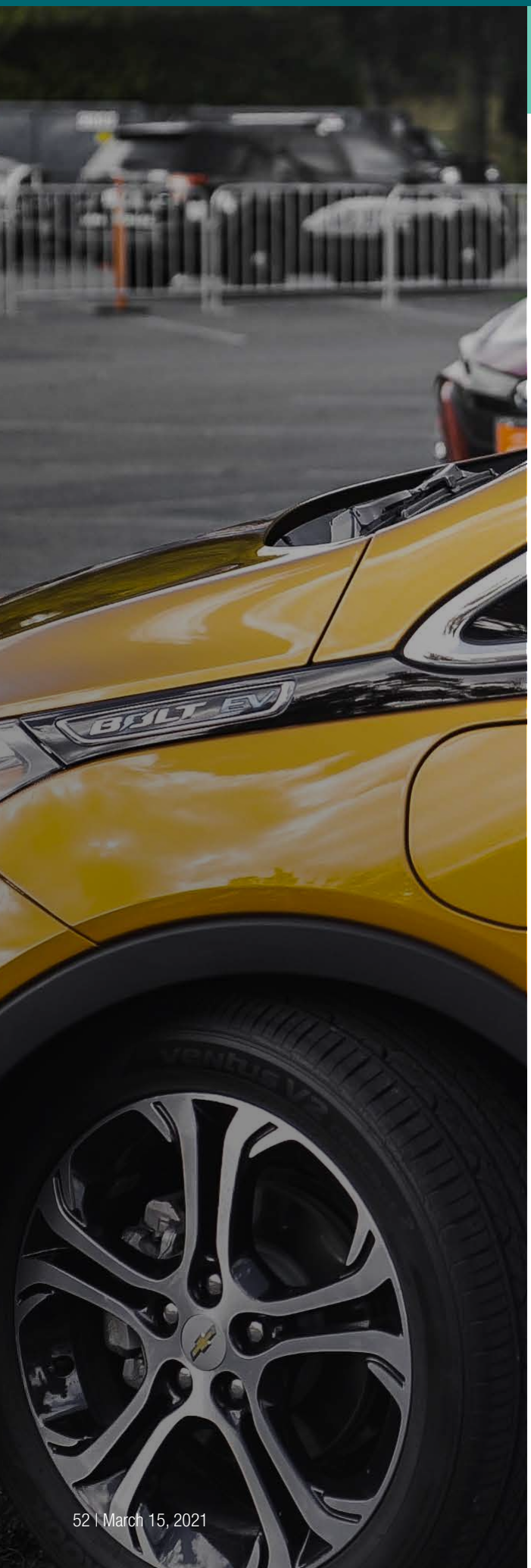
Faster charging capabilities will be required for medium- and heavy-duty vehicles, and many freight trucks are being designed to accept these faster speeds. PSE recently participated in the West Coast Clean Transit Corridor Initiative, which was a collaboration between nine electric utilities and more than two dozen municipal utilities, to evaluate charging needs for freight haulers and delivery trucks along Interstate 5 and adjoining highways. The study showed that stakeholders, including utilities, must begin proactive engagement to accommodate long lead times (lasting multiple years in most cases) for system planning and site development to enable the required charging infrastructure.[76]

Our Up & Go Electric program has played an important role in fostering consumer confidence and starting to fill infrastructure gaps. That said, our program's approximately 800 total charging ports (including residential) are only a small portion of what will be required over the next five years.

In addition to expanding access to public charging, PSE is proactively working with community organizations to help expand access and benefits of electrified transportation. We are already engaged with a community car share program with King County Metro. PSE could expand partnerships with transit organizations and counties to bring forth conversations of how public transit routes can be expanded to account for needs of low-income and disadvantaged communities. Public transit electrification in such communities works simultaneously to provide transportation coverage in areas that may be deficient and suffering from redlining, while also widening the exposure and education of electrification. As such, PSE will continue to evaluate market needs and design programs that address those gaps.

Figure 8 – Charging station locations by Census Tract





PSE ELECTRIC VEHICLE FORECASTS AND LOAD IMPACT

It is estimated that there will be approximately 18.7 million electric vehicles on the roadways in the U.S. by 2030, which represents 7% of all vehicles on the roadway,[77] up from approximately 2% today. In PSE's territory, our most recent forecasts completed in 2021 estimate that sales volume will be approximately 29% EVs in 2030. In recent customer research, PSE found that approximately 68% of customers said they were likely to buy an EV.[78]

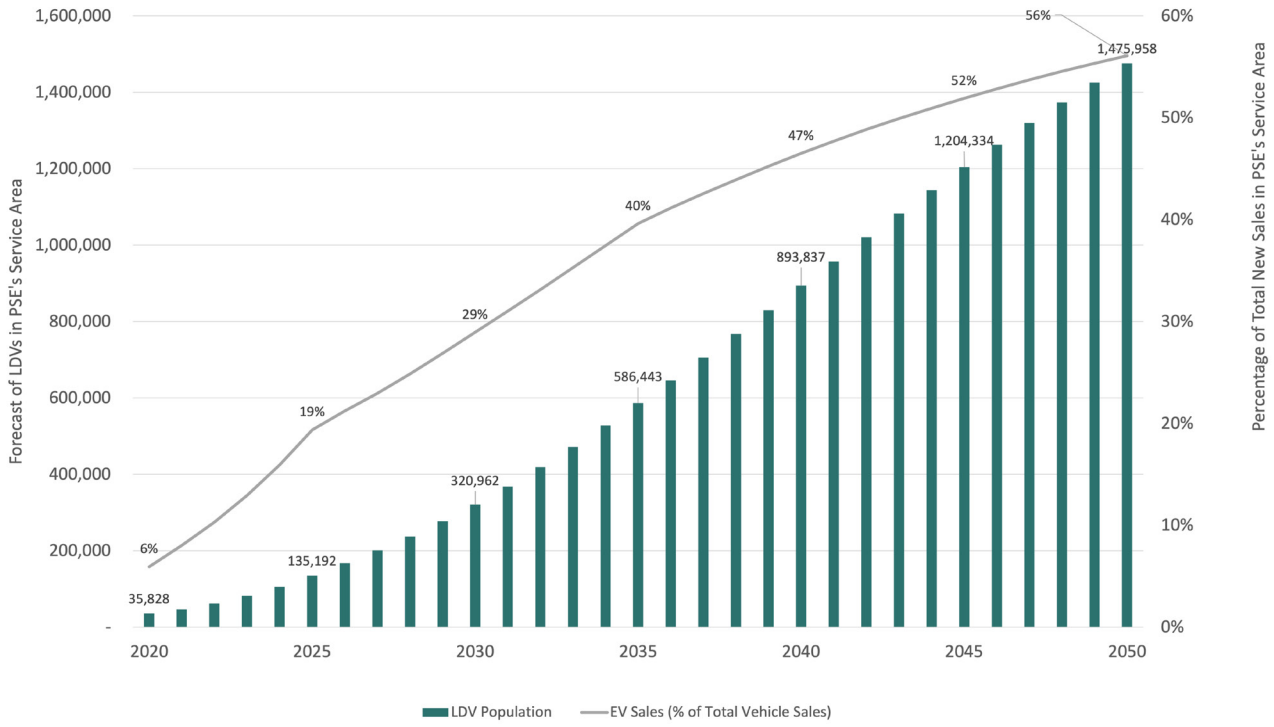
Given that the EV market is rapidly evolving, PSE works in coordination with Guidehouse (Navigant) to develop annual forecasts to better assess market conditions and the potential load impact. These forecasts incorporate the anticipated impacts of current policies. Much of this section is based off of forecasting work performed with Guidehouse and PSE's load forecasting team. Our latest adoption forecast estimates the number of light-, medium-, and heavy-duty vehicles in each Census Tract of PSE's service area through 2050 and are delineated by local market, consumer purchases, and vehicle attributes.

The accuracy of these forecasts continues to improve as more data informs the model. Of note is the recent COVID-19 pandemic, which will have some negative impact on near-term purchases. PSE's adoption forecasts were run in early 2021, taking into account COVID-19 impacts. It is worth noting that, during the 2020 legislative session, Washington passed a Zero-emission Vehicle (ZEV) mandate—all but ensuring an overall increase in EVs in the coming years, despite COVID-19 impacts. Moreover, some anticipate that EV purchases will accelerate after the pandemic subsides since auto manufacturers haven't slowed their production of new EVs.

From our most recent 2020 forecast modeling, it's estimated that by 2030, there will be nearly 332,000 EVs in PSE's service area across vehicle classes. By 2050, there will be nearly 1,559,000 EVs, comprised of roughly 1,476,000 LDVs, 59,000 MDVs, and 24,000 HDVs. This forecast is evolving for MDV and HDV as these markets are still in the early stages of commercialization. It also shows that electric LDVs will comprise the vast majority of EVs throughout PSE's service area. However, medium- and heavy-duty fleet EVs will begin to represent an increasing segment in the coming years.

As mentioned above, the LDV forecast is slightly more robust since the market has been developing over a longer period of time. Figure 9 below presents (1) the forecasted number of light-duty EVs in PSE's service area, by year, for each class of vehicle and (2) the population of EVs, as a percentage of total vehicles of the same class, in PSE's service area.

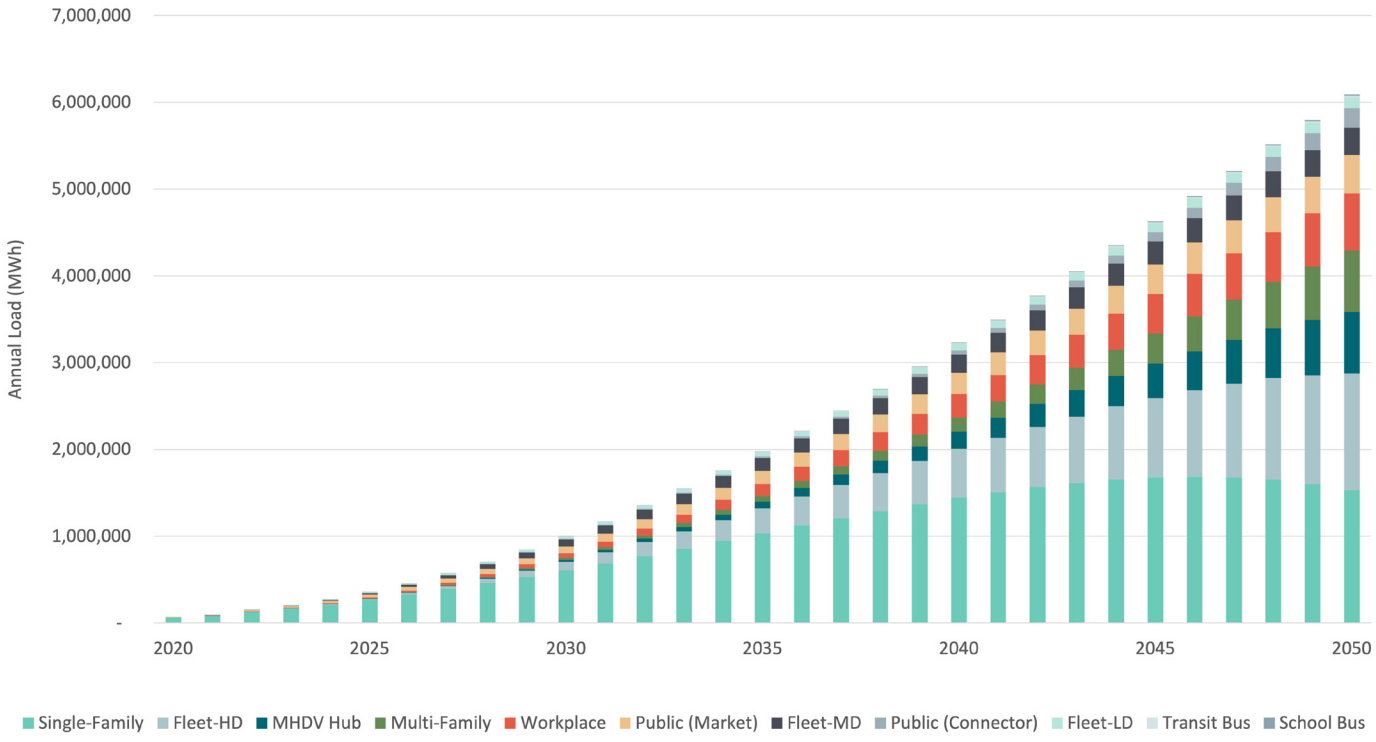
Figure 9 – Total Light-Duty Vehicles on the Road & EV Sales Volume Percentage in PSE Service Area



ENERGY FORECAST

Adoption estimates, coupled with faster charger speeds, will become increasingly important since electric vehicle energy consumption significantly contributes to PSE's load forecast. PSE's EV load forecasts estimate how much energy will be consumed, including when and where. These estimates are then developed into use cases and matched to their respective loads and charging requirements. PSE's forecasted charging use cases include charging in single-family homes and multi-family homes as well as workplaces, charging for fleets (LD, MD, and HD), school buses, transit buses, and public charging to serve market needs and equitable access to charging.

Figure 10 – Annual Electric Load by Use Case in PSE Service Area



USE CASES

In the electric vehicle load forecast, as shown in Figure 10, home charging is expected to remain the primary source of charging through 2050. Home charging is expected to increase from approximately 62 GWh in 2020 to 1,531 GWh in 2050, representing an increase of nearly 2,400% over the next 30 years. Single-family home charging energy usage is expected to peak in 2046 at approximately 1,685 GWh (roughly 6.2% of PSE's 2019 Annual MWh sales), and decrease in volume each year thereafter.[79] This change in single-family home charging behavior is attributed to the expectation that multi-family, workplace, and public charging (both connector and market stations) options will increase rapidly after 2030.

The light-duty vehicle portion of the energy forecast indicates (1) the majority of the EV load for next 20 years is expected to occur in single-family homes across PSE's service area and (2) non-single-family home charging is still nascent but may rapidly take off in the coming years. By 2050, medium- and heavy-duty EVs in PSE's service area are expected to consume nearly 460 GWh and 1,300 GWh each year, respectively. These energy consumption numbers begin to increase much more rapidly after 2030, especially for HDV. For MDVs and HDVs, PSE follows a more fluid methodology to forecast load impacts since those markets are emerging. Therefore, PSE will continue to monitor these loads and ensuing forecasts will update as needed.

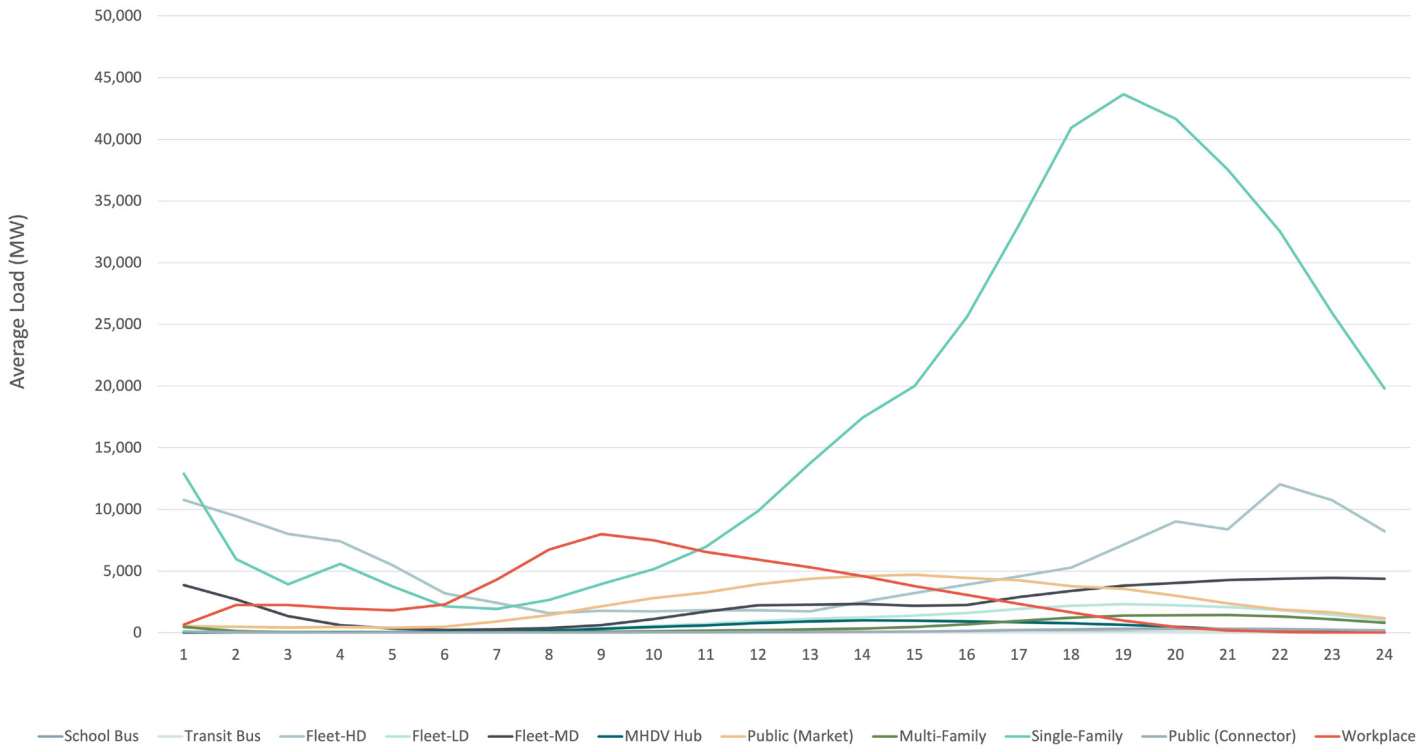
UNMANAGED CHARGING

Electric vehicle charging loads can either create benefits or challenges for electric utilities, depending on when and where the charging occurs. EV charging during periods of off-peak (low) electricity demand can utilize existing grid assets more efficiently and place downward pressure on electricity rates by lowering the average cost of delivery. EV charging during peak demand periods can have the opposite effect – creating a need for new, or upgraded, infrastructure that can increase costs to maintain reliable electric service.[80]

A 2019 report from the Citizens Utility Board in Illinois estimated a potential savings of $2.6 billion for both utilities and customers if vehicle-grid integration strategies and charging programs are implemented. That same report estimated that EV-related grid stress could cost utilities up to $856 million by 2030 if EV owners exclusively charge during peak demand times.[81] A 2019 report by Synapse Energy Economics found that, in the two California service territories with the greatest number of EVs in the U.S. with managed charging, benefits can outweigh costs.[82]

Starting with our EVCI program in 2014, PSE has been analyzing system impacts from EV charging and developing indicative load-shapes for light-duty EVs. Figure 11 below presents the average hourly weekday load shapes for each charging use case for LDV EVs in 2030 without managed charging. These results show that EV drivers are primarily charging their vehicles in the evening timeframe, typically after evening commutes. This charging also coincides with PSE's evening peak times. PSE's 2017 IRP defined peak times as 6 – 11 a.m. and 5 -10 p.m. Both timeframes are important to track as we work to encourage EV charging during other time periods.

Figure 11 – Average weekday load shape by charging use case without managed charging



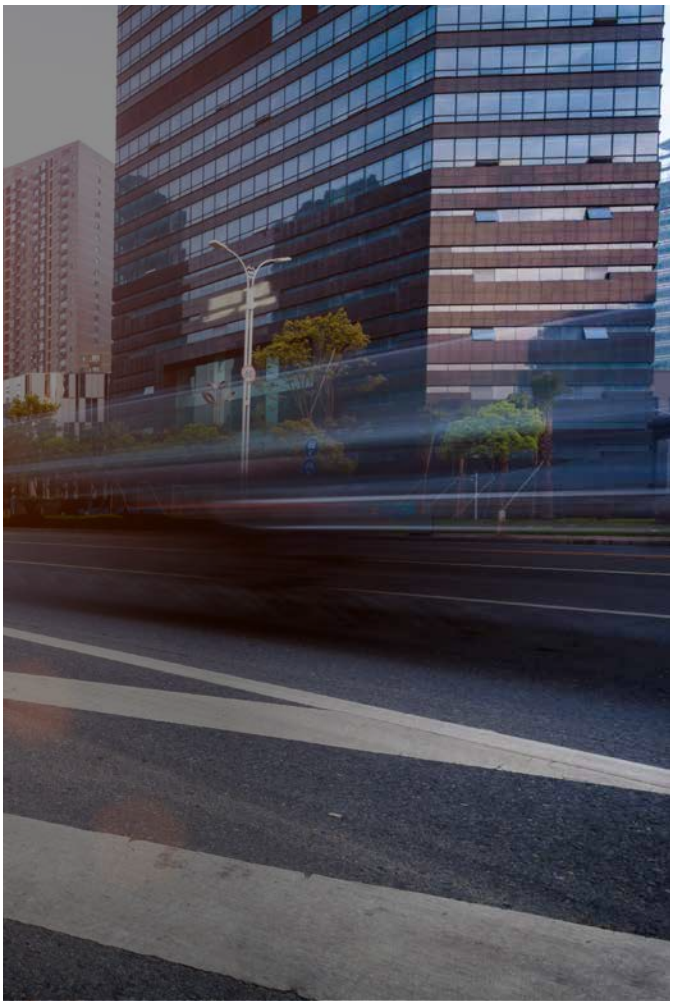
Utilities around the country are investing in programs encouraging off-peak EV charging with indirect tools like time-of-use rates and direct (or active) EV load management, such as managed/smart charging. A significant portion of the system planning costs associated with EVs can be reduced, or even eliminated, by shifting EV charging load out of peak times.[83] The utility benefits by managing its peak load while providing a cost reduction incentive to EV customers. On a larger scale, managed charging also helps develop positive customer charging habits as drivers are more aware how to maximize their fuel savings and encourages EV adoption.

PSE identified this need early on and has already started to plan for managed charging. We initiated this effort from 2014-2017 with our EV Incentive Program, which has since evolved into our current Up & Go Electric Residential Off-Peak program. This pilot encourages customers to charge outside of peak windows (i.e., 6-11 a.m. and 5-10 p.m.). There are many benefits to managed charging that will help offset high customer and utility costs. By providing price signals, customers are able to charge overnight, for example, at a low cost as opposed to a higher rate during peak times. While still in its early phases, the results are promising and indicate that customers do respond to program incentives that encourage shifts in charging times.

PSE'S ROLE IN MANAGING RISKS

In order to advance electric vehicle market development, and ensure the region is prepared for an electrified future, PSE plays an important coordination and development role. Unless there is careful planning in advance, PSE's transmission and distribution systems could be strained, risking reliability and leading to a high financial burden for infrastructure upgrades.

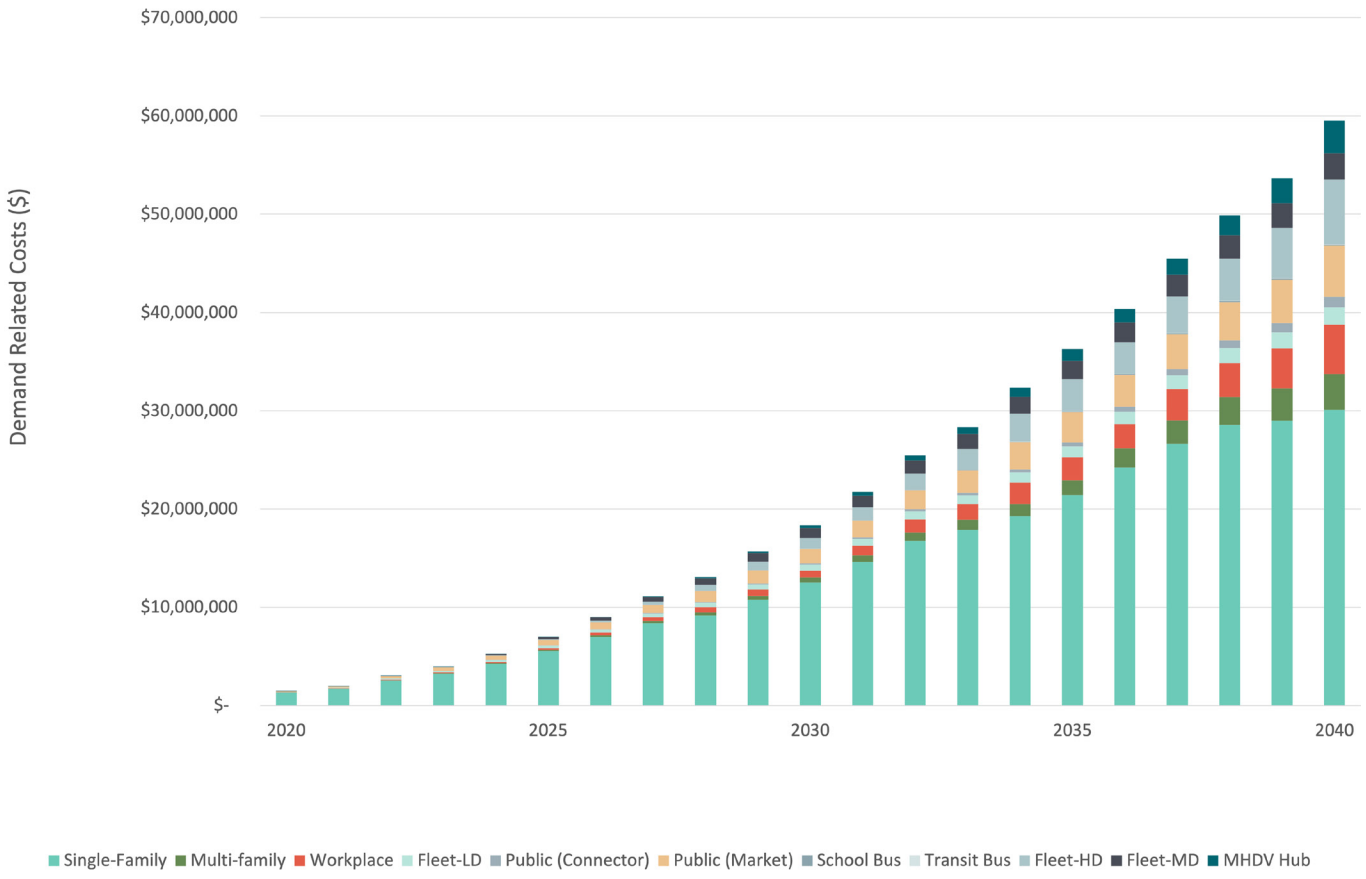
As illustrated in Figure 11, light-duty charging behavior is highly coincident with PSE's peak times, and customers typically charge at the same times throughout the day. Currently, most customers plug in their vehicles in the evening, usually after a commute.[84] This charging behavior creates EV load shapes that highly overlap with PSE's system peak hours, called coincident peaks,—meaning that the majority of EVs are charging when PSE's load is already at its peak.



If charging remains unmanaged, these system loads will lead to high financial costs on PSE's distribution and transmission systems and could risk reliability of the grid. By reducing peak system capacity costs, PSE can operate more efficiently. Furthermore, without managed charging in place by 2040, the combined capacity, distribution, and transmission costs driven by EV demand are expected to exceed $46.8 million from light-duty vehicles and an additional $12.7 million from MDVs and HDVs.[85]

However, if PSE implements timely systems for planning and managed charging, it is possible to significantly reduce these projected demand costs. The collective benefit of managed charging, avoiding costly power delivery upgrades, and managing load during peak periods can help mitigate the incremental system costs of the projected EV load. The result of proactive risk management could help provide downward rate pressure and an opportunity to further expand EV programs for widespread EV adoption. Figure 12 presents the estimated marginal demand related costs by use case based on 2020 system peak hours. The majority of costs related to unmanaged demand will result from single-family residential charging customers. This projection does not yet include medium- and heavy-duty vehicles, which will likely increase this estimate.

Figure 12 – Costs of unmanaged EV charging demand



In order to realize the tremendous benefits of transportation electrification for all customers, PSE is being proactive by integrating transportation electrification into our system planning, monitoring EV load growth, and encouraging managed charging. PSE continues to examine the charging patterns and responsiveness to price signals within the Up & Go Electric pilot programs and will use these results to help inform the timing and design of residential EV rates. Commercial and fleet customers commonly cite demand charges as one of the largest barriers to EV adoption. PSE is proactively working on how to mitigate demand charges while also sending customers price signals on when is the most beneficial time to charge. PSE recognizes the importance of commercial and public EV charging rates to support this growing segment while managing load to avoid or mitigate costly grid upgrades.

SYSTEM PLANNING

The increase in electric vehicles throughout Washington is a positive step to improving air quality and meeting our statewide carbon-reduction goals. It will also require proactive planning to identify energy and peak capacity needs that are significantly impacted by charging behaviors, including when and where they happen.

As discussed in previous sections, by 2050 it is estimated that 1,560,000 EVs will add 6,091 GWh to the annual energy load. Identifying these load impacts now will help PSE plan for future generation and capacity constraints. Doing so will also require PSE to secure (or allocate) enough transmission capacity for our service area and sufficient distribution capacity to deliver that energy when and where charging is needed.

PSE's load forecast includes anticipated EV charging installations for light-duty vehicles. Using a disaggregated version of the adoption forecast to identify where EVs will be located in the service area, it calculates their expected kWh (per vehicle)—factoring in estimated travel distances and vehicle efficiency.

EV charging infrastructure is expected to be deployed across the service area in nearly equal measure and in every Census Tract. There are a few hotspots, such as the business cores of Redmond, Kirkland, and Bellevue, where higher than average amounts of charging infrastructure will be installed. One takeaway from the map in Figure 8 is that customers' preferred EV charging spots may differ from their vehicles' registration addresses. This means that our system planning must account for a variety of projected charging scenarios throughout our entire service area.

Ensuring that our transmission and distribution system can provide power where it's needed is only half of the equation; it's also important to plan for the time of day when those EVs will charge. This is crucial for mitigating coincident peaks and determining measures PSE can take to manage charging loads.

PSE'S INVESTMENT IN TRANSPORTATION ELECTRIFICATION

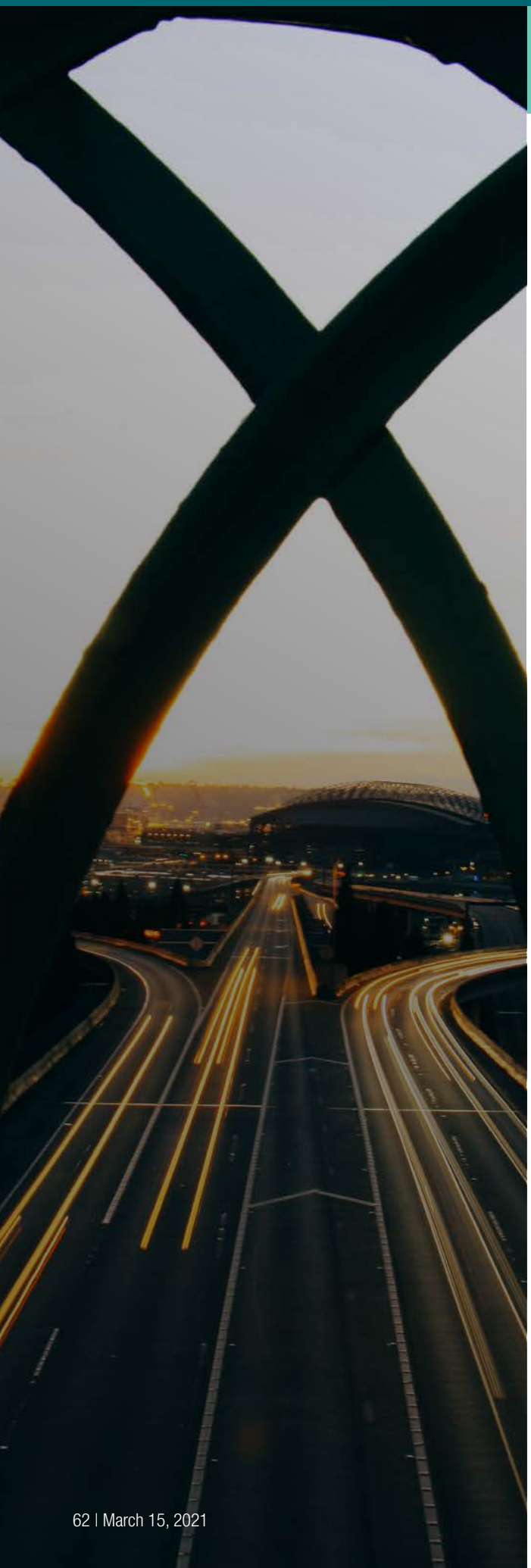
As discussed earlier in this section, the combination of automaker commitments and adoption of zero-emission vehicle regulations will lead to faster electric vehicle adoption. As the market expands, and charging technologies and speeds improve, so will the utilization of EV chargers. We must plan for future EV investments as they become more important in driving decarbonization forward.

The 2017 WUTC Policy Statement on EVs was an important step, underscoring the role that PSE and other utilities must play to shape the EV market throughout Washington. In 2020, the WUTC adopted new rules regarding part of the Clean Energy Transformation Act (CETA) implementation. A large part of reducing greenhouse gas emissions as stated by CETA is widespread EV adoption. Part of our approach to promoting transportation electrification engagement means working with stakeholders and policymakers and adapting our approach as the market evolves. PSE is committed to supporting EV adoption and meeting greenhouse gas reduction targets as stated by CETA.

This includes developing a net-benefit accounting model to ensure that our EV program costs and benefits are allocated to customers with EVs. Within our net-benefit model, the cost of serving a EV load is subtracted from the load's total generated revenue. The net amount is the annual excess revenue (or net benefit) of EV charging.

PSE uses these net benefits to invest in EV program offerings, charging infrastructure, and efforts to support overall market transformation. In addition to investing additional revenue in EV programs, the growth from EVs also leads to downward rate pressure for all customers. We continually update our forecasts and models to ensure that our investments don't exceed the excess revenue generated by EV charging in the long term. We also recognize that these EV programs and adoption result in a range of social and environmental justice benefits, including health savings through reduced GHG emissions, increased transportation access to disadvantaged communities, and access to charging for low-income customers. These considerations shape PSE's strategy to program design and a 10-year evaluation period ensures that EV program investments do not unfairly burden customers who do not own EVs.

5. PSE'S TRANSPORTATION ELECTRIFICATION FUTURE



As Washington state moves toward its decarbonization goals, PSE is investing in a cleaner future. This means addressing needs across multiple customer segments—including residential, commercial, and low-income and disadvantaged communities—and being responsive as their needs evolve.

PSE has taken an active role in developing transportation electrification solutions that meet customer needs. In designing and launching our transportation electrification products and services, we have taken a portfolio-based approach that supports our overall objectives and, as always, prioritizes customer needs. Our current Up & Go Electric program has expanded these efforts to include developing products and services that support charging availability, making electric fueling more affordable, increasing electric vehicle accessibility for low-income and disadvantaged communities, and promoting overall awareness of transportation electrification. As an electric utility, we also need to invest in system planning and load management to ensure our grid can handle and manage the forecasted EV demand.

In this section, we outline how PSE plans to launch new and expanded transportation electrification programs that support our three high-level goals: advancing the transformation of the EV market, filling gaps in charging infrastructure, and planning and managing new loads in order to meet our customers' needs and reduce the barriers identified in Section 3. We also provide our six-year roadmap and explain how it provides a solid foundation for future initiatives.

PSE PROGRAM DESIGN MECHANISMS

Since there are a variety of approaches PSE can take in designing and launching programs, we continue to explore and evaluate different strategies that could aid market transformation, serve customer needs, and support our program designs. To date, most utilities' transportation electrification efforts have focused on broad-based education and charging infrastructure. This section outlines the different business models utilities have explored related to charging infrastructure and its associated usage.

Because of the variety of transportation electrification customer segments, and the diverse barriers and needs they each face, focusing on the most effective strategies is crucial to enabling market transformation. As such, PSE continues to examine different approaches and match them to specific market and customer needs. For instance, some customers and segments may want a turnkey, utility-owned charging infrastructure, whereas others may prefer a make-ready utility infrastructure and customer-owned charging systems. As new program opportunities are identified, PSE will strategically determine the appropriate mechanism based on market segment, existing barriers, cost/benefit analysis, and other considerations.

Table 4 and Figure 13 provide a snapshot of program approaches across the U.S. and their impacts, including PSE programs that are similar. This is not meant to be an exhaustive list, as PSE's programs and business models will continue to evolve in response to market gaps and customer needs. It should also be noted that these program approaches are for infrastructure (charging) components of programs, other activities like Education & Outreach may have a different business model.

Figure 13 – Illustration of Utility Approaches for Infrastructure Programs[86]

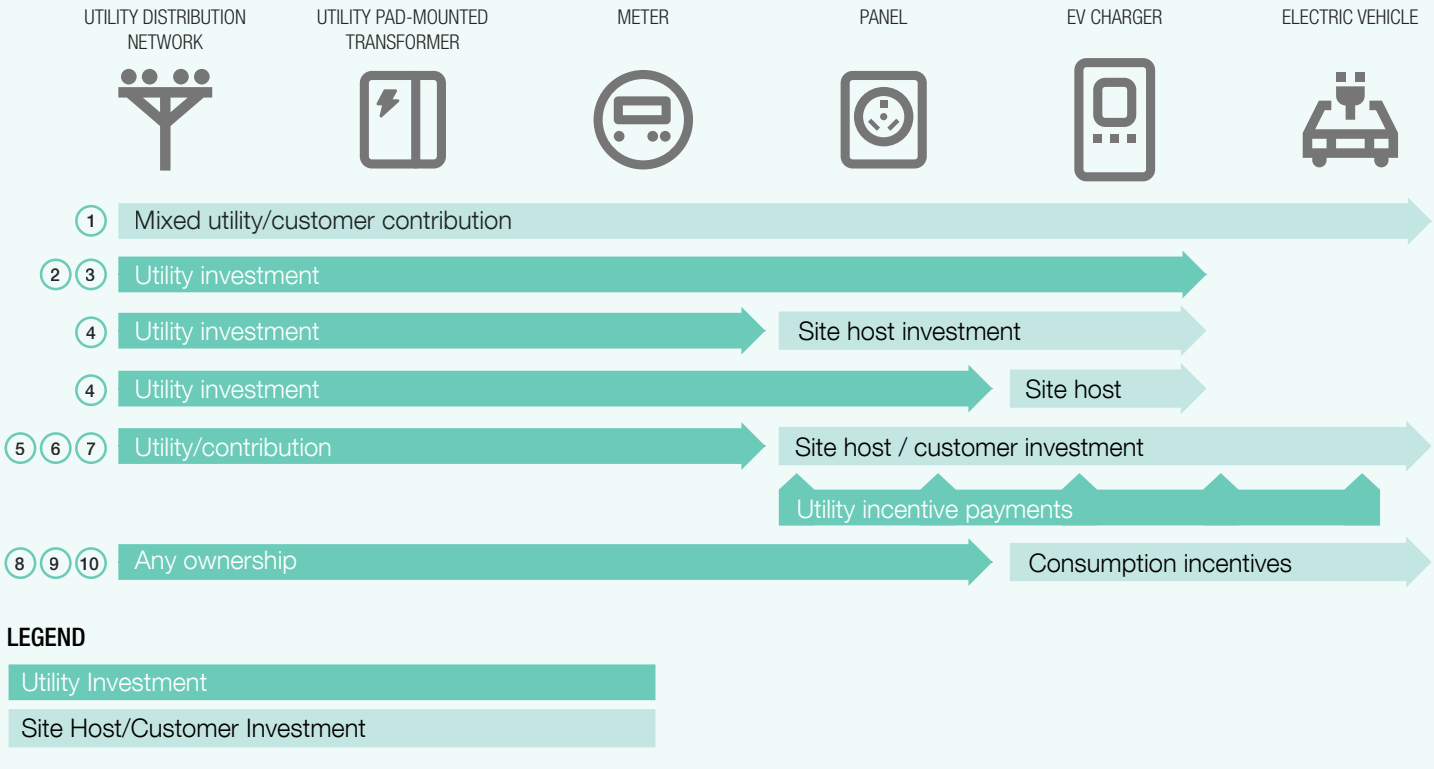


Table 4 – Overview of Utility Approaches for Infrastructure Programs

	Utility charging program type	Description	Past or current PSE program
1	Business as usual/line extensions	The utility upgrades the electrical infrastructure required to install charging infrastructure, up to the point of electrical line extensions. This includes upgrading transformers, and other distribution infrastructure, in preparation for a higher electrical load due to EV charging. Costs are shared with the customer in margin allowances. This type of funding falls under business as usual and is made without a commission proceeding.	Current commercial customers
2	Utility owned/ operated	This is utilized where EVSE and infrastructure are funded, deployed, owned, and operated by a utility. A utility is also responsible for operating and maintaining the EVSE. Usage or contribution payments may be required from program participants.	Current Up & Go Electric charging pilots
3	Leased or rented EVSE	This is utilized where EVSE and infrastructure are funded, deployed, owned, and operated by the utility, and the customer is charged a bundled (flat) price for the charger. This can also be coupled with rate structures or subscriptions for the energy consumed. Depending on the agreement, the customer may own the charger at the end of the contract.	
4	Make-ready infrastructure	The utility funds, owns, designs, and installs all electrical/civil infrastructure on both sides of the meter for EV charging (including conduit, wiring, disconnects, switchgear, electrical panels, concrete pads, and the associated installation activities including trenching, boring, and repaving). Investment in the EV charger itself is left to the site host, and private market EV charging providers can compete to offer their services and products. Contribution payments may be required from program participants.	
5	Infrastructure rebates	The utility funds all or part of the make-ready infrastructure via a rebate, but the project is managed and owned by the customer.	
6	EVSE rebates	The utility provides incentives to non-utility entities for use toward EV chargers. The utility provides a rebate for the chargers, but not for the make-ready infrastructure to support them, and does not own any of the infrastructure.	2014-17 rebate program
7	Vehicle rebates	The utility may help fund the purchase of an EV, often to cover the difference between a conventional gas vehicle and an EV. Most recently, this is seen with MD/HD vehicles (e.g., school buses) to cover the cost difference for conversion. In some cases, the vehicle can be used as a vehicle-to-grid resource for the utility.	Up & Go Electric low-income program
8	Rates	This involves designating specific customer classes related to EV users and designing rates that match those demand patterns—or to incentivize charging behavior.	
9	Program-based incentives	This involves incentives or payments that are part of customer participation in a utility EV program. The customer receives incentives based on their participation and compliance with program guidelines.	Up & Go Electric Residential program
10	Subscriptions	This involves utilizing bundled pricing where customers are charged a flat rate over a time period, regardless of their consumption. Typically, this is tied to certain time windows when the subscription applies.	

PSE PLAN FOR UPCOMING PROGRAMS

To support Washington's clean energy goals and the acceleration of electric vehicle adoption, PSE is planning both new and expanded EV programs. The design of these programs is focused on addressing and mitigating market barriers, creating equitable access and benefits to transportation electrification, and enabling a sustainable path forward for EV load. The preliminary design of these programs can be seen in Table 5. The first set of programs is focused on the introduction of a new Commercial & Fleets program, as well as expanding several of the initial Up & Go Electric pilots.

COMMERCIAL & FLEETS

As described in Section 3, launching a program focused on fleets is critical to support electric vehicle adoption across light-, medium-, and heavy-duty vehicles. PSE has examined the design of other fleet programs across the country, reached out to program leaders to understand what went well and lessons learned, and will continue to engage fleet customers and other key stakeholders to finalize the program design. In addition, PSE is conducting internal and external stakeholder sessions to explore EV rate designs to support charging while also creating opportunities for load management.

PSE's approach to supporting the Commercial & Fleet segment is to provide offerings tailored to the needs of various types of fleets. For example, fleets such as school buses and low-income and disadvantaged community service providers may need turnkey support (e.g., make-ready, EV chargers, and vehicle rebates). Other fleets, however, may need make-ready support and rebates to offset EV charger costs. PSE will evaluate cost sharing options and other mechanisms to meet market needs in the most cost-effective way.

PUBLIC CHARGING & MULTI-MODAL

PSE recognizes the important role of public charging, including reducing "range anxiety" for consumers, providing charging infrastructure for those without home charging, and supporting multi-modal services (e.g., Uber and Lyft drivers). PSE looks to continue expanding public charging in areas not met by the private market as well as providing make-ready support to third-party-owned locations. In addition, PSE will conduct community outreach and solicit input for expanding electric vehicle charger access in low-income and disadvantaged communities and may seek to offer EV charger rebates for third-party-owned stations in these locations.

RESIDENTIAL MULTI-FAMILY

PSE seeks to expand the very popular and successful Residential Multi-Family pilot. As a trusted advisor to property managers, PSE has been effective in achieving enrollment and providing charging access to communities with significant market barriers, including low-income and disadvantaged communities.

While PSE aims to continue providing turnkey services to mitigate market barriers, PSE is considering ways to scale in a cost-effective manner while also promoting equity. This may include customer contributions with reduced contributions for locations in low-income and disadvantaged communities.

WORKPLACE

Workplace charging broadens access for all customers. PSE seeks to expand this program and prioritize enrollment of small- and medium-sized as well as BIPOC-owned workplaces as market barriers can be higher.

LOW-INCOME AND DISADVANTAGED COMMUNITIES GENERAL PILOTS

PSE's current Up & Go Electric program has included support for service providers to low-income and disadvantaged communities. Having a program dedicated to this segment has enabled PSE to more effectively support these communities with greater flexibility to meet evolving needs. PSE seeks to expand this effort and aims to support both service providers and individuals within these communities directly.

RESIDENTIAL SINGLE-FAMILY

The majority of electric vehicle charging happens at home. PSE anticipates that as EV adoption increases across all income levels, there will be continued need to support the acquisition and installation of EV chargers. While the pilot program is still in progress, PSE is exploring different utility and customer ownership models (e.g., lease/rental) to provide flexibility and financing options to customers.

As this segment continues to grow, off-peak charging will be important to help mitigate system impacts. PSE will evaluate the pilot results and incorporate lessons learned to continue supporting EV adoption while encouraging off-peak charging. As a part of this effort, PSE will assess EV rates for residential customers and mechanisms for load management.

INNOVATIVE TECHNOLOGY DEMONSTRATIONS

As vehicle and charging technology continues to evolve, innovative technology demonstrations will enable PSE to adapt and prepare for increasing adoption of both EVs and distributed energy resources in support of the Clean Energy Transformation Act.

Table 5 – Summary of planned programs during Transportation Electrification Plan

Program	Description	Preliminary Program Design
Residential Multi-Family	Expand on PSE's current Up & Go Electric Multi-family program to support deployment of charging infrastructure at multi-family locations.	PSE to install and maintain Level 2 charging equipment
Public Charging & Multi-Modal	Expand upon PSE's Up & Go Electric Public charging model by continuing to deploy public charging infrastructure to support market needs, while also offering make-ready options for private sector involvement. PSE will also expand public chargers to serve multi-modal customers (e.g. ride-share, shuttles).	PSE to install and operate public charging stations (DCFC and Level 2), provide make-ready support for third-party-owned stations, and EV charger rebates for low-income and disadvantaged communities
Workplace	Expand PSE's Up & Go Electric Workplace charging program with an emphasis on supporting small/medium and BIPOC-owned businesses	PSE to install and maintain Level 2 charging equipment
Commercial & Fleets	A new EV program to support the growing needs of commercial customer who wish to electrify their fleet(s). This includes utility- and customer-side programs and incentives, technical advisory, and expanded support for low-income and disadvantaged community partners.	Make-Ready: Utility side (PSE-owned) and Customer side (PSE-owned or optional rebate) EV Charger: PSE-owned or rebate EV Rebates: for low-income and disadvantaged communities Off-Peak Charging Incentives and/or alternative rates
Fleets Load Mgmt. and Alternative Rates	Develop load management strategies to support managed charging	Investigate options for alternative rates to incentivize off-peak charging
Low-income and Disadvantaged Communities General Pilots	Expanding access and benefits to low-income, highly impacted communities, and vulnerable populations that experience disproportional environmental risk from environmental burdens	Make-Ready, EV Charger Rebate, EV rebate
Residential Single Family	Explore a continuation of PSE's Up & Go Electric Residential program, building on capabilities around residential load management. PSE is also exploring different utility/customer charger ownership models (e.g. lease/rental) to provide flexibility and financing options to customers.	PSE-owned EV Chargers, EV Charging Rental, Off-Peak Charging Incentives
Residential Load Mgmt. and Alternative Rates	Develop load management strategies to support managed charging	Continuation of pilot to evaluate alternative rates to incentivize off-peak charging
Education & Outreach	Marketing, Customer Awareness	Continue to expand education and outreach activities including website resources, EV events, and partnerships (e.g., dealerships, low-income and disadvantaged communities)
Innovative Technology Demonstrations	Research and development of cutting edge EV supporting technology including vehicles, charging infrastructure, data management, and vehicle-to-grid	PSE will continue to design offerings and test technologies as they come to market.
Enabling Activities	Includes Data Management & Analysis, System Planning & Optimization	Harmonizing the integration of EVs into system planning and enabling monitoring/ management of EV loads

COSTS AND BENEFITS FOR ELECTRIC VEHICLE PROGRAMS

In developing the design and budget for each of these new and expanded programs, PSE incorporated feedback from customers and stakeholders, conducted benchmarking of other utility electric vehicle programs, and evaluated lessons learned from Up & Go Electric pilot experiences to date as well as from other utility EV program leaders. Pairing this effort with analysis of system costs and revenue from EV adoption, these programs offer expanded support of EV adoption while balancing cost impacts to all customers. Table 6 shows a summary of preliminary program budgets. Central to PSE's guiding principle of social equity and environmental justice, PSE is developing program criteria to ensure that disadvantaged communities and low-income customers are supported and benefit from each of these programs, reflected in Table 7.

Table 6 – Preliminary Transportation Electrification Plan Spend Areas (2021-2026)

Phase	Programs	Draft Budget $M (Low)	Draft Budget $M (High)
I	Residential Multi-Family	$10	$12
I	Workplace	$4	$7
I	Commercial and Fleets	$25	$35
I	Fleets Load Mgmt. & Alt. Rates	$1.5	$2.5
I	Low-income and Disadvantaged Communities General Pilots	$1	$3
II	Public Charging & Multi-Modal	$15	$18
II	Innovative Technology Demonstrations	$2	$6
II	Residential Single Family	$4	$6
II	Residential Load Mgmt. & Alt. Rates	$1.5	$2.5
I + II	Low-income and Disadvantaged Communities	See Table 7	See Table 7
Shared Program Costs			
I + II	Education & Outreach	$5	$9
I + II	System Planning & Optimization	$3	$4
I + II	Data Management & Analysis	$3	$4
	Total	**$75**	**$109**

Table 7 – Preliminary approach of program design to support disadvantaged communities and low-income customers

Low-income and Disadvantaged Communities	Estimated Spend Low ($M)	Estimated Spend High ($M)	Target
Low-income and Disadvantaged Communities General Pilots	$1	$3	
Residential Multi-Family	$3	$4	30% of locations
Public Charging & Multi-Modal	$3	$4	50% of PSE-owned locations
Commercial & Fleets	$10	$14	40% of spend
Education & Outreach	$1.5	$3	30% of spend
Low-income and Disadvantaged Communities Total	**$18.5**	**$27.5**	
Total as % of Total Budget	25%	25%	

The following three tables list the estimated cost of capital investments, allowed capital return, and O&M expenses for the TE Plan plus existing EV programs (Table 8), for existing EV programs alone (Table 9), and for the TE Plan alone (Table 10). Prior to each program filing, however, PSE will continue to refine budgets utilizing updated EV adoption forecasts, customer and stakeholder feedback, and lessons learned from the conclusion of current Up & Go Electric pilots. For all capital investments pertaining to EVSE, calculations assume an 8.57% rate of return based on a pre-tax weighted cost of capital that includes the allowed 2% incentives rate of return on equity, and cost recovery of capital investments amortized over the 10-year average depreciable life of EVSE. All other capital investments assume a 7.6% rate of return based on a pre-tax weighted cost of capital. The percentage targets are set by PSE but could increase depending on the needs identified in low-income and disadvantaged communities. As part of ongoing efforts to reach disadvantaged and low-income customers, PSE wants to gather feedback and better understand customer preferences and necessities to provide intentional and effective programs.

Table 8 – Estimated costs for Existing and Future Programs from PSE capital investments and O&M expenses (2019-2026)

Year	Capital Investments	Allowed Capital Investment Return	O&M Expenses
2019	$1,675,376	$-	$1,332,728
2020	$3,047,493	$14,579	$2,290,379
2021	$5,011,264	$183,392	$3,518,086
2022	$10,290,575	$591,809	$7,817,182
2023	$12,889,855	$1,244,359	$8,558,444
2024	$11,997,021	$2,119,569	$7,441,477
2025	$15,920,978	$3,035,311	$8,266,102
2026	$11,062,798	$4,113,832	$7,850,128

Table 9 – Estimated existing EV Program costs from PSE capital investments and O&M expenses (2019-2026)

Year	Existing Programs Capital Investments	Allowed Capital Investment Return	Existing Programs O&M Expenses
2019	$1,675,376	$-	$1,332,728
2020	$3,047,493	$14,579	$2,290,379
2021	$4,636,269	$183,392	$2,825,785
2022	$1,032,373	$581,875	$2,083,877
2023	$85,250	$809,966	$1,832,535
2024	$666,873	$716,865	$1,318,638
2025	$4,957,709	$604,866	$1,238,213
2026	$-	$836,538	$-

Table 10 – Estimated Proposed EV program costs from PSE capital investments and O&M expenses (2021-2026)

Year	Existing Programs Capital Investments	Allowed Capital Investment Return	Existing Programs O&M Expenses
2021	$374,995	$-	$692,301
2022	$9,258,202	$9,934	$5,733,304
2023	$12,804,605	$434,393	$6,725,909
2024	$11,330,148	$1,402,704	$6,122,839
2025	$10,963,269	$2,430,445	$7,027,889
2026	$11,062,798	$3,277,294	$7,850,128

Based on EV adoption forecasts, Table 11 provides the annual costs and benefits of EV adoption for PSE customers. These illustrate how the revenue from EV charging can fund EV programs without burdening customers, reduce fuel and maintenance costs, and provide health benefits for all through avoided carbon emissions. Additional details on revenue and utility generation and delivery costs can be found in Appendix C.

Table 11 – Annual costs and benefits for PSE customers

Year	#EVs	Utility Billing Rev	kWh	Coincident kW (Winter)	Utility Generation and Delivery Cost	Net Revenue	Avoided CO2 Emissions (Tons)	Avoided Social Cost of Carbon	Customer Transportation Fuel and Maintenance Savings
2021	46,840	$10,738,624	92,515,532	14,159	$4,109,989	$6,628,634	38,236	$2,867,665	$49,556,637
2022	62,283	$18,049,809	154,448,465	22,247	$6,319,836	$11,729,972	63,937	$4,795,283	$63,227,439
2023	82,270	$24,268,292	204,565,682	28,841	$8,181,060	$16,087,231	85,171	$6,387,841	$90,163,891
2024	107,047	$32,543,300	271,616,910	37,972	$10,645,110	$21,898,190	114,220	$8,566,471	$123,581,224
2025	137,409	$43,004,182	355,714,080	50,538	$14,050,517	$28,953,665	151,275	$12,555,808	$168,528,493
2026	170,510	$56,132,487	456,531,303	65,087	$18,180,250	$37,952,236	196,428	$16,303,485	$219,687,827
2027	206,053	$71,173,052	571,008,891	79,910	$24,458,937	$46,714,115	248,660	$20,638,789	$276,396,605
2028	244,426	$88,512,105	701,352,830	92,903	$30,322,459	$58,189,645	308,924	$25,640,653	$336,543,088
2029	286,292	$107,720,310	842,406,570	111,056	$37,263,728	$70,456,581	374,704	$31,100,454	$402,686,404
2030	331,857	$129,634,523	999,241,041	128,899	$43,567,105	$86,067,417	448,004	$39,872,349	$472,957,303

From the values presented in Table 11, paired with the budgets of existing pilots and planned EV programs, revenue requirements may be calculated and compared against the 0.25% annual revenue requirement limit defined by the Revised Code of Washington (RCW) 80.28.360. Table 12 shows net revenue requirement from the capital investments. PSE will continue to monitor EV adoption and adjust spending levels as necessary to remain under the 0.25% limit. Note that O&M costs are not included in this table as only capital expenditures are relevant to the 0.25% revenue limit calculation.

Table 12 – Net revenue requirement of EV programs compared to the 0.25% annual limit

Year	Capital Investment	RevReq from Capital Investment	Net Revenue	Net RevReq	Net Revenue less Capital Investment RevReq	0.25% WA Electric Revenue Requirement
(a)	(b)	(c)	(d)	(e) = (d)—(c)	(f)	(g)
2021	$5,011,264	$365,497	$6,628,635	$6,263,137	0.017%	$5,510,467
2022	$10,290,575	$668,155	$11,729,973	$11,061,818	0.030%	$5,510,467
2023	$12,889,855	$1,233,941	$16,087,232	$14,853,291	0.056%	$5,510,467
2024	$11,997,021	$2,057,263	$21,898,190	$19,840,927	0.093%	$5,510,467
2025	$15,920,978	$2,845,119	$28,953,665	$26,108,546	0.129%	$5,510,467
2026	$11,062,798	$3,684,304	$37,952,237	$34,267,933	0.167%	$5,510,467
2027	$-	$4,351,494	$46,714,115	$42,362,621	0.197%	$5,510,467
2028	$-	$4,169,787	$58,189,645	$54,019,859	0.189%	$5,510,467
2029	$-	$3,528,907	$70,456,582	$66,927,675	0.160%	$5,510,467
2030	$-	$3,020,959	$86,067,418	$83,046,458	0.137%	$5,510,467

TIMELINE & NEXT STEPS

PSE intends to implement this Transportation Electrification Plan immediately following Utilities and Transportation Commission review to meet pressing commercial customer needs for vehicle electrification. At the same time, we will continue building upon our current Up & Go Electric Light-Duty Program and aim to propose new customer programs after the submission of this plan.

PSE proposes to implement Transportation Electrification programs in a phased approach. Phase 1 will primarily include support for Fleet and Commercial customers, Residential multi-family customers, Workplace, and low-income and disadvantaged communities. Phase 2 will expand existing support for Public charging, Residential single-family customers, and direct additional funds towards Innovative Technology Demonstrations. Shared costs such as Education and Outreach, Load Management and Alternative Rate development, Data Management, and System Planning will compliment all customer facing programs.

Moreover, we will continue to be proactive in designing and launching new products and services and strive for continuity between current offerings and future ones.

In addition, PSE recognizes the need to report on the cost and benefits of programs and will continue to include these metrics in UTC Stakeholder reports and include detailed estimates in all upcoming tariff filings. As always, meeting customers' needs and expectations will drive our efforts.

The most pressing need we will address is designing and launching a new Commercial & Fleet pilot program. This will be essential to:

- Be responsive to our customers' needs as they move toward electrified mobility, including providing technical advisory services and helping address infrastructure gaps
- Understand the electric load impact from fleets, particularly medium- and heavy-duty vehicles and their associated charging behavior
- Proactively manage loads and provide programs that incentivize customers to charge outside of peak time windows

We are continuing to implement Up & Go Electric Light-Duty Program and are gaining valuable knowledge on market needs and program operations. These pilots will help to inform what programs we will offer in the future—specifically around: Residential Single-Family, Residential Multi-Family, Public Charging, and Workplace. As mentioned earlier in this document, our residential programs were incredibly popular with customers, and we seek to expand these programs during the timeframe of this TE Plan to meet evolving customer needs and continue to deliver safe, reliable, and affordable power.

During the timeframe of this TEP (2021-2026), PSE plans to launch two rounds of EV programs, as illustrated in Figure 14.

Figure 14 – PSE planned timing for EV program filings

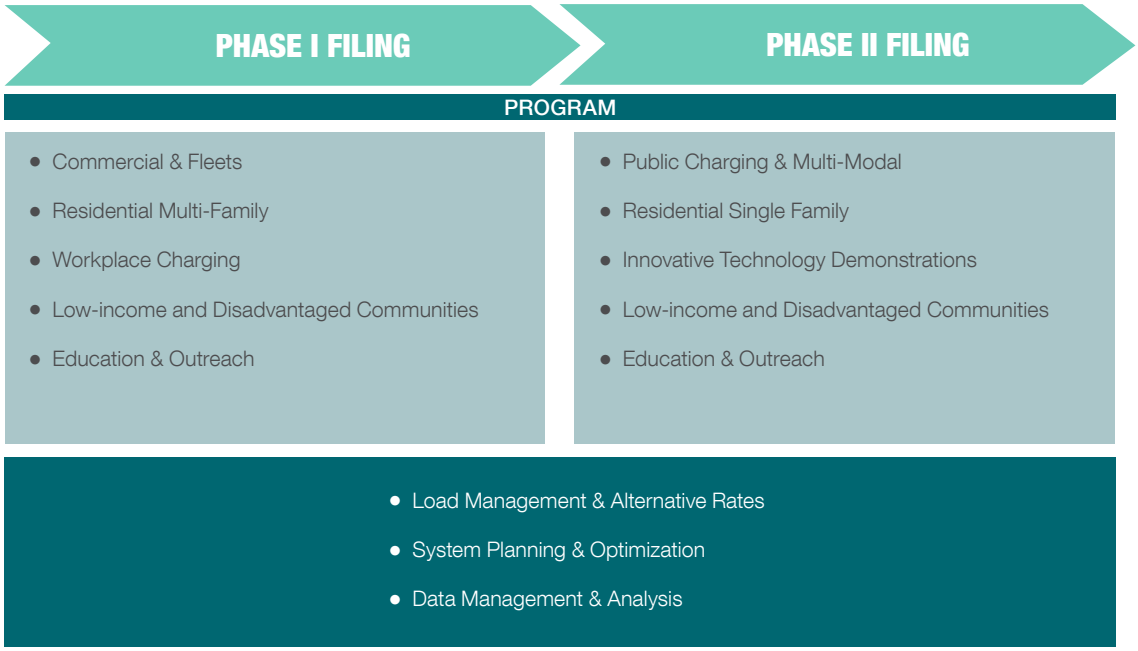


Figure 15 below indicates the anticipated program focus for each customer segment in the coming years. We plan to design and launch a new Commercial & Fleet program in as well as expanded Residential Multi-family, Public and Multi-Modal Charging, and Workplace programs in 2021. We will subsequently look at new programs for the customer segments currently covered by Up & Go Electric.

Figure 15 – PSE's Transportation Electrification Six-Year Roadmap

Customer segment and programs	2021	2022	2023	2024	2025	2026	Types of vehicles
All customers							
Education and awareness	●	●	●	●	●	●	
Low-income and disadvantaged communities							
Up & Go Electric (Current Pilot)	●	●					
Evaluate Up & Go Electric results, and next programs		●	●				
Launch expanded programs		●	●	●	●	●	
Residential stand-alone							
Up & Go Electric (Current Pilot)	●	●					
Evaluate/Design new offerings	●	●					LDV
Evaluate Up & Go Electric results, and next programs		●	●				
Launch expanded programs		●	●	●	●	●	
Residential multi-family							
Up & Go Electric (Current Pilot)	●	●					
Evaluate/Design new offerings	●	●					LDV
Evaluate Up & Go Electric results, and next programs		●	●				
Launch expanded programs			●	●	●	●	
Public charging							
Up & Go Electric (Current Pilot)	●	●					
Evaluate/design new rates and programs as part of Commercial & Fleet program	●	●					LDV multi-modal
Evaluate Up & Go Electric results, and next programs			●				
Launch expanded programs			●	●	●	●	
Workplace (employer/employee)							
Up & Go Electric (current pilot)	●	●	●				
Evaluate Up & Go Electric results, and next programs		●	●				LDV
Launch expanded programs			●	●	●	●	
Commercial fleet (e.g., freight, local delivery)							
Design and launch new Commercial & Fleet pilot program	●	●	●	●	●	●	LDV Fleet MDV Fleet HDV Fleet
Evaluate results					●	●	
Determine next programs					●	●	
Transit, government, and community agencies							
Design and launch new Commercial & Fleet pilot program	●	●	●	●	●	●	LDV Fleet MDV Fleet HDV Fleet
Evaluate results					●	●	
Determine next programs					●	●	

CONCLUSION

PSE is committed to creating a better energy future and doing our part to help Washington state meet its ambitious decarbonization goals. We believe that electricity is the fuel of the future for almost all transportation types, and PSE is committed to providing clean electricity to our customers to fuel their electric vehicles. PSE wants all customers to experience the benefits of electric mobility—from cleaner air to the conveniences of advanced technology. Since 2014, PSE has offered customer programs to accelerate EV adoption. EV adoption is a critical piece to meeting Washington's deep decarbonization goals and address environmental challenges, especially in the medium- and heavy-duty sectors.

PSE is not only committed to developing new programs and services to accelerate the adoption of electric transportation and building a resilient and modern grid to enable it, but also to creating an entire ecosystem capable of supporting an electrified transportation future. PSE cannot take this journey alone; close collaboration with policymakers, environmental groups, social justice advocates, and business leaders will be required to successfully electrify and decarbonize the transportation sector. Most importantly, PSE is committed to partnering with our customers to serve their needs and make their communities better places to live and work. While there is significant work to be done to plan for and achieve our vision for transportation electrification, we are confident that we can achieve this future TOGETHER.

APPENDIX A – INDUSTRY RESOURCES

1. Vehicle Types & Charging Standards
2. U.S. EV Sales Volume & Automaker Investment Commitments
3. Ownership Considerations

TYPES OF VEHICLES & CHARGING STANDARDS

Table A-1 outlines the features of different vehicle types, which is consistent across vehicle classes. Not included in this summary are less utilized vehicle technologies in Washington (e.g. fuel cells).

Table A-2 shows the charging standards for light-duty vehicles. These standards stay consistent for most medium- and heavy-duty vehicles, with most vehicles using a J-1772 (CCS). Although there are special charging types dependent on vehicle. For instant, fast charging for transit buses can happen with an overhead charger, and the Society of Automotive Engineers has released a new J3068 coupler for medium-duty vehicles similar to the light-duty J-1772.

Table A-1 – Features of Different Light-Duty Vehicle Types[87, 88, 89]

Battery Electric Vehicle (BEV)	Plug-In Hybrid Electric Vehicle (PHEV)	Hybrid Electric Vehicle (HEV)	Internal Combustion Engine (ICE)
			
• Power source: battery power only • Electric range: up to 350 mi • MPGe Range*: 70-140 • Average annual emissions: 4,100 lbs. CO_2e per vehicle	• Power source: battery power and gasoline engine • Plug-in optional • Electric Range: up to 100 mi • MPGe Range*: 40-130 • Average annual emissions: 5,885 lbs. CO_2e per vehicle	• Power Source: alternates between gas engine and electric motor • No plug-in • Electric range: N/A • MPGe Range*: 15-60 • Average annual emissions: 6,258 lbs. CO_2e per vehicle	• Power Source: gasoline or diesel engine • Electric range: N/A • MPG Range*: 20-60 • Average annual emissions: 6,258 lbs. CO_2e per vehicle

Table A-2 – Summary of Light-Duty Charging Types and Standards[90, 91]

AC 120V "AC" LEVEL 1	AC 240V "AC" LEVEL 2	DC Fast Charge		
				
J1772 charge port	**J1772 charge port**	**J1772/CCS**	**CHAdeMO**	**Tesla combo**
Residential/Workplace charging	Residential/Workplace/Public charging	Public charging		
• Uses standard outlet (120 V AC) • Power requirements up to 1.4 kilowatts, like a toaster • Adapter comes with the car • Accommodates average daily driving needs • Very low cost installation, often free • Charging rate: 3-5 miles of range per hour	• Requires higher-voltage circuit (240 V AC) • Power requirements up to 19.2 kilowatts, like an electric clothes dryer • Equipment & installation costs vary widely (~$6,500 in public and ~$2,000 at home) • Charging rate: 12-75 miles of range per hour	• Requires very high voltage circuit & 3-phase power (200 – 450 V DC) • Power requirements up to 350 kilowatts, like the max power for several homes • No common connector standard (CHAdeMO, Combined Charging System (CCS), Tesla) • Equipment & installation costs vary widely • Can approach gasoline refueling experience: 100 miles or more of range per hour		

UNITED STATES ELECTRIC VEHICLE SALES VOLUMES

Figure A-1 shows the sales volume in the U.S. over the past four years. This has steadily grown over time, with electric vehicles continuing to take more market share of passenger and light-duty vehicles.

Table A-3 shows the investment commitments from automakers around EVs. While COVID has slowed some production operations, these automaker commitments have stayed consistent.

Figure A-1 – U.S. EV Sales from 2015 through 2019, showing the growth in the U.S. EV market[92]

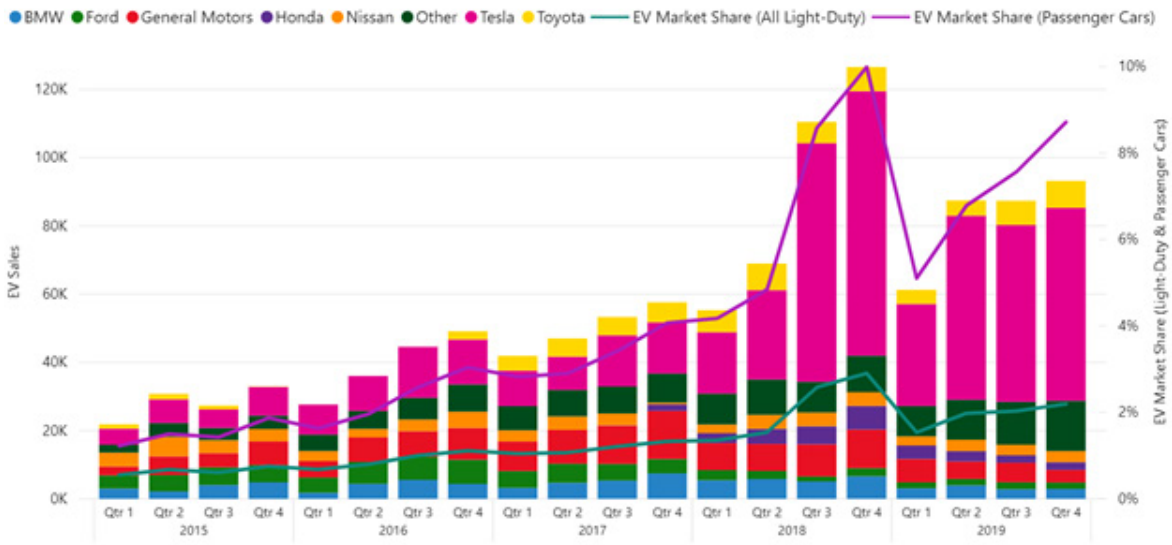


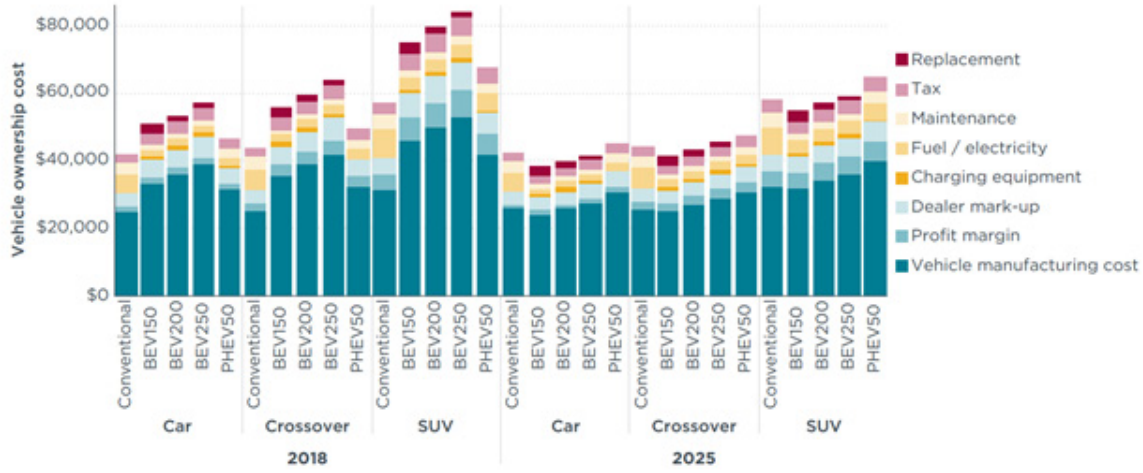
Table A-3 – EV Investment Commitments from Major American Automakers and Leading Global Commitments through March 2020[93]

Automaker	Estimated/Announced Investment	Vehicle Type	Primary Investment Countries
Volkswagen	$93.3 billion	LDV	Germany, China
Volkswagen	$1.7 billion	MDV/HDV	Germany, USA
Daimler	$43 billion	LDV	Germany, China
Daimler	$3.2 billion	MDV/HDV	Germany, USA
Hyundai	$40 billion	LDV	South Korea, China
General Motors	$20 billion	LDV	USA, China
Tata Group	$18 billion	LDV	India, UK
Toyota	$15.2 billion	LDV	Japan, China
Changan	$15 billion	LDV	China, Japan
Ford	$11 billion	LDV	USA, China
Fiat-Chrysler	$10 billion	LDV	USA, Italy
Nissan	$10 billion	LDV	Japan, China
Tesla	$10 billion	LDV/HDV	USA, China
Nikola Motors	$1 billion	MDV/HDV	USA
FDG Electric Vehicles	$1 billion	MDV/HDV	China, USA
Rivian	$700 million	MDV/HDV	USA
Proterra	$690 million	MDV/HDV	USA

OPERATING & OWNERSHIP CONSIDERATIONS

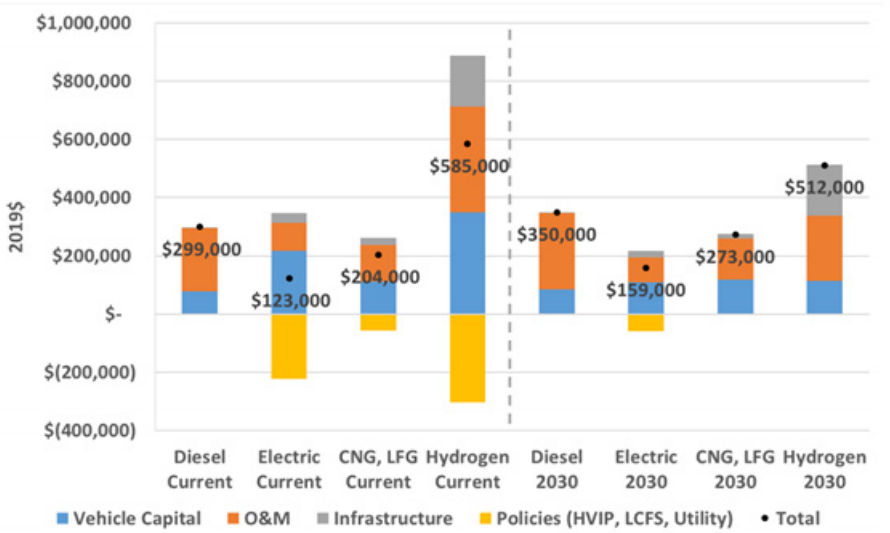
Two major considerations that influence consumer decisions around purchasing an electric vehicle are total cost of ownership (TCO) and emissions of EVs compared to conventional vehicles. The TCO of different vehicle types varies significantly due to differences in upfront costs and operating costs. However, the 80% decline in lithium-ion battery packs between 2010 and 2018 has increased the availability of lower cost EVs across vehicle types. Analysts expect this trend to continue. BNEF predict EVs in most vehicle segments will reach price parity with internal combustion engine vehicles by the mid-2020s.[94] Figure A-2 shows average TCO estimates for 2018 and 2025 projections for different passenger vehicle categories from research conducted by the International Council on Clean Transportation.

Figure A-2 – TCO for conventional and electric vehicles in 2018 and 2025 for cars, crossovers, and SUVs. Some EVs have a lower TCO compared to conventional vehicles in 2025.[95]



Similar to light-duty vehicles, the TCO for medium- and heavy-duty trucks can already be competitive with conventional vehicles in the presence of government grants and low-cost charging.[96] Figure A-3 outlines TCO estimates and predictions for electric drayage trucks. The following sections discuss these TCO and emissions considerations in more detail.

Figure A-3 – TCO Analysis for Class 2-8 Drayage Trucks using different fuel types, electric trucks having the lowest TCO, currently and in 2030 projections.[97]



UPFRONT COST

The upfront cost of vehicles is a major factor influencing the TCO. Electric vehicles typically have a higher upfront cost compared to conventional vehicles, although some EVs are now cost competitive with their conventional counterparts. As shown in Table A-4, medium- and heavy-duty EVs still have significantly higher upfront costs versus conventional models. However, further declines in battery prices are expected to help electric trucks and buses reach price parity with conventional models by the mid-2020s.

Table A-4 – Upfront Cost Estimates by Fuel Type, showing upfront cost estimates for different medium- and heavy-duty vehicles[98]

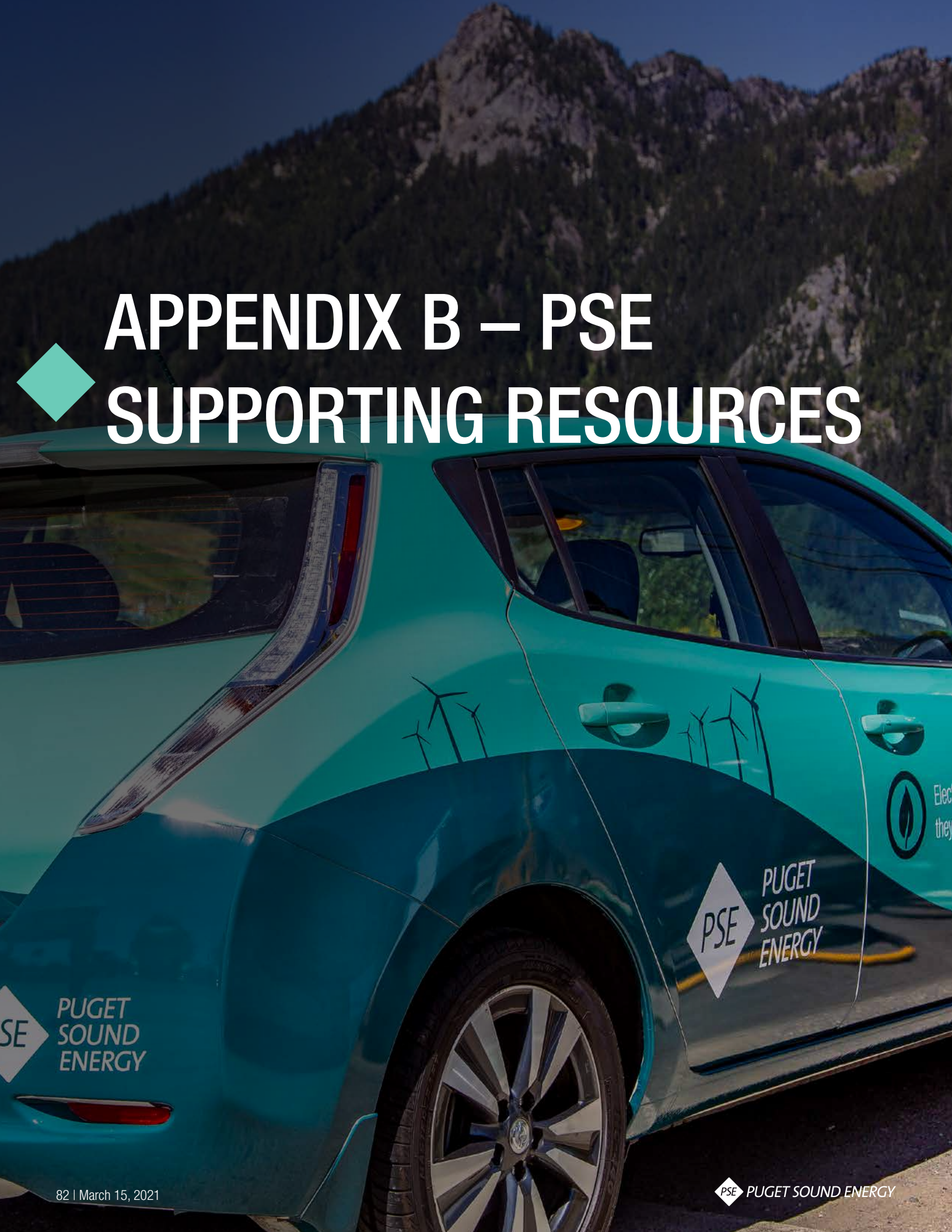
Vehicle Type	Diesel	Electric	Primary Investment Countries
Transit Bus	$476,000	$753,000	Germany, China
School Bus (Type C)	$105,000	$275,000	Germany, USA
Class 6 Short-haul Truck	$63,000	$250,000	Germany, China
Refuse Truck	$150,000	$352,500	Germany, USA
Class 8 Long-haul Truck	$160,000	$375,000	South Korea, China

OPERATING COST[99]

Fuel costs, which represent a significant operating cost for vehicles, are generally lower for electric vehicles than internal combustion engine vehicles. This is due to the lower cost of electricity compared to gasoline and diesel. Maintenance costs also account for a large share of vehicle operating costs. According to the National Renewable Energy Lab, EVs generally have lower maintenance costs than conventional vehicles, largely because EVs have fewer moving parts and use regenerative breaking, which reduces wear on brake pads. Early data from surveys conducted on EV adopters support this expectation of lower maintenance costs.

Operating costs can be higher for commercial EVs compared to ICE vehicles when factoring in lost revenue due to downtime during charging. It is also important to note that EV fleet owners may install their own charging stations. These costs can be substantial and result in EVs having a higher TCO than conventional vehicles.[100] However, in many states fleet owner rebates for vehicles and charging can offset the initial upfront costs.

APPENDIX B – PSE SUPPORTING RESOURCES



UP & GO ELECTRIC LOW-INCOME ELECTRIC VEHICLE PILOT PROJECT METHODOLOGIES

USE CASE IDEATION (2018-29)

PSE's initial 2018 filing proposed three low-income programs designed in partnership with Community Action Partnership (CAP) agencies that provide transportation services to low-income customers. The non-emergency medical services transportation pilot was intended to evaluate whether electrified transportation options can support the more than 1.6 million rides Hopelink provides annually to over 45,000 individuals in need of non-emergency medical transportation services. The low-income weatherization electric vehicle transportation pilot was intended to provide direct access to an EV for one weatherization program for the purpose of audit/inspection/project coordination needs during the course of delivering weatherization projects to PSE served low-income households. The multi-family low-income charging pilot was intended to provide direct access to shared EVs for low-income communities, and determine whether multi-family buildings would be an appropriate format for using these types of vehicles.

As conversations around the non-emergency medical services transportation pilot continued, PSE and Hopelink recognized the opportunity to gain additional input from community stakeholders regarding mobility gaps, needs, and opportunities. In May 2019, PSE and Hopelink co-hosted an electric mobility workshop with 20 South King County mobility stakeholders in attendance. Attendees represented a mix of government and transit agencies, policy advocates, and non-profit organizations. In the workshop we first discussed the current state of mobility in the region and the current EV options and offerings. We then led participants through a series of use case brainstorming exercises that culminated in small teams creating and presenting mini business plans for the most popular use cases. The business plans included a high level outline of basic program elements, potential for scalability, barriers and benefits to electrification, as well as suggested contacts for future feasibility discussions. Out of the workshop came four additional opportunities for electrification: food access networks, school buses, shift worker or farm worker transportation networks, and electrification of the Muckleshoot Transportation Department.

USE CASE ASSESSMENT

To dive deeper into each of the seven use cases, PSE conducted conversations with approximately 20 nonprofits, government agencies, community service organizations, and private mobility organizations to better understand the networks that currently exist in these use cases, the daily operations of those programs and networks, their fleet needs, any additional benefits or barriers to electrification, and lessons learned from similar pilot programs.

In order to assess the seven potential use cases we created a decision matrix. The matrix is intended to help prioritize which projects can be completed in the near term and which projects we will continue to explore but may require more time and resources. In some use cases there are opportunities to leverage existing programs, services or networks, and in some use cases longer-term partnerships with those working on new mobility solutions would need to be explored.

A caveat is that this rating methodology is mostly qualitative as opposed to quantitative. Ratings were determined based on the conversations held or literature reviewed.

In the decision matrix, each use case was assessed across seven categories:

Scalability: If the pilot proves successful in providing benefits, are there opportunities to scale it to serve additional customers or programs?

1	There is no opportunity to scale
2	Few opportunities exist to scale and serve additional customers or programs
3	Several opportunities exist to scale and serve additional customers or programs
4	Many opportunities exist to scale and serve additional customers or programs
5	Innumerable opportunities exist to scale and serve additional customers or programs

Replicability: If the pilot is scaled, could it be easily replicated or would each iteration require additional resources or customization?

1	This pilot cannot be replicated
2	Each iteration would require significant additional resources or customization
3	Could be replicated with moderate additional resources or customization
4	Could be replicated with minor additional resources or customization
5	Could be replicated with no additional resources or customization

Projected benefits: How many areas can we project benefits in?

1	No projected benefits
2	Benefits predicted in one to two areas
3	Benefits predicted in three to four areas
4	Benefits predicted in five areas
5	Benefits predicted in six or more areas

Agency resources and interest: Have we identified potential partners and if so, do they have the resources or interest to participate in this type of pilot?

1	Agency has little to no resources or interest
2	Agency has low to moderate interest and resources
3	Agency interest is unknown
4	Agency has resources to commit if benefit can be proven
5	Agency has ample resources and interest to commit to the program

Pilot implementation timeframe: How long would it take us to get this type of pilot up and running?

1	3+ years
2	2 – 3 years
3	1 – 2 years
4	Within a year
5	Within six months

EV availability and cost: Is the type of vehicle required readily accessible or is there less availability or increased customization required that may increase cost?

1	No indication that EVs will be available for this fleet
2	There is indication of future production
3	Necessary EVs are intended to enter the market as early as next year
4	The necessary EVs are available now but cost is high ($100k+)
5	The necessary EVs are available now and cost is moderate (< $100k)

Overall viability: Is this use case viable for near term implementation or are additional resources needed to overcome the identified barriers?

1	Barriers and resource needs are nearly insurmountable
2	Many barriers exist and more research is necessary to determine if they can be overcome
3	This pilot may be viable for future implementation after resources are committed to research and overcome stated barriers
4	This pilot is viable for near term implementation and minimal additional resources are needed to overcome stated barriers
5	This pilot is viable for near term implementation and no additional resources are needed to overcome stated barriers

OPERATIONAL DESIGN

Once we solidified which use cases to pursue and their participants, we worked with those participants to create mutually-agreeable pilot project plans. These project plans document:

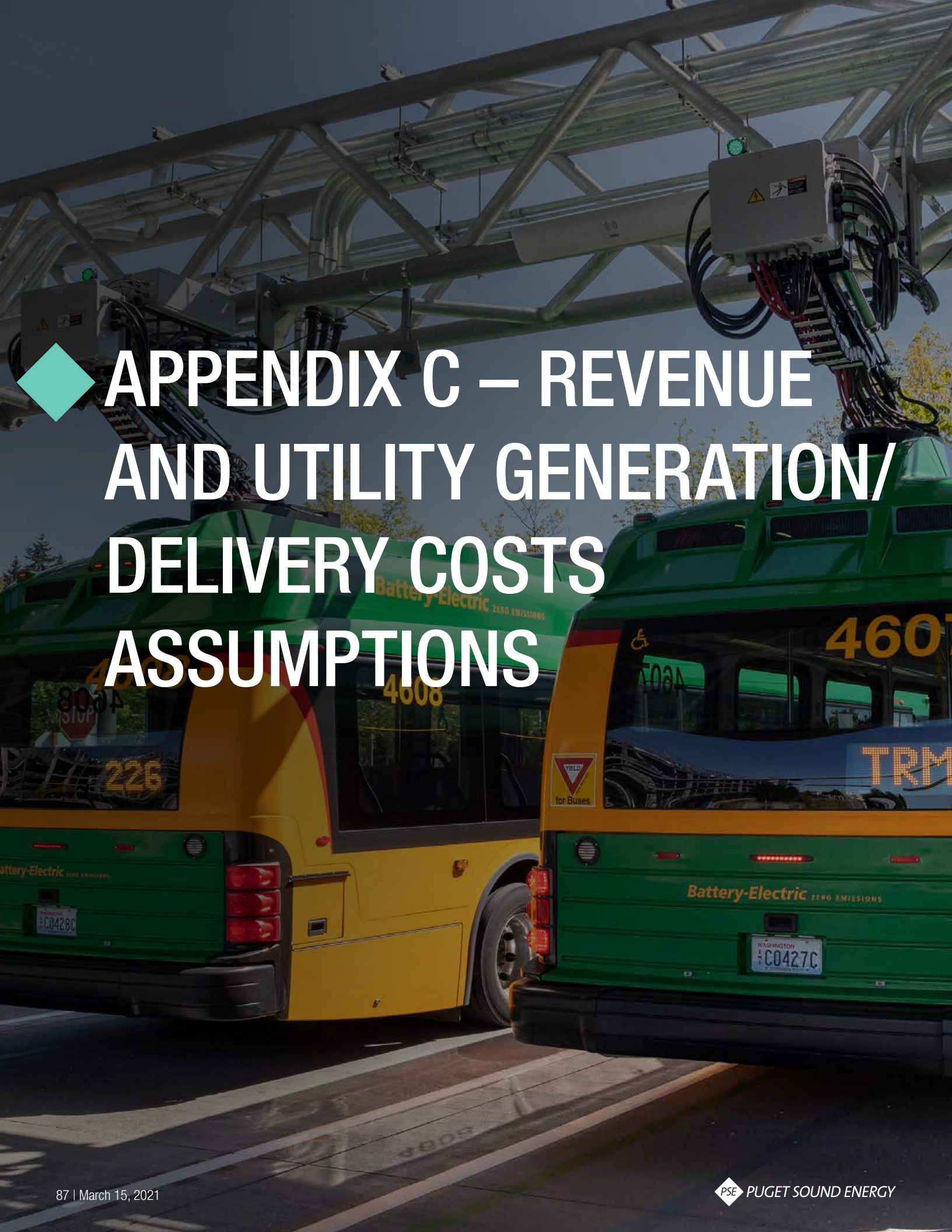
- Which geography in our territory is served by this use case
- Which populations are served through the use case
- Scope details, including:
  - The number and type (L2 or L3) of charging port
  - The number of EVs involved in the project and whether those EVs are light-duty or medium to heavy-duty
    - When we initially scoped these projects we anticipated that the majority of the EVs we utilized would be light-duty. However, as we explored these use cases further with the community and learned more about their needs, we found that there were beneficial use cases that would require medium to heavy-duty EVs to execute on.
- Target launch date and any critical schedule dependencies (e.g. EV or EVSE lead time)
- Budget:
  - The Anticipated spend for charging infrastructure and installation, including all capital costs related to the EVSE, any anticipated site upgrades, as well as any ongoing operations and maintenance costs throughout the life of the pilot
  - PSE and the participants' anticipated EV contribution:
    - The participant will provide the cost of a similar, gas powered vehicle and PSE will provide the incremental cost of the electric vehicle. PSE has accommodated participant negotiation of their contribution as most participants indicated they likely wouldn't purchase a brand new vehicle or would shop around for deep discounts. We also heard overwhelmingly from these participants that funding for rolling stock, particularly for medium to heavy-duty vehicles was the largest barrier to participation.
    - While PSE will own and operate the charging infrastructure through the three year life of the pilot, the participant will own and operate the electric vehicle.

- Dollars PSE will provide to participants to fund any operational changes associated with the pilot. We acknowledge that additional staff resources might be required for data collection and management and training on the EV and its charging infrastructure. In most cases PSE will contribute an additional $10,000 over the life of the pilot to support these operational changes. $5,000 will be distributed in the first year and $2,500 will be distributed at the beginning of both the second and third year of the pilot.

- Projected pilot benefits:
  - Ways in which these projects may expand services to low-income customers, whether that be an increase in the number of customers served, a larger geographic reach or an increased portfolio of services
  - Reduced or avoided operational costs, depending on whether this EV is net new to the fleet or replacing a gas powered vehicle. We are also working with participants to determine how they will use their operational savings over the life of the project to provide increased or enhanced services to low-income customers.
  - Reduced or avoided carbon emissions
  - Increased opportunities for EV education and outreach
  - And any unique social or safety benefits that may result from the implementation of these projects

Figure B-1 – Up & Go Electric Low-Income Project Summary, resulting from Use Case Ideation and Methodology

Use case: Participant		Primary population served	Planned equipment				Benefits					
			L2 ports	L3 ports	Light-duty EV	Medium—heavy-duty	Service expansion	Operations costs	Carbon emissions	Education and outreach	Social	Safety
Low-income weatherization	Opportunity Council	Whatcom, Island and San Juan County Low-income households receiving weatherization services	2		1		✓	✓	✓	✓		
	HopeSource	Kittitas County Low-income households receiving weatherization or other social services	2		1		✓	✓	✓	✓		
	Housing Authority of Skagit County	Skagit County Low-income households receiving weatherization or housing services	2		2		✓	✓	✓	✓		
Tribal transportation: Muckleshoot Indian Tribe		Auburn Community members whose mobility needs are not met by existing transportation services		1		1	✓	✓	✓	✓	✓	✓
School bus: Participant TBD		TBD Low-income or underserved children		1		1	✓	✓	✓	✓		✓
Non-emergency medical transportation: Participant TBD		TBD Those without transportation to medical appointments	1		1		✓	✓	✓	✓	✓	
Community car share: King County Metro		City of Algona and City of Pacific Individuals or groups whose mobility needs are not met by existing transportation services	2		2		✓	✓	✓	✓	✓	



APPENDIX C – REVENUE AND UTILITY GENERATION/ DELIVERY COSTS ASSUMPTIONS

REVENUE

Revenue projections were estimated by use case using the electric vehicle load forecast for each use case. The load in each use case was assumed to be priced under the rate schedule that best suited typical customers of that use case. The list of use cases and the schedule they were priced at is presented below. For each schedule, all riders were included in the per kWh price and it was assumed that rates would increase 2.5% per year:

- Single Unit Dwelling (SUD); L1 & L2: Sch 7E as of 2/12/2021. Assumed all charging occurred in Tier 2 block.
- Multi-Unit Dwelling (MUD); L1, L2, & L3: Sch 24E as of 2/12/2021. Average of Seasonal rate.
- Workplace; L2: Sch 24E as of 2/12/2021. Average of Seasonal rate.
- Single Unit Dwelling Shared charging (SUD-Shared); L1, L2, & DC: Sch 25E as of 2/12/21. Average of seasonal rate. All first block.
- Public Market; L2 & DC: Sch 25E as of 2/12/21. Average of seasonal rate. All first block.
- School Bus; L2 & DC: Sch 25E as of 2/12/21. Average of seasonal rate. All first block
- Transit Bus; L2 & DC: Sch 25E as of 2/12/21. Average of seasonal rate. All first block.
- Fleet-Light-duty; DC, L2: Sch 24E as of 2/12/2021. Average of Seasonal rate.
- Fleet-Heavy-duty; DC: Schedule 26E as of 2/12/21
- Fleet-Medium-duty; L2, DC: Schedule 26E as of 2/12/21
- MHD Hub; L2, DC: Schedule 26E as of 2/12/21

UTILITY GENERATION AND DELIVERY COSTS

Generation costs were calculated using Mid-C power price forecasts consistent with the 2021 IRP multiplied by the energy forecasted to be consumed by electric vehicle charging each year.

Delivery costs were calculated using Capacity, Distribution, and Transmission costs from the 2021 IRP as well as the load characteristics of each EV charging use case. Capacity and Transmission costs were calculated using the average of the load of each use case in each monthly system peak hour. For the purposes of this estimate, future peak hours were assumed to be the same as 2020. Distribution costs were calculated using the highest non-coincident peak hour of each use case per year.

ENDNOTES

1 PSE 2019 electric vehicle market perception research, where customers stated they were “Extremely Likely” or “Somewhat Likely” to consider purchasing an EV

2 BloombergNEF, Electric Vehicle Outlook 2020, https://about.bnef.com/electric-vehicle-outlook/

3 BloombergNEF, Electric Vehicle Outlook 2020, https://about.bnef.com/electric-vehicle-outlook/

4 Puget Sound Business Journal, “Washington pushes ahead with electric vehicle adoption as feds scale back efforts”, 2020

5 SECC, 2020 State of the Consumer Report

6 Alternative Fuels Data Center, Dept of Energy, Emissions from Hybrid and Plug-In Electric Vehicles, retrieved May 2020, https://afdc.energy.gov/vehicles/electric_emissions.html

7 Puget Sound Energy, “PSE sets ‘Beyond Net Zero Carbon’ goal.” Retrieved from: https://www.pse.com/press-release/details/pse-sets-beyond-net-zero-carbon-goal

8 Atlas EV Hub, “National EV Sales Dashbaord,” March 2020. [Online]. Available: https://www.atlasevhub.com/materials/private-investment/. [Accessed March 2020].

9 Atlas EV Hub, “Global Private Investment Dashboard,” March 2020. [Online]. Available: https://www.atlasevhub.com/materials/private-investment/. [Accessed March 2020].

10 Best of 2020: The year of EV investments” Retrieved from https://www.todaysmotorvehicles.com/article/best-of-2020-ev-investments/

11 SEPA—EV Future, Utility Success Smart Electric Power Alliance (SEPA) “Preparing for an Electric Vehicle Future: How Utilities can Succeed”,October 2019.

12 Department of Energy, “Medium- and Heavy-Duty Vehicle Electrification” December 2019

13 SEPA—EV Future, Utility Success Smart Electric Power Alliance (SEPA) “Preparing for an Electric Vehicle Future: How Utilities can Succeed”, October 2019.

14 BNEF, “Electric Vehicle Sales to Fall 18% in 2020, but Long Term Prospects Remain Undimmed”, May 2020. https://about.bnef.com/blog/electric-vehicle-sales-to-fall-18-in-2020-but-long-term-prospects-remain-undimmed/

15 The International Council on Clean Transportation (ICCT) estimated that the greater Seattle area only has 31-40% of the required charging needed to meet the 2025 demand

16 Washington State Department of Commerce, “2021 State Energy Strategy”. Retrieved from: https://www.commerce.wa.gov/growing-the-economy/energy/2021-state-energy-strategy/

17 CALSTART, Global Commercial Vehicle—Drive to Zero, Retrieved May 2020. https://globaldrivetozero.org

18 Puget Sound Clean Air Agency, “Greenhouse Gas Emissions Inventory”, 2018

19 ICCT “Policies to reduce fuel consumption, air pollution, and carbon emissions from vehicles in G20 nations”, May 2015.

20 Union of Concerned Scientists, “Inequitable Exposure to Air https://www.ucsusa.org/resources/inequitable-exposure-air-pollution-vehicles

21 International Energy Agency, “Global EV Outlook 2020”, June 2020.

22 US Department of Energy. (n.d.). Types of Vehicles by Weight Class. Retrieved from: https://afdc.energy.gov/data/10381

23 Heid, B., Hensley, R., Knupfer, S., Tschiesner, A. (n.d.). What’s sparking electric-vehicle adoption in the truck industry? Retrieved from https://www.mckinsey.com/industries/automotive-and-assembly/our-insights/whats-sparking-electric-vehicle-adoption-in-the-truck-industry.

24 Alternative Fuels Data Center, “Average Annual Vehicle Miles Traveled by Major Vehicle Categories,” March 2020. [Online]. Available: https://afdc.energy.gov/data/10309.

25 Edison Electric Institute, “Preparing to Plug In Your Fleet,” October 2019. Available: https://www.eei.org/issuesandpolicy/electrictransportation/Documents/PreparingToPlugInYourFleet_FINAL_2019.pdf.

26 Atlas Public Policy, “Assessing Financial Barriers to the Adoption of Electric Trucks,” February 2020. Available: https://atlaspolicy.com/rand/assessing-financial-barriers-to-the-adoption-of-electric-trucks/

27 Jason Deign. “World’s Second-Largest Ferry Operator Switching From Diesel to Batteries.” Retrieved from: https://www.greentechmedia.com/articles/read/worlds-second-largest-ferry-operator-switching-from-diesel-to-batteries

28 Adapted from Rocky Mountain Institute “Seattle City Light—Transportation Electrification Strategy” 2019.

29 Atlas Public Policy, “National EV Sales Dashboard,” [Online]. Available: https://www.atlasevhub.com/materials/national-ev-sales/.

30 BNEF Electric Vehicle Outlook 2019. Retrieved from: https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport

31 Atlas EV Hub, “National EV Sales Dashboard,” March 2020. [Online]. Available: https://www.atlasevhub.com/materials/private-investment/. [Accessed March 2020]

32 Forbes, “Global Pandemic Won’t Stop the Switch to Electric Cars”, retrieved June 2020.

33 Nonprofits Struggle to Stay Alive amid COVID-19.” Retrieved from https://nonprofitquarterly.org/nonprofits-struggle-to-stay-alive-amid-covid-19/

34 Who’s left riding public transit? A COVID data deep-dive.” Retrieved from https://medium.com/transit-app/whos-left-riding-public-transit-hint-it-s-not-white-people-d43695b3974a

35 Atlas Public Policy, “Electric Trucks and Buses Overview,” July 2019. [Online]

36 WA Governor Jay Inslee, Transportation Overview, Retrieved May 2020, https://www.governor.wa.gov/issues/issues/transportation

37 WA State Department of Commerce, 2017 Biennial Energy Report and State Energy Strategy Update

38 WA Department of Ecology, “Improving air quality and public health”, retrieved May 2020. https://ecology.wa.gov/Air-Climate/Air-quality/Vehicle-emissions/Investing-in-cleaner-transportation/Improving-air-quality-public-health

39 Atlas Public Policy, “Electric Utility Filings Dashboard,” [Online]. Available: www.atlasevhub.com/materials/electric-utility-filings.

40 PSE Customer Research (2020)—86% of PSE customers respond that it would be “Extremely Appealing” or “Somewhat Appealing” to have their utility offer EV charging products & services.
41 Lyft, “Leading the Transition to Zero-emissions: Our Commitment to 100% Electric Vehicles by 2030”, retrieved June 2020. Available: www.lyft.com/blog/posts/leading-the-transition-to-zero-emissions
42 The Edison Foundation—Institute for Electric Innovation, “Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030” November 2018.
43 PSE Customer Research, “EV Market Perception Research”, 2019.
44 Sierra Club “A National Study of the Electric Vehicle Buying Experience”, 2019.
45 BloombergNEF, “Electric Vehicle Outlook 2020”, 2020.
46 Atlas Public Policy, “Electric Trucks and Buses Overview,” July 2019.
47 ICF International. “Comparison of Medium- and Heavy-Duty Technologies in California,” 2019.
48 Brittany Chang. “We compared the Tesla Cybertruck, Rivian R1T, and 5 other upcoming electric pickup trucks by 11 different specs. The Cybertruck won nearly half.” Retrieved from: https://www.businessinsider.com/electric-pickup-truck-comparison-tesla-cybertruck-rivian-r1t-2020-2
49 BNEF. Electric Buses in Cities. Retrieved from: https://about.bnef.com/blog/electric-buses-cities-driving-towards-cleaner-air-lower-co2/
50 Sean Szymkowski. “Electric car ownership is the cure for range anxiety, study shows.” Retrieved from: https://www.cnet.com/roadshow/news/electric-car-ownership-range-charging-study/
51 EIA. 2020 Annual Energy Outlook. Retrieved from: https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Transportation.pdf
52 PSE Up & Go Electric Pilot Program, 2018-Present.
53 ICCT, “Quantifying the Electric Vehicle Charging Infrastructure Gap Across US Markets,” 2019.
54 Smart Columbus Case Study: “Increasing EV Charging Access at Multi-Unit Dwellings”. Retrieved from: https://smart.columbus.gov/playbook-assets/electric-vehicle-charging/case-study--increasing-ev-charging-access-at-multi-unit-dwellings.
55 ICCT “EV Charging Best Practices,” 2017.
56 Atlas Public Policy, “Assessing the Business Case for Hosting Electric Vehicle Charging Stations in New York State,” 2019.
57 Atlas Public Policy, “Assessing Financial Barriers to Adoption of Electric Trucks,” 2020.
58 ICCT “EV Charging Best Practices,” 2017.
59 Washington Department of Ecology, “Volkswagen enforcement action grants” Retrieved from: https://ecology.wa.gov/About-us/How-we-operate/Grants-loans/Find-a-grant-or-loan/Volkswagen-enforcement-action-grants
60 Atlas EV Hub. “Public Funding Awards Dashboard.” Retrieved from: https://www.atlasevhub.com/materials/public-agency-requests-funding-awards/
61 Washington Department of Ecology, “40 electric school buses headed to Washington districts,” April 2020.
62 Washington Department of Transportation. Innovative Partnerships—Electric Vehicle Charging Infrastructure. Retrieved from: https://www.wsdot.wa.gov/business/innovative-partnerships/electric-vehicle-charging-infrastructure
63 Washington Department of Commerce. Electrification of Transportation Systems Program. Retrieved from: https://www.commerce.wa.gov/growing-the-economy/energy/clean-energy-fund/electrification-of-transportation/
64 Department of Energy, “Medium- and Heavy-Duty Vehicle Electrification” December 2019
65 US Energy Information Administration, “2020 Annual Energy Outlook”. Retrieved from: https://www.eia.gov/outlooks/aeo/pdf/AEO2020%20Transportation.pdf
66 BNEF, “Electric Vehicle Outlook 2020”. Retrieved from: https://about.bnef.com/electric-vehicle-outlook/
67 Atlas EV Hub. “State EV Registration Data Dashboard.” Retrieved from: https://www.atlasevhub.com/materials/state-ev-registration-data
68 Auto Alliance. “Auto Drive WA Forward”. Retrieved from: https://autoalliance.org/in-your-state/WA/pdf/?export
69 https://insideclimatenews.org/news/21122020/electric-vehicles-in-2020/#:~:text=Electric%20cars%20made%20up%20only,nine%20months%20of%20the%20year
70 Data.WA.gov, “Electric Vehicle Population Data,” Retrieved Feb 2021.
71 CALSTART, “US Zero-Emission Bus Fleet Grows Nearly 37 Percent Over Previous Year,” October 2019. Available: https://calstart.org/zeroing-in-on-zebs-pr-2019/
72 Washington Department of Ecology, “40 electric school buses headed to Washington districts,” April 2020.
73 Atlas EV Hub, “EV Charging Deployment Dashboard,” March 2020. Available: https://www.atlasevhub.com/materials/ev-charging-deployment/
74 EEI, “Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030,” 2018.
75 Atlas EV Hub, “EV Charging Deployment Dashboard,” March 2021. Available: https://atlasevhub.com/materials/ev-charging-development
76 West Coast Clean Transit Corridor Initiative, “Interstate 5 Corridor—California, Oregon, Washington”, March 2020
77 EEI, “Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030,” 2018.
78 PSE Customer Research, “EV Market Perception Research”, 2019.
79 PSE’s 2019 10k, Page 13 (https://www.pugetenergy.com/pages/filings.html)
80 Atlas Public Policy, “Vehicle-Grid Integration,” October 2019. Available: https://atlaspolicy.com/rand/vehicle-grid-integration/
81 Illinois Citizens Utility Board , “Charging Ahead—Deriving Value from Electric Vehicles for all Electricity Customers,” March 2019.
82 Synapse Energy Economics , “Electric Vehicles Are Driving Electric Rates Down,” June 2019. [Online]. Available: https://www.synapse-energy.com/sites/default/files/EV-Impacts-June-2019-18-122.pdf
83 California Independent System Operator, “California Vehicle-Grid Integration (VGI) Roadmap,” CAISO, Sacramento, 2014
84 PSE’s 2019 10k, Page 13 (https://www.pugetenergy.com/pages/filings.html)
85 Cost estimates include PSE’s Avoided Capacity, Transmission, and Distribution Costs ($/kW) consistent with PSE’s Draft 2021 IRP.

86 This figure outlines the main business models for utility investment in EV charging infrastructure. For each business model, the figure shows which parts of the investment are made by the utility.

87 US Department of Energy. (n.d.). Find and Compare Cars. Retrieved from: https://www.fueleconomy.gov/feg/findacar.shtml

88 Alternative Fuels Data Center, "Hybrid and Plug-In Electric Vehicles," 2020. [Online]. Available: https://afdc.energy.gov/vehicles/electric.html. Accessed March 2020.

89 Alternative Fuels Data Center, "Emissions from Hybrid and Plug-In Electric Vehicles," [Online]. Available: https://afdc.energy.gov/vehicles/electric_emissions.html

90 CHAdeMO. https://www.chademo.com/activities/protocol-development/

91 ANSI Webstore, "SAE J 1772-2016," https://webstore.ansi.org/Standards/SAE/SAE17722016J1772

92 Atlas EV Hub, "National EV Sales Dashbaord," March 2020. [Online]. Available: https://www.atlasevhub.com/materials/private-investment/. [Accessed March 2020]

93 Atlas EV Hub, "Global Private Investment Dashboard," https://www.atlasevhub.com/materials/private-investment/. March 2020.

94 BNEF Electric Vehicle Outlook 2019. https://about.bnef.com/electric-vehicle-outlook/#toc-viewreport

95 International Council on Clean Transportation. "Update on electric vehicle costs in the U.S. through 2030." Retrieved from: https://theicct. org/sites/default/files/publications/EV_cost_2020_2030_20190401.pdf

96 Atlas Public Policy. Assessing Financial Barriers to Adoption of Electric Trucks. Retrieved from: https://atlaspolicy.com/wp-content/uploads/2020/02/Assessing-Financial-Barriers-to-Adoption-of-Electric-Trucks.pdf

97 ICF International. Comparison of Medium- and Heavy-Duty Technologies in California. Retrieved from: https://caletc.com/wp-content/uploads/2019/12/ICF-Truck-Report_Final_December-2019.pdf

98 ICF International. Comparison of Medium- and Heavy-Duty Technologies in California. Retrieved from: https://caletc.com/wp-content/uploads/2019/12/ICF-Truck-Report_Final_December-2019.pdf

99 Idaho National Laboratory. Advanced Vehicle Testing Activity. Retrieved from: https://avt.inl.gov/sites/default/files/pdf/fsev/costs.pdf

100 Atlas Public Policy. Assessing Financial Barriers to Adoption of Electric Trucks. Retrieved from: https://atlaspolicy.com/wp-content/uploads/2020/02/Assessing-Financial-Barriers-to-Adoption-of-Electric-Trucks.pdf