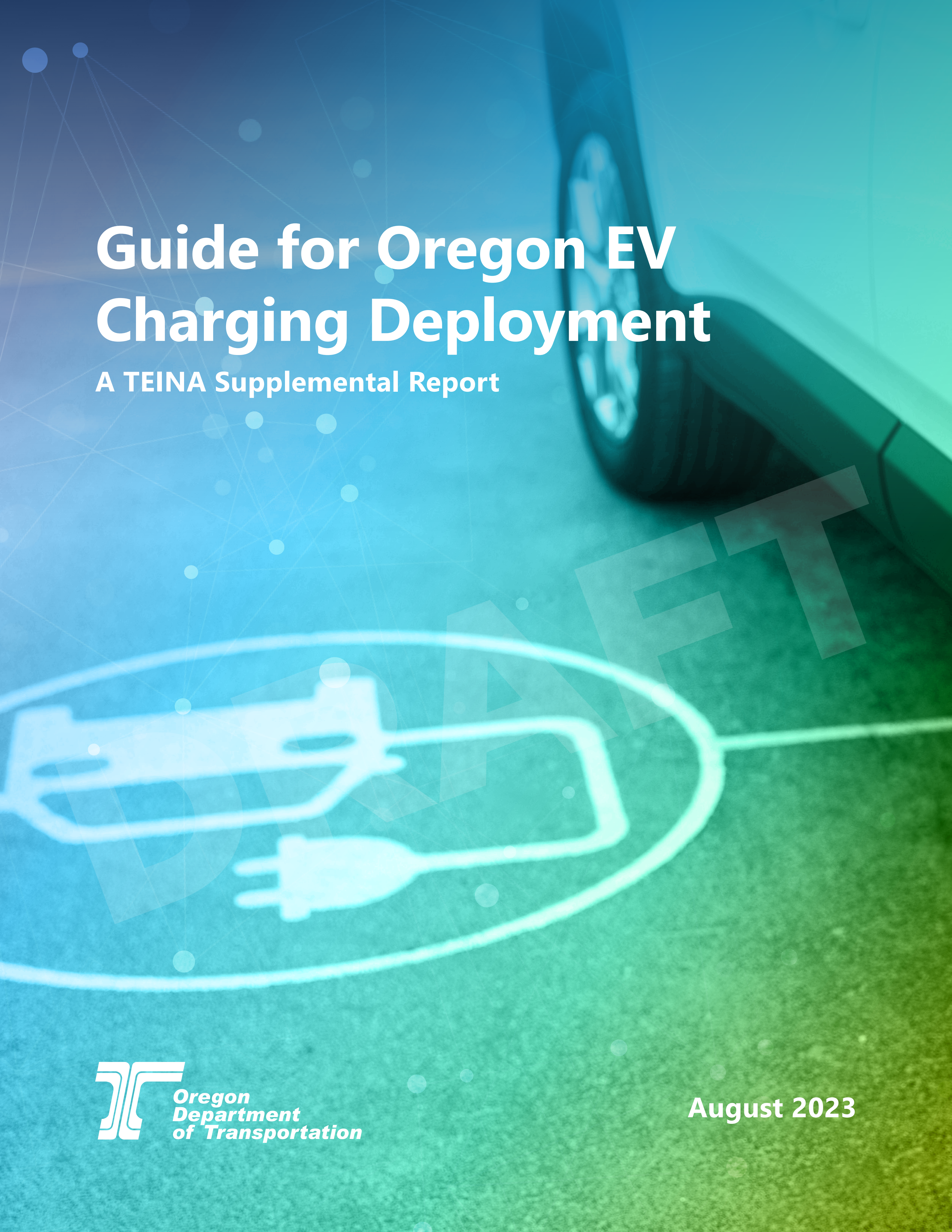
Guide for Oregon EV Charging Deployment

A TEINA Supplemental Report



Oregon Department of Transportation

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Guide for Oregon EV Charging Deployment

A TEINA Supplemental Report

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Foreword

This report was produced by the Oregon Department of Transportation's Climate Office under the guidance and direction of Mary Brazell, Transportation Electrification Program Manager; Jillian DiMedio, Senior Transportation Electrification Analyst; and Suzanne Carlson, Climate Office Director.

The consultant project team that assisted the Climate Office in the production of this report was led by Kittelson & Associates, Inc. with support from RMI. Contributing staff from Kittelson & Associates, Inc. included Wayne Kittelson, Project Manager; Wende Wilber, Stakeholder Engagement Leader; Christopher Bame, Technical Analyst; and Ralph Bentley and Susan Mah, Senior Graphic Designers. Contributing staff from RMI included Ben Shapiro, Manager—Carbon-Free Transportation; and Aradhana Gahlaut, Associate—Carbon-Free Transportation.

The project received additional feedback and suggestions from the Oregon Department of Energy and the Oregon Department of Environmental Quality, as well as an Advisory Group consisting of Greg Alderson, Portland General Electric; Tom Ashley, Shell Recharge Solutions; Phil Barnhart, Emerald Valley Electric Vehicle Association; Chris Chandler, Central Lincoln Public Utility District; Marie Dodds, AAA Oregon; Judge Liz Farrar, Gilliam County; Ingrid Fish, City of Portland; Stu Green, City of Ashland; Jamie Hall, General Motors; Zach Henkin, Center for Sustainable Energy; Joe Hull, Midstate Electric Cooperative; Juan Serpa Muñoz, Eugene Water and Electric Board; Vee Paykar, Climate Solutions; Cory Scott, Pacific Power; Jairaj Singh, Unite Oregon; Charlie Tracy, Oregon Trail Electric Cooperative; and Dexter Turner, OpConnect. The Oregon Department of Transportation and the consultant project team acknowledge with sincere appreciation the feedback and suggestions provided by the Advisory Group members while also noting that the members were not asked and have not formally endorsed the content of this report either individually or collectively.

Executive Summary

The Oregon Department of Transportation's *Guide for Oregon EV Charging Deployment* (the "Guide") serves as a "one-stop shop" full of information and resources to support all those interested in the deployment of light-duty public EV charging infrastructure throughout the state. The Guide offers an overview of EV charging infrastructure basics; best practices; tools for estimating demand and equitably locating stations; planning level cost estimates; a synopsis of today's funding sources; and strategic and equity considerations for EV charging station investments.

This Guide supports deployment of charging infrastructure and is organized into five chapters:

- Electric Vehicle Supply Equipment (EVSE) Basics
- Best Practices for Planning, Design, and Deployment of EVSE
- Planning Level Cost Estimates
- Planning and Deployment Approach
- Priority Focus Areas for EVSE

Electric Vehicle Supply Equipment (EVSE) Basics

The Guide provides a foundational understanding of the different types of EV charging equipment, often referred to as Electric Vehicle Supply Equipment (EVSE), and provides insight regarding which type will be most appropriate for different use cases.

EVSE is categorized into three types based on output power levels: Level 1 (L1), Level 2 (L2), and Direct Current Fast Chargers (DCFC)—sometimes referred to as Level 3 (L3). **Table 1** shows the high-level differences between charger types.

Table 1. Characteristics of different EV charger types by power level

Charger Type	Input Voltage	Output Power Level	Typical LDV* Charging Time	Use Cases
L1	110 or 120V	1 to 2 kW	Up to 12+ hours	Residences and limited workplaces
L2	208, 220 or 240V	3 to 19 kW	6 to 8 hours	Residential, commercial, workplace, and fleets
DCFC	480 to 1000V	20 to 350 kW	20-45 minutes	Highway refueling stops, recreational areas, shopping centers, fleets

**Light Duty Vehicle charging times will vary by EV. The estimates shown in this table are based on an EV with a battery electric range of approximately 300 miles and charged approximately 80% to a full battery state-of-charge, starting from a 20% state-of-charge.*

Best Practices for Planning, Design, and Deployment of EV Charging

EV charging infrastructure installations (referred to in this report as EVSEs for brevity) are an essential precursor to, and driver of, EV adoption because a robust network of EVSEs builds consumer confidence that drivers will be able to charge their vehicles conveniently and affordably. Without sufficient EVSE deployment, it will be challenging to achieve Oregon's Advanced Clean Cars II and statutory goals for EV adoption. To ensure EVSE deployments are well-designed and optimally located, a number of considerations must be taken into account, including local planning and permitting decisions, business model and site design options, engagement with the local electric utility, and prioritizing equitable access to EVSE.

EV Charging Considerations

Planning and Permitting

Local governments can support the deployment of EVSE through planning, policies, regulations, incentives and installation of sites. A review of approaches in cities and states across the country revealed the following best practices:

- Incorporate EVSE needs into comprehensive planning efforts to achieve EV readiness.
- Establish specific goals for the number of publicly available charging ports to be deployed locally, by a given year, setting EVSE deployment targets.
- Deploy EVSE on public land for residents and visitors, to encourage EV adoption.
- Adopt a streamlined permitting and inspection process for EV charging installations, enabling more rapid, predictable, and less costly deployment of EVSE.
- Establish EV ready infrastructure requirements in building codes and ordinances.
- Establish minimum EV parking requirements and ratios.
- Enact laws that compel housing and community associations to allow EVSE deployment.
- Develop educational resources to increase EV awareness for residents, local businesses, and developers.

Business Models and Site Design

Selecting a viable business model and designing the specifics of an EVSE deployment are closely related topics that jointly define the overall approach to providing charging at a given location. While many variations exist, there are three primary business models:

- **The network owned and operated model[1].** EVSE network providers develop and own EV charging stations; evaluate, select sites and negotiate with site hosts; and work directly with utilities and jurisdictions on permitting and process developments. Site hosts may have little or no control over the site development, pricing, operations, or customer service, but also have lower risk.
- **The site host owner-operator model.** Site hosts procure EVSE from a hardware manufacturer, work with contractors to install the equipment and then directly operate the EVSE. Site hosts retain control of site development, operation, pricing and revenue collection, and customer service while also taking on the corresponding risks.
- **The third-party owner-operator model.** Third parties, such as a local retail outlet, typically develop the site (working with jurisdictions and electric utilities on permitting, code, and process requirements); determine prices and revenue sharing; and provide ongoing operation, maintenance and customer service. Third parties often lease space from site hosts and may share a portion of revenues collected. Third parties take on much of the project risk while site hosts lose control over some aspects of the deployment (e.g., customer experience and full revenue collection).

[1] *Networked EVSE refers to a combination of EV charging equipment components and software that enable connection to a private company's network, either through the Internet or via cellular data. Networked charging allows for centralized management, administration, communication, remote diagnostics, flexibility to set pricing and payment mechanisms, participation in utility-sponsored managed charging programs, data collection, and other features.*

Prospective site hosts must consider, in addition to cost, the level of control they desire and how involved they care to be in operating the EVSE when determining which approach will best suit their needs.

Regardless of the business model chosen, a clear operations and maintenance plan should be put in place with targets for reliability, and include a provision for a 24/7 customer service phone number for users to troubleshoot charging, payment, or other issues. This strategy and related best practices help to ensure EVSEs are reliable and accessible.

Utility Engagement

Local electric utilities play a key role in supporting EVs and EVSE and need to be engaged early and often throughout the development of EVSE sites. Site hosts and/or project developers must work with utilities to ensure the chargers being deployed can be accommodated by the site's existing electric service capacity, and if not, to undertake a service upgrade.

In general, the more information site hosts and/or project developers can provide to utilities early in the development process, the better. Typical data required includes site plans; expected number and power levels of EVSE; electric panel size and service voltage/phase; electrical single line diagrams; and anticipated new electrical load. Local governments, site hosts, and EVSE developers will want to work with the local utility to understand their processes and also to explore what incentives and other supporting programs might be offered.

Ensuring Equitable Access to EV Charging

EVSEs should support communities and all people should have access. Thus, engagement is key, especially in disadvantaged and rural communities. Several useful strategies are broadly applicable for ensuring engagement and targeted investment in disadvantaged and rural communities:

- Conducting community or mobility needs assessments.
- Developing accessible public charging in the right-of-way.
- Providing focused incentives and/or financing options for lower income residents.
- Conducting education and outreach campaigns that center around underserved communities and are designed to overcome cultural barriers and mistrust.

There are also key questions that should be asked to ensure EVSE development takes place equitably, including:

- What groups should be included in planning discussions and throughout project implementation?
- What types of charging are most important to each user type?
- Which areas are most vulnerable to insufficient attention and investment?
- What unintended impacts might arise and how can they be prevented?

Careful attention to inclusion and equity in both the planning and deployment processes are critical to establishing an EVSE landscape that meets the needs of all Oregonians.

Deploying EVSE at Specific Locations

While many best practices are shared across all EVSE deployment types, different locations also present distinct challenges and opportunities. Accordingly, deployments at different location types—such as multi-family housing (MFH), workplaces, public Level 2 charging destinations, and public DC fast charging stations—can benefit from different considerations, as summarized in **Table 2** below.

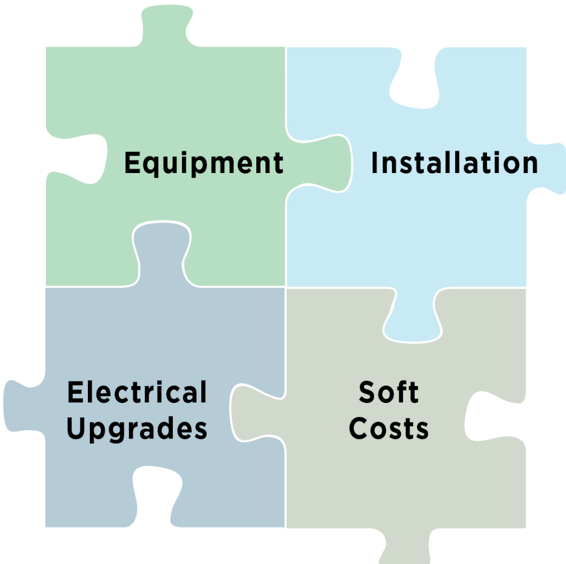
Table 2. Strategies to Support EV Charging Deployment at Different Locations

Strategy	MFH	Workplace	Public L2	Public DCFC
Establish EVSE deployment targets that include specific goals for different location types.	✓	✓	✓	✓
Ensure charging is deployed at MFH of all types, including in diverse socioeconomic parts of the local area.	✓			
Consider specific deployment targets for curbside charging to provide market certainty for EVSPs			✓	
Provide incentives such as upfront or reimbursable rebates to cover the cost of EVSE and/or installation, especially when such programs are not offered by the local electric utility.	✓	✓	✓	✓
Offer higher incentives for locations in disadvantaged communities to help to provide EV charging for a broader group of residents and/or employees.	✓	✓	✓	✓
Provide educational and outreach materials for prospective building owners, managers, or site hosts, including the end-to-end process for developing EVSE in compliance with local requirements.	✓	✓	✓	✓
Develop streamlined permitting processes for EVSE, including tailored processes for different locations (e.g., MFH residential vs. public L2), as needed.	✓	✓	✓	✓
Work with the local electric utility to explore EV rates that do not impose large demand charges, which can make costs unsustainable at low utilization rates.				✓

Planning Level Cost Estimates

When planning for EVSE deployments, it can be challenging to estimate all the costs likely to be incurred. Four categories of costs are important to consider: equipment; installation (including the customer-side of the meter electrical connection costs); electrical upgrades on the utility side of the meter (such as transformers); and soft costs (such as site acquisition, permits, easements, environmental review, and other processes). **Figure 1** identifies the four cost categories that contribute to the total EVSE deployment cost.

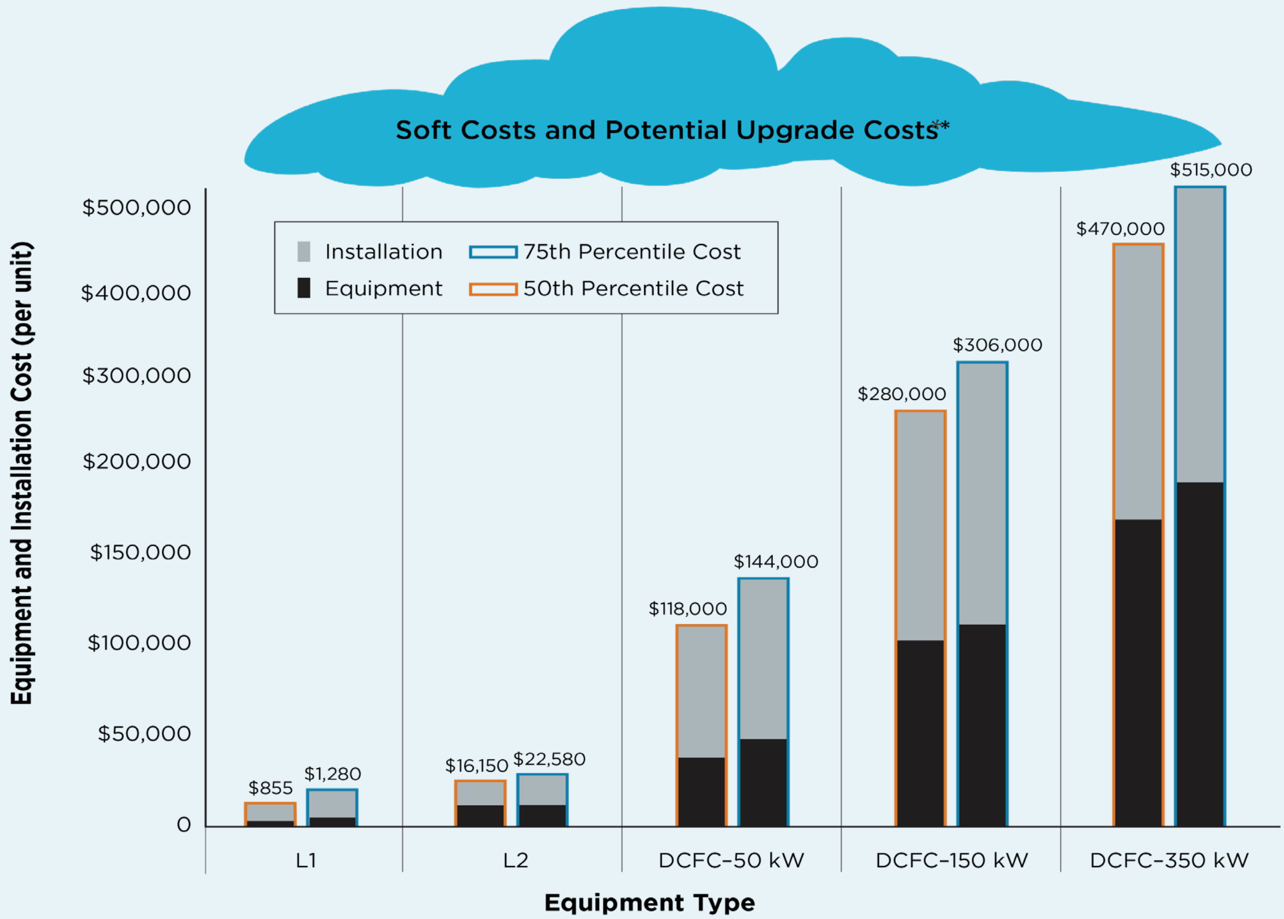
Figure 1. EVSE deployment cost components



This Guide provides in-depth insight to help planners estimate equipment and installation costs. The other two categories of cost—electrical upgrades and soft costs—are highly variable, site specific, and are not discussed at length in this report. Nevertheless, it is critical to consider all four cost categories as EVSE deployment plans are developed. Planners may wish to consult with the local electric utility and the authority having jurisdiction (e.g., county or city) early and often during EVSE planning and deployment, to better assess costs that may be incurred due to either electrical upgrades or various aspects of soft costs.

The planning level estimates of the cost, per port, of equipment and installation of EV charging infrastructure at a site are illustrated in **Figure 2.** Cost ranges for EV charging equipment and its installation were developed using estimates from recent, published research and then adjusted for inflation to 2022 levels; supply chain constraints and feedback from informed Oregon stakeholders further updated cost estimates. Two scenarios are illustrated: (1) estimates of costs using the 50th percentile of the cost range (low), and (2) estimates of costs using the 75th percentile of the cost range (high). If networked charging and additional ancillary services are included in a planned EV charging infrastructure installation, the 75th percentile cost estimates are more likely to reflect real-world experience in Oregon than the 50th percentile cost estimate, on a per port basis. However, significant economies of scale can reduce costs if several chargers are installed at the same time, at the same site. Soft costs and potential upgrade costs are shown schematically in **Figure 2** as a cloud above all the equipment and installation costs to illustrate the need to take these costs into consideration, recognizing that these costs are highly variable and site specific. To better estimate these and other costs, it is important to reach out to utilities and/or authorities having jurisdiction.

Figure 2. Estimated total equipment and installation cost of EV charging equipment at a site



** The soft costs and potential upgrade costs are not included in the graphic's bar charts. As noted in the narrative, these costs can be substantial and need to be considered when planning.*

Sources: RMI, the International Council on Clean Transportation (ICCT), the National Renewable Energy Laboratory (NREL), Atlas Public Policy, and updated for inflation, supply chain constraints, and feedback provided by informed stakeholders in Oregon.

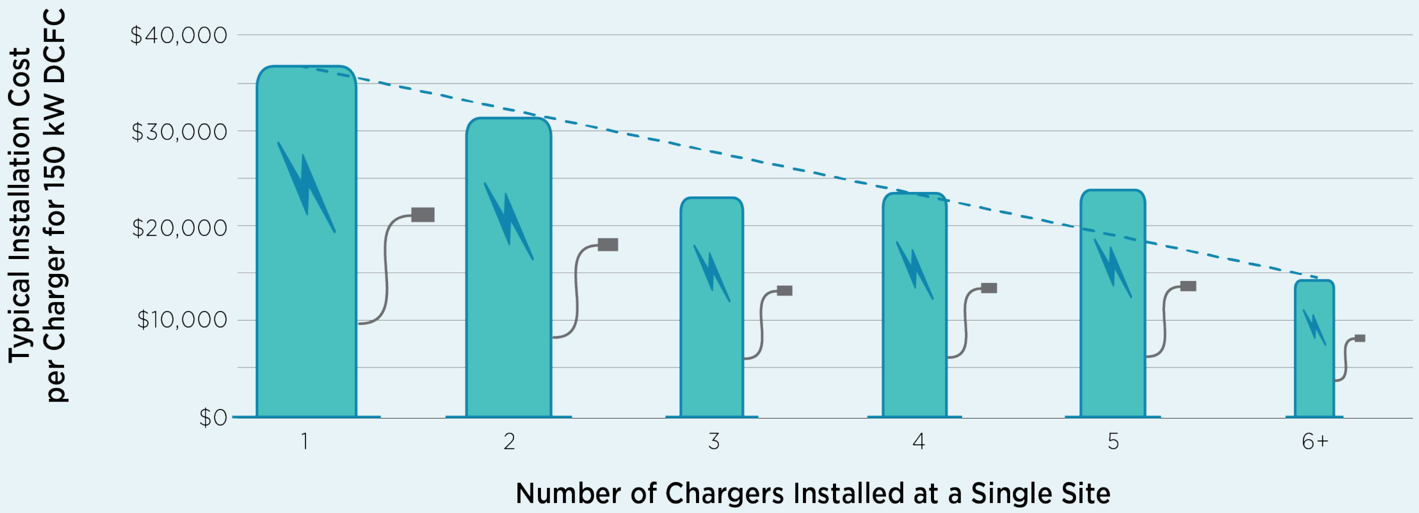
Managing Project Costs

The needed features and services of the charging equipment should be identified first before selecting EV charging equipment or site locations. Anticipated EVSE utilization, and determining whether networked chargers are desired, are also factors that need to be considered early on. Site characteristics impact EVSE installation costs, especially:

- **Proximity to electrical equipment.** Minimizing the distance to service panels, switchboards and electrical meters can help keep costs down.
- **Weather protection and durability.** Equipment in outdoor settings may have additional requirements for weather protection and heavy use.
- **Surface type.** The parking surface (for example asphalt, concrete, or unpaved) impacts the cost of trenching/coring/boring and installing charging and electrical equipment.

Project scale (the number of chargers at a site) can also significantly affect the per-port cost of EVSE installations, with increasing numbers of EV chargers (up to about 6 EV chargers per site) substantially decreasing both per charger and per port costs. **Figure 3** presents one research study's data illustrating the potential impact of lower per unit costs due to economies of scale as the number of chargers included at the same site rises. These economies of scale are due to distributing the cost of upgraded electrical infrastructure across a larger number of EVSE chargers and ports. Additionally, economies of scale and competitive bidding processes can affect per-unit equipment costs, with larger purchase orders having greater eligibility for bulk discounts. However, the installation cost per charger may increase if the number of chargers is increased to the point of triggering a larger grid-side upgrade requirement.

Figure 3. Effects of project scale on per-charger cost*



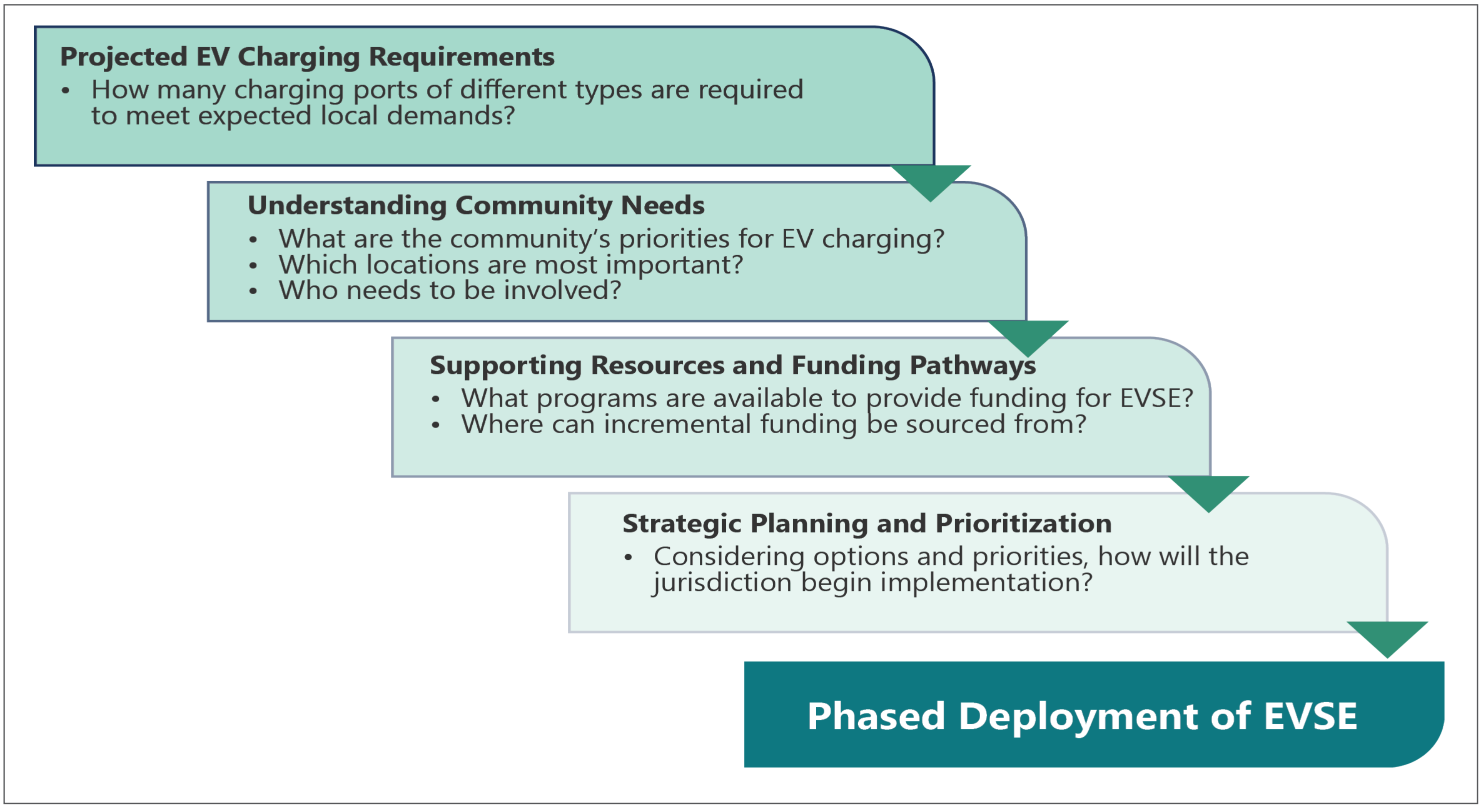
Source: International Council on Clean Transportation (ICCT)

**This figure displays data from ICCT's study, and illustrates the general concept of how economies of scale can reduce per port EV charger installation costs. However, the data used by ICCT is different from cost estimates provided elsewhere in this report, which are a composite of data from several studies, and have been adjusted for inflation, supply chain constraints, and feedback from informed Oregon stakeholders.*

Planning and Deployment Approach

Several key steps and elements are necessary for any organization or jurisdiction to effectively plan for and deploy EVSE. This chapter addresses these steps and elements, as shown in **Figure 4:** (Planning and Deployment Approach), reflecting the key steps of Projected EV charging requirements; Understanding community needs; Supporting resources and funding pathways; and Strategic planning and prioritization.

Figure 4. Planning and Deployment Approach



Projected EV Charging Requirements

Understanding how many and what type of EV chargers are needed in a specific geography or local jurisdiction, in both the near term and future, can help city, county, utility and other planners make better plans for implementing EV charging infrastructure locally. To estimate charging needs in Oregon communities, ODOT developed the TEINA Dashboard for EV charging infrastructure developers and local decision makers, based on ODOT's Transportation Electrification Infrastructure Needs Analysis (TEINA) 2021 study.

The TEINA Dashboard is an easy-to-use Excel spreadsheet that allows users to tailor results for specific geographies (e.g., counties, cities, or census tracts), and display anticipated charging needs for that area each year from 2020 through 2035. The TEINA Dashboard, which includes instructions for use, can be accessed on ODOT's GO EV Charge webpage along with an explanatory video[2]. Users can rely on TEINA estimates or provide their own projections of EV use and calculate the number and type of EV charging that will be needed in a specific region.

Understanding Community Needs

Each community will require its own unique combination of EVSEs, including how many (total number of ports) and where (ports by location type). Community characteristics that will affect the determination of these needs include:

- Mobility patterns and travel characteristics
- Land use and zoning characteristics
- Local economic characteristics and trends
- Equity considerations
- Climate and weather patterns

Fully understanding these needs will be critical for effectively supporting the growth of EVs in different areas of the state.

Supporting Resources and Funding Pathways

Once community needs have been assessed, EV charging infrastructure developers and local planners will want to explore supporting resources and funding for deploying EVSE. At the federal level, the Infrastructure Investments and Jobs Act (IIJA) and the Inflation Reduction Act (IRA) have provided renewed funding opportunities for EVSE deployment.

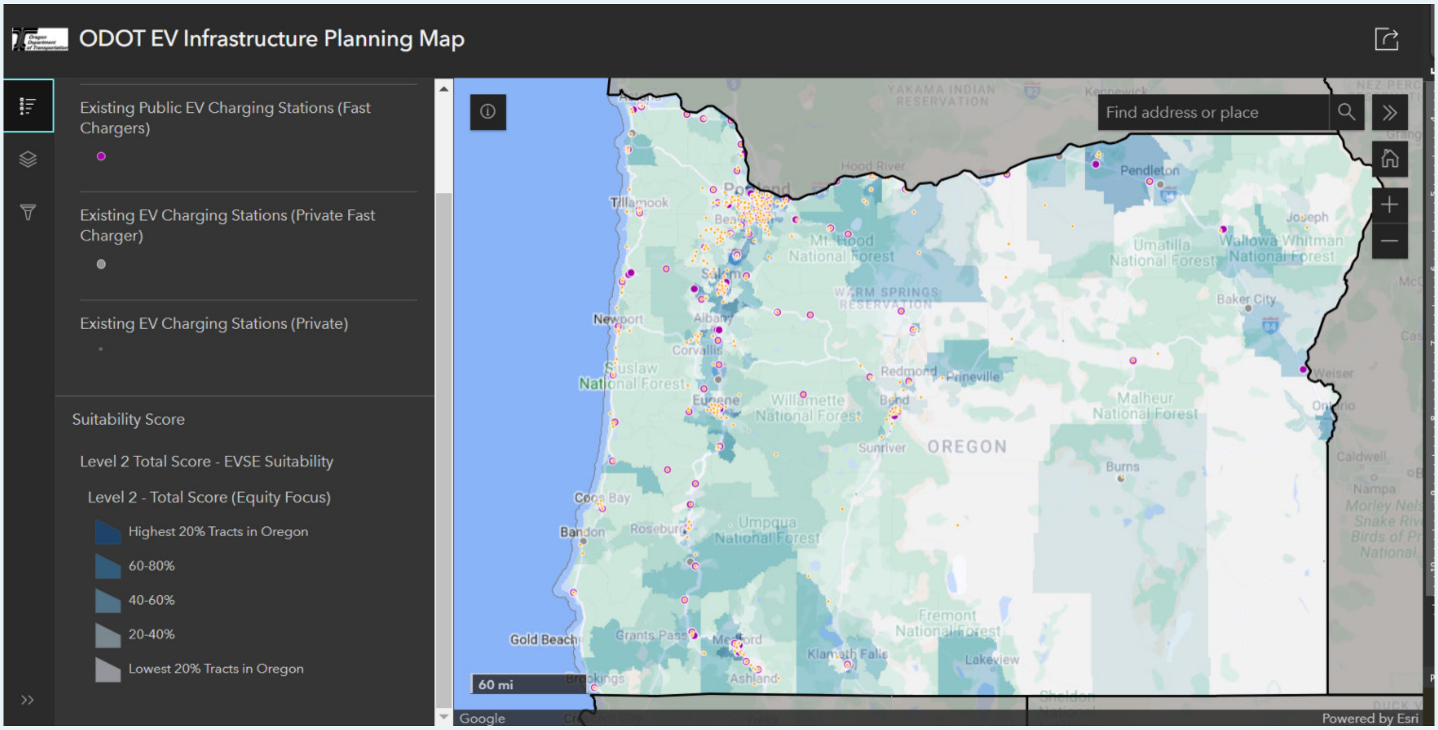
The state of Oregon is also providing financial, technical, and educational support for EVSE deployment in recognition of the rapid scaling required to enable EV adoption in line with legislative and regulatory goals. This includes ODOT's funding for fast-charging along corridors (via the National Electric Vehicle Infrastructure formula program) and its program for Level 2 charging in communities (Community Charging Rebates Program), both of which can help offset the upfront costs of equipment and installation. It also includes the Department of Environmental Quality's Clean Fuels Program (CFP), which can help offset operational costs for EV charging in the state. Additionally, Oregon's public and investor-owned electric utilities (IOUs) are providing various forms of support for EVSE, including incentives and technical assistance. The Oregon Public Utility Commission (PUC) requires the state's three electric IOUs to submit Transportation Electrification Plans, which propose programs and investments to support EV adoption in their service territories. More detail on funding sources can be found in Chapter 5 of the Guide within the section titled Supporting Resources and Funding Pathways.

[2] *The original TEINA webpage can be found here.*

Strategic Planning and Prioritization

EV charging infrastructure developers and local planners could benefit from a strategic plan for prioritizing EVSE deployment in their area. Information from this Guide's companion resources and tools (including the TEINA Dashboard), as well as insights from a community needs assessment, can help inform the specific approach that will best suit local conditions. Importantly, planners may wish to consider the EVSE needs in their area as they complete holistic planning exercises such as general plans or long-range transportation plans. To enable EV charging infrastructure developers and local governments to prioritize EVSE deployments more easily within their communities and through their planning processes, ODOT has developed an EV Infrastructure Planning Map for assessing priority areas for EVSE deployment. **Figure 5** illustrates an example output from this interactive tool.

Figure 5. ODOT EV infrastructure planning map



The EV Infrastructure Planning Map is a GIS-based webmap that allows users to strategically plan for and site L2 and DCFC EVSE in Oregon communities. The tool allows decision makers to view siting criteria geospatially, including demographic, land use, transportation and equity related data layers, and then use that information to make siting decisions based on community-specific characteristics and priorities. In addition to individual data layers, the map includes "priority score" layers (for both public L2 and public DCFC EVSE). These layers prioritize census tracts for EV charging based on pre-weighted scores for equity, charging network gap filling and station utilization criteria. The EV Infrastructure Planning Map is intended to allow planners to easily focus on the siting considerations most important to their community. Detailed instructions for using ODOT's EV Infrastructure Planning Map can be accessed on ODOT's GO EV Charge webpage along with an explanatory video covering sample scenarios for use[3].

[3] *The original TEINA webpage can be found here.*

Priority Focus Areas for EVSE

Achieving Oregon's transportation electrification goals will take concerted effort and collaboration between many different entities, including multiple public and private sector parties. Information provided in this Guide can help provide a roadmap for the "how to" of EV charging infrastructure deployment, suggestions for community engagement, and tools that can facilitate planning and siting goals consistent with community priorities.

Table 3 provides a summary of state-wide EV charging deployment priorities, including specific recommendations for several of the key light-duty use cases which build upon the priorities identified in the TEINA study.

Table 3. TEINA infrastructure deployment priority recommendations

Light-duty EV Use Case	Recommendation
Urban	Develop Level 1 and Level 2 community charging sites for (long duration charging—important for Multi-Family Housing residents).
	Locate public Level 2 and DCFC on public property with sufficient existing power capacity, especially in low-income, BIPOC, and disadvantaged communities.
	Prioritize workplace charging at large and women/minority-owned employment locations.
	Address urban charging deserts by prioritizing urban DCFC hubs that serve multiple needs (e.g., Multi-Family Housing and Transportation Network Company drivers)
Rural	Address rural charging deserts by prioritizing rural corridor, tourism, destination, and public Level 2 charging.
Corridor	Expand Oregon's highway corridor DCFC network across all federal and state highways.

EV charging infrastructure developers and diverse stakeholders will serve Oregon well by prioritizing EVSE deployment in keeping with TEINA priorities, specifically at multi-family housing, workplaces, and in current charging deserts. Deployment in these locations can be accomplished through the following recommended actions:

- Develop programs and policies to support the deployment of EVSE at multi-family housing.
- Promote workplace charging to provide low-cost, long-dwell time non-residential charging.
- Develop EVSE deployments in current charging deserts.

Deploying sufficient EVSE to support Oregon's anticipated light-duty EVs is a large undertaking, yet one that can be achieved through collaboration, shared goals, and a commitment to catalyzing the growth of transportation electrification in the state. A diverse mix of organizations are increasingly investing in EV charging, including: electric vehicle service providers (EVSPs); subsidiaries of major gasoline retailers; convenience store operators; truck stop operators; a new consortium of seven automakers; rental car companies; electric utilities; tourist venues; and the public sector. Working collaboratively to make this a reality is an imperative for the transportation sector and is also needed for the state to succeed in its ambitions for reducing climate impacts and transitioning to a low-carbon economy.

1. Introduction

Worldwide, automakers are increasingly offering more makes and models of electric vehicles (EVs) including electric cars, sport utility vehicles (SUVs), pick-up and delivery trucks, buses, and long-haul freight trucks. A wide array of electric bikes and scooters are also rapidly entering the market. Consumer demand and market forces are driving this trend, along with manufacturer commitments, technology improvements and decreases in component costs, and global ambition to achieve greenhouse gas (GHG) reductions from the transportation sector.

The shift towards electrification of light-duty cars, trucks, and SUVs in Oregon is clearly underway, with more than 70,000 registered zero-emission vehicles (ZEVs) in the state. Oregon has one of the highest rates of new ZEV light-duty car sales/leases in the United States[4]. This trend is only likely to accelerate. In December 2022, Oregon adopted the Advanced Clean Cars II regulation, requiring growing numbers of light-duty ZEVs to be offered for sale in the state, with 100% of new light-duty vehicle sales in Oregon required to be ZEVs by 2035. This regulation builds upon Oregon's history of light-duty ZEV requirements and incentives, and complements Oregon's recent adoption of the Advanced Clean Trucks rules, requiring increasing numbers of ZEV medium and heavy-duty (MHD) trucks to be offered for sale over the next decade.

More EVs are entering the marketplace, but consumer concerns about the availability of public EV charging is constantly cited as a principal factor holding back rapid light-duty EV adoption. Oregonians need confidence that public EV charging will be available wherever they live, work and play. Federal, state, and local governments and utilities are funding and adopting policies to incentivize development of public EV charging infrastructure, with a goal to spur investment from both the private and public sectors. A diverse mix of organizations are increasingly investing in EV charging for cars and trucks, including: electric vehicle service providers (EVSPs) on their own or in concert with major EV automakers or retail venues; subsidiaries of major gasoline retailers; convenience store operators; truck-stop operators; a new consortium of seven major automakers; collaborations between automakers, gasoline service stations or retail venues; rental car companies; electric utilities; owners of multi-family housing; employers; retail and tourist venue operators; individual site owner/operators; and the public sector (federal, state, and local governments). This Oregon Department of Transportation 2023 report—*Guide for Oregon EV Charging Deployment* (the "Guide")—serves as a "one-stop shop" full of information and resources to support those interested in the development of light-duty public EV charging infrastructure throughout the state. The Guide offers an overview of EV charging infrastructure; best practices; tools for estimating demand and equitably locating stations; planning level cost estimates; a synopsis of today's funding sources; and strategic and equity considerations for EV charging investments. It is a companion report, and outgrowth of, the Oregon Department of Transportation's (ODOT's) Transportation Electrification Infrastructure Needs Analysis TEINA, which was developed with support from the Oregon Department of Energy, the Department of Environmental Quality, other sister agencies in the Zero Emission Vehicle Interagency Working Group (ZEVIWG), and the TEINA Advisory Group.

The 2021 TEINA study developed scenarios that highlight the overall need for plug-in EV charging across light-duty, medium-duty, heavy-duty, and electric micromobility EV use cases, through 2035. TEINA highlighted the need for substantial investments in public charging infrastructure, noting the imperative for a five-fold increase by 2025, and over 40-fold increase by 2035. TEINA also highlighted the need for public funding to prioritize investments in EV charging infrastructure in rural and underserved areas—where there are urban and rural charging deserts—including multi-family housing, where access to parking, let alone EV charging, poses unique challenges.

[4] *Legislative goals and regulatory requirements specify the need for zero-emission vehicles (ZEVs), which consist of plug-in battery electric vehicles, plug-in hybrid electric vehicles, as well as hydrogen fuel cell electric vehicles. This report focuses on charging for plug-in electric vehicles (EVs), and the terms EVs and ZEVs are used interchangeably throughout the report to refer to plug-in electric vehicles.*

In 2022, ODOT supplemented TEINA by examining opportunities to provide hydrogen fuel cell EV refueling infrastructure , and ways to expand the use of electric bikes and scooters through subsidies and other investments. Additionally, in 2022, as part of the federally funded National Electric Vehicle Infrastructure (NEVI) program, ODOT developed the Oregon National Electric Vehicle Infrastructure Plan (with support from the Oregon Department of Energy and other ZEVIWG sister agencies), to use federal funds to provide high-powered EV charging stations along major corridors throughout the state over the next five years.

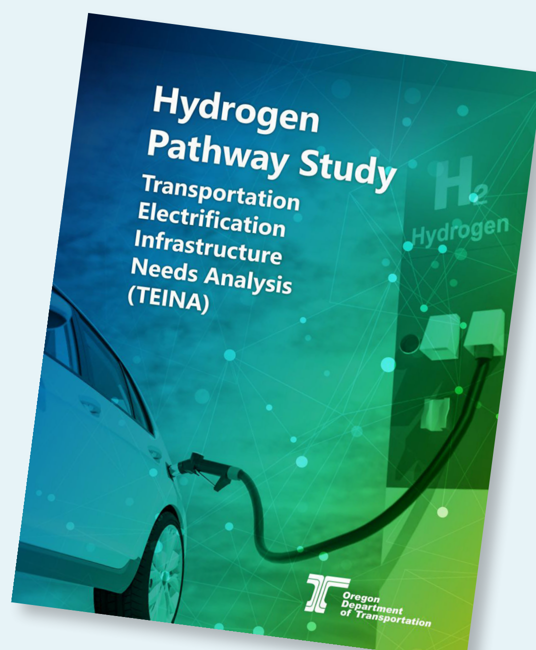
This *Guide for Oregon EV Charging Deployment* ("Guide") builds on this previous foundational work. The Guide is intended to provide useful information to every potential EV charging provider in the state.

The report is organized along five primary topic areas:

- Electric Vehicle Supply Equipment (EVSE) Basics
- Best Practices for Planning, Design, and Deployment of Electric Vehicle Supply Equipment (EVSE)
- Planning Level Cost Estimates
- Planning and Deployment Approach
- Priority Focus Areas for EVSE

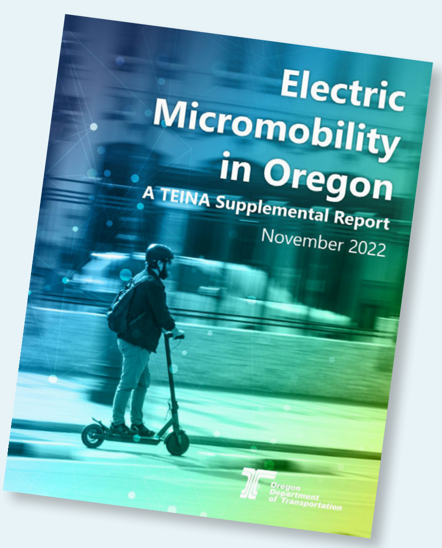
ODOT's Hydrogen Pathway Study

Hydrogen fuel cell electric vehicles (FCEVs) offer another zero emission solution for decarbonizing transportation and have many advantages over battery electric technology, including a longer driving range, shorter fueling times, and lower weight. These characteristics mean that, in some scenarios, FCEVs may offer the easiest and most cost-effective solution for decarbonizing transportation, especially for use cases such as long-haul trucking that have proven more challenging with battery-electric vehicles (BEVs). In recognition of the critical role hydrogen may play in decarbonizing transportation, ODOT published its Hydrogen Pathway Study in April 2022. The study details the hydrogen landscape in North America, includes an FCEV inventory across all vehicle classes and provides short-, medium- and long-term recommendations for how Oregon can best prepare for and develop the market for hydrogen and FCEVs. In addition, the Hydrogen Pathway Study explored an additional scenario to TEINA, where a portion of Oregon's ZEV sales are met by FCEVs (not just BEVs) and then assesses the fueling infrastructure needs to support this potential fleet of hydrogen cars, trucks and buses.



ODOT's Electric Micromobility Study

In addition to electrifying cars, truck and buses, ODOT works to reduce the number of miles driven in Oregon by encouraging alternative modes of transportation such as biking and walking. More than ever before, Oregonians are using electric micromobility devices such as e-bikes, e-scooters, and others to get around. Electric micromobility offers similar benefits to other modes of active transportation including improved physical and mental health, reduced car trips and traffic congestion, and reduced tailpipe emissions. At the same time, this travel mode also appeals to more users due to its many diverse applications. People are using electric micromobility devices to commute, run errands, take kids to school and even move goods and freight. With such diverse applications, electric micromobility will play an important and growing role in serving communities' transportation needs, all while reducing GHG emissions from the transportation sector. To better understand this rapidly growing sector, ODOT published its Electric Micromobility Study in early 2023. The study provides an overview of electric micromobility, highlights its unique benefits and details the key barriers preventing widespread adoption. In addition, the study offers a number of actionable strategies and best practices to facilitate the growth of this industry.



2. Electric Vehicle Supply Equipment (EVSE) Basics

Prior to diving into the core topics covered in this report, it is useful to briefly summarize the basic components of Electric Vehicle Supply Equipment (EVSE). EV chargers in the United States are categorized into three distinct types based on their output power levels, known as Level 1 (L1), Level 2 (L2), and Direct Current Fast Chargers (DCFC, also known as Level 3). **Figure 6** and **Table 4** provide overviews of these three power levels.

Figure 6. EV Charging Power Levels[5]

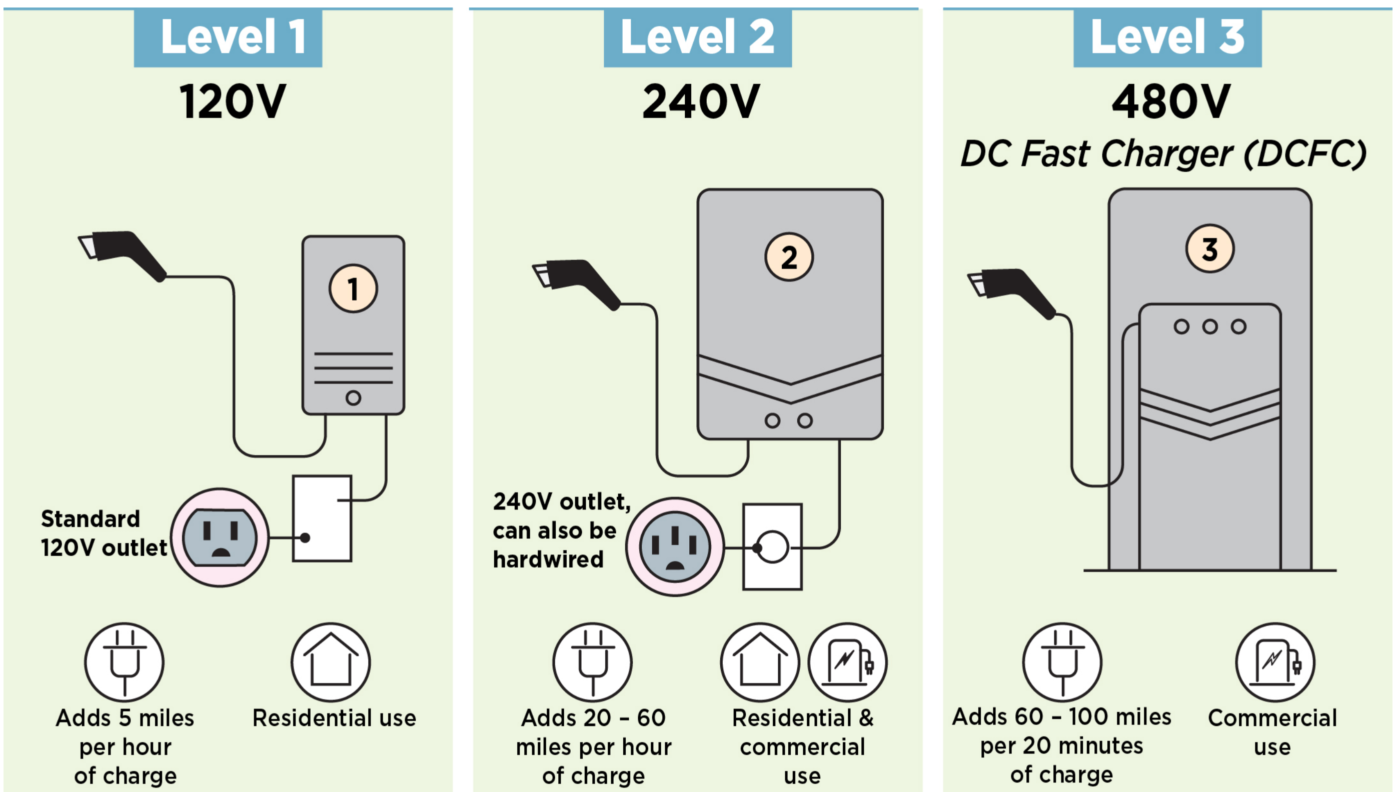


Table 4. Characteristics of different EV charger types by power level

Charger Type	Input Voltage	Output Power Level	Typical LDV* Charging Time	Use Cases
L1	110 or 120V	1 to 2 kW	Up to 12+ hours	Residences and limited workplaces
L2	208, 220 or 240V	3 to 19 kW	6 to 8 hours	Residential, commercial, workplace, and fleet
DCFC	480 to 1000 V	20 to 350 kW	20 to 45 minutes	Highway refueling stops, recreational areas, shopping centers, fleets

**Light Duty Vehicle charging times will vary by EV. The estimates shown in this table are based on an EV with a battery electric range of approximately 300 miles and charged approximately 80% to a full battery state-of-charge, starting from a 20% state-of-charge.*

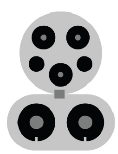
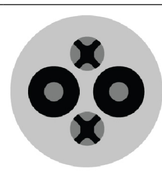
[5] *http://www.aedesign-inc.com/blog/2021/9/23/ev-charging-101.*

L1 chargers are similar to plugging an EV into a regular 120V household outlet. This makes them the easiest to site and install. However L1 is also the slowest form of charging, offering only 1-2 kW of power. This is equivalent to the power consumed by a regular household appliance, such as a microwave. Due to the charging speed provided, L1 is applicable mostly in residential use cases where the user has a relatively short daily commute and can charge overnight, as well as in certain workplaces where employees may leave vehicles parked for many hours at a time.

L2 chargers are available at a variety of output power levels from 3 to 19 kW, and can completely recharge a 300-mile range vehicle in 6-8 hours. These are often appropriate solutions for most residential, commercial, and workplace settings, providing higher power than L1 chargers as well as optional added capabilities such as charge scheduling and load management[6]. L2 chargers require 208V, 220V or 240V service, which in turn often requires installation of dedicated circuits similar to larger appliances such as electric clothes dryers. L1 and L2 chargers use a single, common connector type—SAE J1772—offering ease of use between different vehicle models and charging locations.

DCFC can provide anywhere from 20 to 350 kW of power and require input voltage of at least 480V but can reach up to 1000V levels, akin to industrial machine tools with large power requirements. Subject to the EV's capability to receive power[7], a DCFC can fully charge a 300-mile vehicle in as little as 20 minutes. These stations are best suited for locations with short dwell times (that is, how long the vehicle is stopped) such as recharging along the highway, convenience stores, fast-food restaurants, locations near multi-family housing, and some shopping or recreational areas. DCFC stations are intended to support long distance trips, users without access to home charging, high mileage commuters, and on-demand EV ride-hailing services. DCFC have multiple standards for connectors, three of which are used in North America: SAE Combined Charging System (CCS), CHAdeMO, and Tesla's North American Charging Standard (NACS). While all of these connectors are currently used by certain vehicles, until recently many car manufacturers had been increasingly adopting the CCS standard. In May 2023, several automakers announced their intent to offer the ability to use the Tesla NACS connector on their future EV offerings (see **Figure 7**). It is currently unclear whether some/all of these OEMs will continue to include a CCS option on future EVs as well as the NACS, or whether the NACS connector will become the new standard.

Figure 7. Types of EV Fast Charging

DC Standard	Connector	Used By	
SAE Combined Charging System (CCS)		• GM • Ford • Honda • Kia • Hyundai	• BMW • Mercedes-Benz • Porsche • Audi • VW
CHAdeMO		• Nissan • Mitsubishi	
North American Charging Standard (NACS) formerly Tesla Supercharger		• Tesla	OEMs stating future EVs will offer NACS, as of July 2023 • Ford • GM • Rivian • Volvo • Polestar • Mercedes-Benz • Nissan

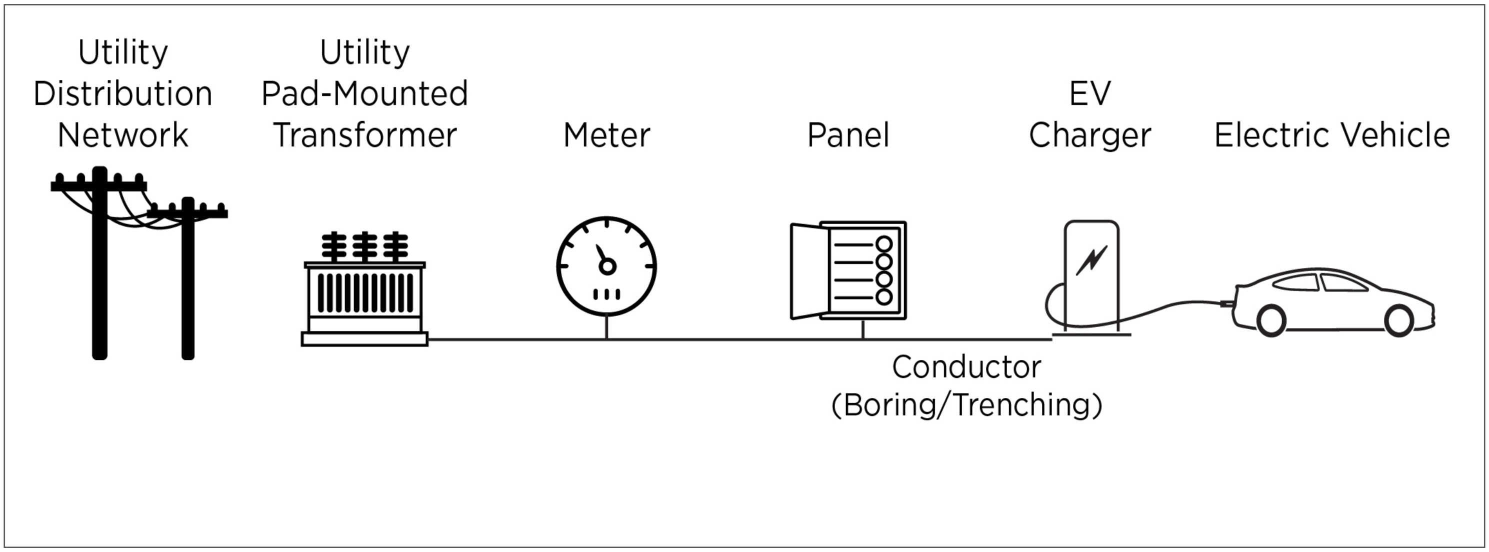
Source: Graphic from Portland General Electric, updated in July 2023 to note automakers with published intentions to use the NACS (Tesla) connector in future EV offerings.

[6] *"Load management" is the process by which the amount of electricity supplied to EVSEs on the same circuit is adjusted as necessary to avoid exceeding the circuit's capacity.*

[7] *Many currently available EV models are capable of accepting only up to 50 kW of charging power, regardless of the capabilities of the EVSE. However, increasing numbers of EVs are able to accept charging at rates of 150 kW—350 kW, including some EVs made by Lucid, Kia, Hyundai, Genesis, Audi, Porsche, Volvo, Rivian, Tesla, Polestar and BMW. See https://www.topspeed.com/fastest-charging-electric-vehicles-in-2023/#genesis-electrified-gv70-genesis-gv60—-350kw-18-minutes.*

EV chargers (also known as EV Supply Equipment or EVSE) are only one component of the broader EVSE infrastructure which must be developed in Oregon to meet EV driver demand and support state transportation electrification goals. **Figure 8** identifies the primary components of this infrastructure, including electric utility equipment such as the distribution network, step-down transformers, and the electricity meter, as well as customer equipment including electric panels, circuitry, and wiring at the site. These components are required to support the connection to the EV charger and to deliver electricity for charging vehicles. Depending on the site, these components may already exist or may need to be installed before the charger is operational. Chapter 4 describes these EVSE components in more detail along with typical cost ranges of equipment and installation, and considerations for cost savings.

Figure 8. Basic Components of EVSE[8]



[8] https://sepapower.org/knowledge/sepa-report-highlights-trillion-dollar-ev-opportunity-for-prepared-and-proactive-utilities/.

3. Best Practices for Planning, Design and Deployment of EVSE

EV charging stations—also known as EV Supply Equipment or EVSE—are critical to enable confident EV adoption, as robust and reliable EV charging builds consumer confidence that drivers will be able to charge their vehicles conveniently and affordably wherever they travel across Oregon. To ensure that EV charging stations are well-designed and optimally located, a number of considerations must be taken into account including local planning and permitting, business model and site designs, engagement with the local electrical utility, and prioritizing equitable access to charging infrastructure.

EV Charging Considerations

This chapter provides guidance and best practices across three general areas which are essential in the development of EV charging locations: local planning and permitting; business model and EVSE design; and utility engagement. **Table 5** summarizes some "best practices" roles and responsibilities of key stakeholders for these three general areas, and **Table 6** emphasizes the charging development considerations each stakeholder will need to address. There is no one-size-fits-all approach for deploying EVSE due to the broad range of different considerations which influence potential deployment strategies. However, by providing an overview of these key areas for consideration—as well as relevant best practices—this chapter is intended to serve as a useful guide for local governments planning for EVSE deployments, EV charging infrastructure developers, and prospective site hosts that will be developing charging at their locations to meet the coming growth in the EV market.

Table 5. Summary of best practices by stakeholder

Development Consideration	Best Practice	Stakeholder: AHJ*	Stakeholder: Utility	Stakeholder: Site Host
Planning and Permitting	• Develop an EV Readiness Plan, including workforce development opportunities	✓		
	• Establish EVSE deployment targets	✓	✓	
	• Directly deploy EVSE	✓		
	• Develop streamlined permitting processes	✓		
	• Implement EV-ready building codes	✓		
	• Estimate community charging needs and include in planning initiatives	✓	✓	
	• Include disadvantaged communities in planning discussions from outset	✓	✓	
	• Provide guidance, education, and outreach	✓		
Business Model and Site Design	• Estimate site-level charging needs		✓	✓
	• Future-proof investments by anticipating charging demand in later years		✓	✓
	• Ensure charging hardware and software are compatible with and between different vendors to protect investments.			✓
	• Select EVSE that is "fit for purpose"			✓
	• Provide clear signage to and sufficient security features for EVSE			✓
	• Ensure EVSE deployment is accessible for all			✓
Utility Engagement	• Include local electric utility in development process early and often	✓	✓	✓
	• Develop streamlined service upgrade and interconnection processes		✓	
	• Dedicate sufficient staff to accommodate EVSE development needs		✓	

**Authorities Having Jurisdiction*

Table 6. Charging Development Considerations and Key Stakeholders to Engage

Development Consideration	Key Stakeholders
Local Planning and Permitting	• Authorities having jurisdiction (AHJs) • Charging service and/or hardware providers
Business Model and Site Design	• Prospective site hosts • Charging service and/or hardware providers • Primary users (tenants, employees, general public)
Utility Engagement	• Electric utility • Prospective site hosts • Charging service and/or hardware providers

Local Planning and Permitting

Local governments can support the deployment of EVSE in a variety of fashions, including by incorporating EVSE needs into planning initiatives; adopting clear and expedited permitting and other supportive policies, regulations, and incentives; determining the process for private charging developers to follow; and by directly installing EVSE at public sites.

Planning and Policies

Incorporating anticipated EV charging needs in local planning efforts such as general plans, capital improvement plans, climate action plans, transportation improvement or long-range transportation plans, active transportation plans, utility master plans, building design guidelines, and zoning codes is a key enabling step for effectively supporting infrastructure deployment.[9] This introduces EV charging as a critical component of a community's built environment, and begins a dialogue around the implementation requirements, roles and responsibilities, anticipated challenges, and expected costs required to deploy this infrastructure to meet the transportation needs of residents, visitors, and local businesses. While many EVSE deployments will be led by private sector players such as EV service providers (EVSPs) or building owners, local planners have a key role in all charging developments to ensure or promote accessibility for all users including those from different income levels, demographic groups, and with differing physical capabilities, as well as promoting interoperability between charging stations from different manufacturers and reliability of the charging station itself.

An effective way for local leaders to consolidate planning around EV charging is through the development of an EV readiness plan, which articulates the current status of EV adoption and EVSE development; expected future trends, goals and needs in the local area; and key actions or policies required to prepare the community for the coming growth in EVs. These plans can be developed at the neighborhood, city, county, or regional level and are most effective when inclusive of a diverse range of stakeholders that align with the plan's priorities and responsible parties.[10] As highlighted elsewhere in this report, ODOT has developed two tools to assist with EV Readiness planning: the TEINA Dashboard, a user-friendly Excel-based tool showing detailed estimates of required EVSE in different parts of the state over time, and the EV Infrastructure Planning Map, which allows planners and other stakeholders to explore potential EVSE sites based on various criteria encompassing mobility patterns, demographic information, equity indicators, and progress towards TEINA goals.

Table 7 highlights a number of the most common local policy approaches, along with examples of where and how they've been deployed. While the appropriate policy mechanisms will depend on each Authority Having Jurisdiction (AHJ), providing both leadership and some form of incentives to support EV charging at the local level is an important catalyst.

[9] https://static.business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf.
[10] https://static.business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf.

Table 7. Local Policies to Support EV Charging Development

Policy	Approach(es)	Implementation Examples
EV Readiness Planning	Incorporate EVSE needs into comprehensive planning efforts. Where possible, indicate specific needs or goals, such as priority locations for public Level 2 or DCFC deployments, particularly those that fill charging gaps in disadvantaged or rural communities, or ideal locations for curbside charging.	• In 2019 the City of Beaverton, OR adopted a Climate Action Plan that includes recommended strategies to support EV charging, such as right-of-way charging strategies and partnering with utility Portland General Electric to develop public charging stations.[11] • In 2021 the City of Alexandria, VA adopted an EVSE Readiness Strategy which includes recommended locations for public charging and periodic audits of zoning and building codes to ensure support for developing charging stations.[12] • The City of Sacramento, CA[13] and Washington D.C.[14] both publish maps of streets that the cities expect to be suitable for curbside charging deployment.
EVSE Deployment Targets	Put forth specific goals for the number of publicly available charging ports to be deployed locally by a given year. Consider specific sub-goals for curbside charging, which can efficiently use existing parking spaces yet requires consideration of right-of-way permitting process.	• Through its 2030 Electric Mobility Roadmap the City of Orlando, FL is targeting 1,400 Level 2 and 250 DCFC ports citywide by 2030.[15] • ODOT's TEINA report[16] provides estimates of required EVSE in Oregon over time, and the companion TEINA Dashboard[17] enables users to explore implications for specific parts of the state. • The New York City Department of Transportation has a goal to deploy 1,000 curbside chargers by 2025 and 10,000 by 2030.[18]
Direct EVSE Deployment	Deploy EV charging on public land for residents and visitors to encourage EV adoption. Can be provided as free public amenity or for fee. Include minimum specifications that reflect best practice in interoperability, reliability and ADA accessibility of charging stations installed with public funding.	• Of its larger goal (see above), the City of Orlando aims to directly deploy 200 publicly owned Level 2 and 40 publicly owned DCFC ports by 2030.[19] • The City of Long Beach, CA has deployed a number of city-owned Level 2 and DCFC charging stations for residents' and visitors' use.[20] • Example RFPs from cities soliciting development of EVSE on public property include the City of Harrisburg, VA[21] and the City of Kyle, TX.[22]

[11] https://content.civicplus.com/api/assets/9bd12401-c855-43f5-8b2e-1975ec930d05.
[12] https://media.alexandriava.gov/docs-archives/tes/eco-city/info/alexandria=evrs=final.pdf.
[13] http://www.cityofsacramento.org/-/media/Corporate/Files/Public-Works/Electric-Vehicles/MAP-CurbsideChargerPotential120318.pdf?la=en.
[14] https://dcgis.maps.arcgis.com/apps/webappviewer/index.html?id=899e24ba10984236be045260379cba0b.
[15] https://www.orlando.gov/files/sharedassets/public/departments/sustainability/21_exo_emobility-roadmap_020322_pages.pdf.
[16] https://www.oregon.gov/odot/Programs/Pages/TEINA.aspx.
[17] *appropriate hyperlink (when we get it).*
[18] https://www1.nyc.gov/html/dot/downloads/pdf/electrifying-new-york-report.pdf.
[19] *Ibid.*
[20] https://www.longbeach.gov/pw/projects/energy-efficiency-infrastructure-projects/evcharging/.
[21] 2022021-PW-P_EV Charging Station RFP_Final_03-23-22.pdf (harrisonburgva.gov).
[22] City of Kyle EV & Golf Cart Charging Infrastructure RFP.

Table 7. Local Policies to Support EV Charging Development (cont.)

Policy	Approach(es)	Implementation Examples
Streamlined Permitting and Inspections	Create streamlined and expedited permitting and inspection processes to enable more rapid, less costly deployment of EV charging. Ensure that process steps and requirements for different types of EVSE deployments are clear (e.g., home vs. curbside).	• The City of Tustin, CA developed an Eligibility Checklist for interested businesses and developers which outlines required information to secure streamlined permitting for deploying EV charging.[23] • The City of Los Angeles, CA provides online permitting approval for home EV charging installations, as well as expedited inspections and meter installations. • The Washington D.C., Department of Transportation and its local utility, Pepco, have published right-of-way permit application requirements that can serve as an informative model.[24]
EV Ready Building Codes	Require a minimum number or percent of parking spaces in new construction to provide EV charging, or electrical wiring for easy future addition of charging.	• The City of Portland, OR has developed code amendments to include EV Ready provisions, which the City Council adopted in early 2023. The City requires a minimum 50% of parking spaces in new construction to be EV Ready (for buildings with 6 or more parking spaces), with higher percentages for certain development types. [25] • Building codes in the City of Middletown, CT mandate that new developments are required to have 25 or greater parking spaces and to provide either Level 2 or DCFC charging stations or connections to a minimum of 3% of these spaces; additional EV charging spaces provided can reduce the total number of spaces which must be developed.
EV Parking Requirements and Minimums	Reserve EV parking spaces for EV charging only; Count EV charging spaces as two parking spaces for the purposes of meeting minimum parking requirements.	• Kansas City, MO requires that EV parking spaces be reserved for EV charging, and allows off-street EV parking spaces to count towards total parking requirements for a building.

[23] *Eligibility Checklist for Expedited Electric Vehicle Charging Station Permit*. https://www.tustinca.org/DocumentCenter/View/647/EVCharger-Eligibility-Checklist—Non-Residential-PDF.
[24] https://ddot.dc.gov/es/node/1590091.
[25] https://www.portland.gov/bps/planning/ev-ready

Table 7. Local Policies to Support EV Charging Development (cont.)

Policy	Approach(es)	Implementation Examples
EV Charging Requirements for Associations	Enact laws that compel housing and community associations to allow EV charging development.	• In Oregon, state law (ORS 94.672) prevents homeowners associations from prohibiting installation or use of a charging station. However, as residents remain responsible for costs this is a necessary but insufficient policy for overcoming challenges to providing broader access to EV charging. • The City of Boston, MA prohibits homeowners associations, community associations, and condominium associations from preventing the installation of EV charging stations.
Provide Guidance, Education and Outreach	Develop educational resources for residents, local businesses, and developers to increase awareness of EVs, including the local process for developing EV charging.	• The U.S. Department of Energy provides various educational resources that local governments can use to promote awareness of EVs and EVSE.[26] • Clean Cities Coalitions (such as Columbia-Willamette Clean Cities) and other non-profits can be useful partners for education and outreach initiatives.[27]

Several additional resources may prove useful for local planners considering policy options to support EVSE deployment:

- AchiEVe Toolkit (Electrification Coalition, Forth, Plug in America, Sierra Club): a collection of model policies for supporting EV adoption and EVSE deployment, categorized by policy focus (e.g., light-duty EV adoption; utility programs).
- How do Communities Become PEV Ready? (Veloz): policy recommendations for local governments to make their communities EV Ready.

Key Planning and Policy Questions to Address

- Which local planning initiatives do not currently incorporate EVSE deployment, but should?
- What community groups have not historically been involved in planning efforts, but should be?
- What additional policies can be put in place to support EVSE deployments?
- Who needs to be engaged to implement additional supporting policy for EVSE deployments?
- How can best practices in interoperability, reliability and accessibility of EV charging stations be promoted?

26 https://www.transportation.gov/rural/ev/toolkit/planning-resources/educational-materials.
27 https://www.cwcleancities.org/.

Permitting and Codes

As with any physical project, developing EV charging requires conformance with applicable local and state regulations including building, land use, and electrical codes. Additionally, the local electric utility has an important role to play in providing power for the site and needs to be engaged early and often throughout the process, initially in the planning phase and continuously as projects progress through construction and enter operation. Accordingly, both responsible jurisdictions and electric utilities have key roles to play in supporting EVSE deployment and ensuring that installations are deployed safely and built to high quality and reliability standards.

Oregon has a unique system when it comes to building codes and land use regulations. The Department of Land Conservation and Development (DLCD) and the Building Codes Division (BCD) of the Department of Consumer Business Services administer respectively the State's land use program and building code. The overarching land use regulations governing counties are set by Oregon Revised Statutes (ORS) and Oregon Administrative Rules (OAR). Cities must also comply but have more flexibility in determining what uses are allowed in urban zones. Notably, the Oregon State Building Code is applied throughout Oregon with little local control, however HB 2180 enabled certain municipalities, by way of land use, to require higher than 20% EV-ready parking spaces in certain new construction.[28]

The State is working to better clarify who has jurisdiction over EVSE deployments. For example, BCD oversees the electrical code and minimum requirements for electrical installations as part of the building permit process. However, the number of parking spaces is usually dictated by the applicable local land use code. ODOT requires permits for any work within its right-of-way.

Table 8 summarizes Oregon's state and local requirements and the entities with jurisdiction over different aspects of land use planning. Prospective EV charging site hosts and developers may wish to view this as a resource for understanding how the different requirements and players fit together to ensure that projects are compliant with all necessary policies and processes. However, further exploration of updates to these requirements is warranted at the time of EVSE deployment consideration.

[28] *HB2180 2021 Regular Session - Oregon Legislative Information System (oregonlegislature.gov).*

Table 8. Land Use Planning Resources for Site Selection, Planning, and Design

Is your project in compliance with state and local statutes, codes, and plans?	
Oregon Department of Land Conservation and Development (DLCD)	
Oregon Revised Statutes	Oregon Revised Statutes contain statutes that apply to land use. https://www.oregon.gov/lcd/LAR/Pages/ORSs.aspx
Oregon Administrative Rules (OAR's) Chapter 660	Oregon Administrative Rules Chapter 660 contains rules of the Land Conservation and Development Commission, which oversees DLCD. Only some statutes apply. https://www.oregon.gov/lcd/LAR/Pages/OARs.aspx OAR 660-012-0410 incorporates updates from DLCD's Climate Friendly & Equitable Communities Rules and requires certain municipalities to include conduit for EV charging in new multi-family/mixed-use developments (with more than five units) to have 40% of all parking spaces EV ready. Guidance0410_EVs.pdf (oregon.gov)
Statewide Planning Goals	A set of 19 statewide land use planning goals outline the state's policies on land use and related topics. https://www.oregon.gov/lcd/OP/Pages/Goals.aspx
Oregon Building Codes Division	
Building Code	The Building Codes Division adopts, amends, and interprets specialty codes that govern the design and construction of developments. https://www.oregon.gov/bcd/codes-stand/Pages/index.aspx
Local Planning Jurisdictions	
Local Comprehensive Plans	Oregon's statewide goals are achieved through local comprehensive planning. State law requires each city and county to adopt a comprehensive plan and the zoning and land-division ordinances needed to put the plan into effect.
Local Functional Plans	This includes a wide range of plans that outline local policies, programs and projects for transportation systems, transit, stormwater management, utilities, etc.
Local Zoning Ordinance	The zoning ordinance establishes permitted land uses, required development standards, and approval processes to obtain local zoning approvals.
Private Zoning (CC&Rs)	Some residential and commercial developments have covenants, conditions, and restrictions, commonly called CC&Rs which are a set of rules governing the use of the development.
Permitting For Construction	
Local Planning and Zoning Approvals	Depending on the project, there may be requirements to obtain local planning and/or zoning approval before a permit is issued to verify the project is in compliance with state and local regulations.
Construction/Building Permits	Most cities or counties have a local building department that provides plan review, permit, and inspection services. Use the Local Building Department Directory to find where to access services in the area. https://www.oregon.gov/bcd/Pages/index.aspx
Right-of-Way, Utility, and Access Permits	Permits may be required from the Oregon Department of Transportation or local jurisdictions for work in public right-of-way including utility extensions and driveways.

Last updated: 7/28/2023

Some jurisdictions have developed guidance documents for prospective EV charging site hosts, outlining required information and the overall process for EVSE deployments. These guides help site hosts ensure that their EV charging planning and designs conform with local requirements to avoid delays in project development and the associated costs. The types of information that site hosts and potential charging service partners may need to provide to responsible jurisdictions include site plans; electrical single-line diagrams; estimates of anticipated new electrical load and how this may affect the existing service panel; and how EVSE deployments will ensure accessibility and compliance with ADA requirements.

Any development of public-facing charging—whether owned by a public or private entity—would be wise to include community organizations in the siting and design process to ensure that deployments are supported by residents, businesses, and the broader community. This is especially important from an equity perspective, as transportation and other planning processes may risk a lack of sufficient engagement with a diverse group of local stakeholders. These stakeholders could help inform details of EVSE deployment such as location, amenities, design and layout, employment opportunities, and other features that will improve the reception, usefulness, and attractiveness of this new infrastructure within the community.

Local Permitting and Code Policies to Support EV Charging

As discussed briefly in the previous section, there are several important permitting- and code-related policies that local governments can implement to support EVSE deployments.

EV Ready Building Codes

EV Ready building codes require new construction to include a minimum level of EV electrical wiring and/or capacity to support charging stations, providing meaningful cost savings relative to retrofitting buildings for EV charging.

In Oregon the state legislature passed House Bill 2180 in 2021, requiring that new construction of commercial, multi-family residential of five or more units, and mixed-use buildings provide electrical capacity for EV charging at a minimum of 20 percent of their parking spaces. While this state legislation is a useful starting point, certain municipal governments can also develop codes that go above this 20 percent requirement to further support EVSE deployments in their jurisdiction. The Department of Land Conservation and Development has added an amendment, as part of the Climate Friendly and Equitable Communities rules, effective April 2023, for certain municipalities to require (in new multi-dwelling/mixed-use developments with more than 5 units) 40% of all provided parking spaces be EV ready, with appropriate electrical capacity and conduit.

Streamlined Permitting Processes

Streamlining permitting processes makes it easier, more straightforward, and less expensive to deploy new EVSE. Several specific actions can make these processes manageable and accessible, including:[29]

- Standardize review of zoning, building, and electrical permits, including clear identification of application materials, fees, timeline, point(s) of contact, and required inspections.
- Implement an online permitting process, including acceptance of electronic signatures and payments.
- Provide a comprehensive checklist of information required to receive permits for EVSE deployments on the local jurisdiction's website. Include important information that differs between EVSE location types, such as additional right-of-way permitting requirements that must be adhered to for curbside charging.
- Identify an EV charging station permitting ombudsperson to serve as the single knowledgeable point of contact at the local level.[30]

For examples of model processes, please see the searchable database of local climate ordinances developed by the Great Plains Institute.[31]

[29] https://nj.gov/dep/drivegreen/pdf/chargeupyourtown.pdf.
[30] https://static.business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf.
[31] https://betterenergy.org/blog/database-of-climate-ordinances-now-available-to-planners/.

Key Permitting and Codes Questions to Address

For responsible jurisdictions:

- Is there an opportunity to implement EV-ready building codes beyond state requirements?
- What does the current permitting process for EVSE look like, and how can it be streamlined? Are there specific considerations for different types of EVSE, such as curbside charging deployed in the right-of-way?
- Who can be appointed as the single point of contact for EVSE permitting at the local level?

For site hosts/developers:

- What utility, state or local easements may be needed?

Business Models and Site Design

Selecting a viable business model and designing the specifics of an EVSE deployment are closely related topics which jointly define the overall approach to providing charging at a given location. Depending on the business model, different parties will play different roles. **Table 9,** which was developed by the U.S. Department of Transportation, summarizes which entities may play different roles across various business models.

Table 9. Key Roles Involved in EVSE Deployments[32]

Potential Parties	Electricity Provider	EVSE Provider	EVSE Owner	Site Host
Utility	✓	✓	✓	
Charging Network Provider		✓	✓	
Property Owner		✓	✓	✓
Tennant		✓	✓	✓

Business Model

Three Primary Business Models

The appropriate business model for an EVSE deployment will depend on the location, intended users, size and economics of the project, and level of control desired by the site host. In other words, there is no single approach that is applicable across all potential sites. While many business model variations exist, there are three primary approaches: the network owned and operated model; the site host owner-operator model; and the third-party owner-operator model .

The **network owned and operated model** is typically driven by the plans of the network provider. These EV network providers develop and own the EV charging stations, working directly with the responsible jurisdictions, utilities, and others to obtain necessary permitting and process requirements. They tend to

[32] *Adapted from U.S. Department of Transportation, https://www.transportation.gov/rural/ev/toolkit/ev-partnership-opportunities/electric-utilities.*

evaluate and select optimal locations at their discretion, engaging in negotiations with the site host to set contract terms of use. The site host may have little or no control over site development, pricing, operations, or customer service. Prospective site hosts will want to consider the level of control they desire, how involved in operating the EVSE they wish to be, and whether they want to own and operate an EV charging site, or have a network provider own and operate the charging site.

In the **owner-operator model,** the site host procures EVSE from a hardware manufacturer, works with a contractor to install the equipment (including any necessary site or electrical upgrades), and then directly operates the EVSE. This preserves control of site development, operation, pricing and revenue collection, and customer service for the site host, but also entails the host taking on the corresponding risks.

The **third-party owner-operator model,** in contrast, entails a larger, ongoing role for the provider of the EVSE. The third-party charging service provider is typically involved in developing the site (including working with responsible jurisdictions and electric utilities to satisfy all permitting, code, and process requirements); determining the pricing structure and revenue sharing approach; ongoing operation and maintenance; and customer service. Third parties (such as a local retail outlet) often lease space from site hosts and may share a portion of revenues collected. In this business model much of the project risk is shifted onto the third-party service provider, but site hosts lose some control over aspects of the deployment including the customer experience and the opportunity for full revenue collection.

Regardless of the business model chosen, a clear operations and maintenance plan is important to put in place with targets for reliability, including provisions for a 24/7 customer service phone number for users to troubleshoot charging, payment, or other issues.

Pricing Decisions

Pricing for EV charging can take several forms, with three general strategies: 1) providing free charging as an amenity; 2) charging a nominal fee to cover the operating and/or capital costs; or 3) pricing electricity to earn a profit margin.[33] Additionally, site hosts must choose whether any other fees will be assessed, including membership fees for using the charging network or "dwell-time" fees which disincentivize leaving cars parked beyond the necessary charging time. The appropriate pricing choice for a given site host will depend on the motivation for installing EV charging, the business model selected, and the costs the site host and/or third-party provider has incurred. These costs are discussed in further detail in Chapter 4 (Planning Level Cost Estimates). If a third-party is involved, site hosts will need to also work with them to establish any revenue sharing arrangements (typically in exchange for the third party's use of the site to install EVSE) and to determine who benefits from Oregon's Clean Fuels Program credit generation.[34]

Public EV charging best practices include providing clear and advance communication of pricing to customers using the standard approach of a $/kilowatt-hour ($/kWh) rate. EV batteries are rated in terms of the amount of energy they can store and expressed in kWh (e.g., a 60- or an 80-kWh battery), in the same way that a conventional vehicle might have a 15- or 20-gallon tank. Pricing in $/kWh therefore conveys how much it will cost per unit of energy purchased, just as $/gallon pricing does for gasoline or diesel. At times pricing is alternatively communicated as $/minute or $/mile, but these approaches don't convey how much energy is actually being transferred and are not considered best practice. Pricing in $/minute doesn't convey how many kWh are dispensed per minute, while $/mile prices are inherently flawed because different EV models use different amounts of energy (kWh) per mile in the same way that a conventional sedan generally gets more miles per gallon of gasoline than a pickup truck or SUV. It is best practice for public charging sites to offer $/kWh pricing that is set fairly and communicated transparently prior to customer use, with any fees for parking, non-member use of EVSE, or other non-energy costs to also be clearly displayed for consumers up front.

Payment Methods

In addition to pricing decisions, site hosts and/or EV charging providers who are not providing charging as a free amenity must determine what payment methods will be accepted, examples of which include credit cards (both chip-enabled and contactless options), mobile app-based payments and QR codes, and inclusion within other fees (e.g.,

[33] *https://www.transportationenergy.org/research/reports/installing-and-operating-public-electric-vehicle-c.*

[34] *The Clean Fuels Program (CFP) is a market-based credit and debit system for reducing the carbon intensity of transportation fuels in Oregon over time, administered by the Oregon Department of Environmental Quality. For additional information please see https://www.oregon.gov/deq/ghgp/cfp/Pages/default.aspx.*

monthly Home Owner Association dues). EVSE vendors and EV charging service providers can help determine the best payment options for a given site deployment, based on anticipated user base and usage patterns. Best practice is to provide multiple options so that the EVSE is available to the broadest range of potential users. Project planners will want to ensure that payment method choices don't restrict access for some potential user groups such as the unbanked or drivers without smart phones. Planners and prospective site hosts should also be aware that any EVSE receiving public funding and/or utility incentives may be required to adhere to specific standards for payment methods. These standards are intended to ensure convenient access for diverse groups and compliance is not typically onerous. Charging stations should be accessible by all drivers independent of network memberships or subscriptions; a 24/7 customer service line should be available for users to resolve charging questions and enable payment over the phone; and stations should accept more than one form of payment, including a form of debit and credit card as well as a mobile payment option.

Key Business Model Questions to Address

- Who will own the EVSE? Who will operate and maintain it?
- Who is responsible for customer service?
- How is risk shared between the different parties?
- Who can use the EVSE?
- What fees, if any, will be charged for use of the EVSE? How will payments be made?
- How will site hosts or operators ensure that drivers don't leave cars plugged in for longer than intended, especially if there is no fee charged to drivers for electricity?
- What local, state, federal, and/or utility incentives are available to reduce project costs? What standards must be met as a condition for receipt of incentive funding?
- What workforce development opportunities are available? How many temporary and permanent jobs may be created?

Site Design and EVSE Specifications

Site characteristics such as type (residential, commercial, public), parking and circulation layout, electric service capacity and location, and current as well as expected EV demand profiles will affect the overall site design and the number and type of deployed EVSEs. These characteristics are discussed in more detail in the following paragraphs.

Size of Deployment

An estimate of EV charging needs at the site is required to determine the appropriate size of the EVSE deployment. Various tools and resources exist to assist site hosts and planners with this exercise (see ODOT planning resources described in Chapter 5: Planning and Deployment Approach), but the general process includes estimation of the number of vehicles that will use the equipment as well as the hours and times of day these vehicles will need to be charged. If different vehicles use the chargers at different and complementary times of day, then a smaller deployment might suffice. However, if many or most vehicles require charging at or near the same time then a larger deployment will generally be required. Importantly, site hosts, planners, and developers may wish to consider both the near-term needs at the site and the growth in EV charging demand that will materialize in Oregon as additional EV models become available, costs for consumers fall, and the EV market expands when determining the size of the charging deployment.[35]

[35] *For a sense of how quickly EV charging demand at different location types is likely to grow in Oregon, please see the TEINA study as well as the companion TEINA Dashboard, which allows users to view expected charging needs at the statewide, county, city, and census tract level from the present through 2035.*

Physical Design

Physical design of the charging location must take into account both civil and electrical engineering considerations, specifically the parking layout, circulation of vehicle and pedestrian traffic, and proximity of potential EV parking spaces to electrical equipment. These considerations can at times be directly in conflict. An example of this occurs when desired parking locations are far from the electric service panel, requiring either lengthy trenching and conduit runs or movement of the parking spaces closer to the panel to minimize these costs. Best practices in physical design of EV charging sites have been compiled by various organizations and can serve as useful resources for local planners, developers, and sites hosts. For example, specific guidance includes limiting conduit runs to 25 feet or less from the electrical panel to the EVSE when possible to avoid expensive trenching and construction costs; charging outlets and connectors should also be between 36 inches and 48 inches from the surface of the floor.

It is also important to select EVSE that is suitable for the use case, or "fit for purpose." For example, EVSE intended to provide charging for several different parking spaces, or vehicles with charging ports sited at the front or back of vehicles, must include dispenser cables of sufficient length to enable vehicles parked in different spaces to use the charger. Similar considerations apply for other deployment types such as when curbside charging is provided for parallel parking spaces and include features such as proper cable length, appropriate pedestal or pole-mounting height, and designs to avoid damage from vehicles such as trash trucks, street sweepers, and snow plows.[36]

Another key consideration is "future-proofing" of EVSE deployments, aimed at anticipating future EV charging needs and building accordingly to avoid costly retrofits in the future. Future-proofing charging sites can involve pre-wiring during new construction or renovations such as providing excess electrical capacity for future chargers, deployment of higher power chargers in advance of future charging demands, preparing for onsite energy generation and storage, and related strategies to ensure charging

[36] https://www.flo.com/en-CA/blog/choosing-and-deploying-the-curbside-charger-that-is-just-right-the-goldilocks-endeavor/.

deployments can meet the needs of both today's and tomorrow's EVs.[37]

Networked Charging

"Networking" in this context refers to a combination of EV charging equipment components and software that enable connection to a private charging company's network, either through the Internet or via cellular data. Networked charging allows for centralized management, administration, communication, diagnostics and data collection. Non-networked chargers entail less upfront costs but offer less functionality than the networked alternative. Non-networked chargers are essentially an electrical appliance that provides electricity to an EV without many additional features. Networked chargers offer the added flexibility of allowing EVSE owners and/or operators to set pricing, collect usage data, remotely monitor the EVSE and diagnose any problems, and participate in utility-sponsored managed charging programs that provide incentives for hosts or drivers to align charging sessions with times of lower cost and/or lower emissions from the electric grid. These more sophisticated chargers entail a higher upfront cost and also typically include an ongoing network fee, which may or may not be incurred by the site host depending on the business model and arrangement with a third-party provider.

When deciding whether to deploy networked or non-networked EVSE, developers and site hosts may wish to consider the use case. If capabilities like data collection and remote monitoring and diagnostics, participation in utility-sponsored managed charging programs, the ability to charge a fee for use of the EVSE, and/or the ability for potential users to locate a charger online are desirable or essential, then networked chargers should be deployed. If the use case does not require features such as these then developers or site hosts may want to choose non-networked chargers, which will reduce upfront and ongoing costs while still providing the required EV charging services. Networked chargers should be considered for any installations that are publicly accessible to enhance operations and ensure reliability as well as at locations that will include the installation of four or more chargers, to enable utility-sponsored managed charging and thus reduce impacts to the electric grid.

Signage

Providing clear signage indicating the location of EVSE stations is essential for ensuring that drivers can find and use this infrastructure. Examples of signage currently in use are presented in **Figure 9.** EVSE signage can also help prevent accidental blocking of EV charging spaces by vehicles that are not plugged in and charging. Additionally, developing clear and consistent signage helps to promote awareness of EVSE options and increases interest in driving an electric car. Signage and markings should be located and mounted for good visibility. All signs should conform to state and/or local requirements regarding visibility, legibility, size, shape, color, and reflectivity.[38] The state departments of transportation of Oregon, Washington, and California adopted a standardized symbol to identify publicly accessible electric vehicle charging stations along major roadways, which is shown in **Figure 9** as the left-most image. [The West Coast Electric Highway](#) website should be consulted for signage dimensions and style, to ensure consistent, standardized signage is used throughout Oregon.

Figure 9. Examples of EV charging signage[39]

[37] https://static.business.ca.gov/wp-content/uploads/2019/12/GoBIZ-EVCharging-Guidebook.pdf.
[38] https://nj.gov/dep/drivegreen/pdf/chargeupyourtown.pdf.
[39] https://www.flexpostinc.com/blog/signpost-considerations-for-ev-charging-stations/.

Security

Site design must also consider appropriate security measures, both to ensure drivers remain safe and to discourage vandalism. Basic security features include appropriate lighting—which should be functional during all hours—as well as EVSE deployments designed to be tamper-resistant and robust enough to avoid damage from would-be vandals. Where feasible, developers and/or site hosts may wish to also consider how EVSE can be sited to be closer to foot traffic such as near store entrances and frequently used pathways, and avoid tucking chargers in remote corners of parking lots and garages. Additional security features such as video cameras may also prove beneficial for some deployment types. Ensuring that a 24/7 customer service number is available at the site benefits drivers from a security perspective in addition to offering good customer service and the opportunity to pay for parking by phone if other payment mechanisms are down.

Ensuring cybersecurity and integrity of EVSE infrastructure is also of paramount importance, with two main areas of concern: 1) securing user physical safety and personal information; and 2) protecting operational integrity and connected infrastructure. While charging technology and the cybersecurity systems that protect them are evolving quickly there are some foundational cybersecurity principles and techniques that public charging infrastructure should adopt, including the following:

- **Boot Security:** Boot security uses embedded manufacturer approved/authenticated hardware devices to authenticate operating system software when an EV charger is "booted" up. If the operating system at the boot stage is not authenticated, the charger will stop the malicious operating system from loading or making changes to the charger.

- **Secure over-the-air updates:** Secure methods to update software on deployed chargers should be available such as "over the air updates" or updates that can be issued remotely. When the software components on EVSE are updated, there should be protections in place to authenticate the software update before the update is accepted and implemented. This mitigates the risk of malicious software being loaded onto a device.

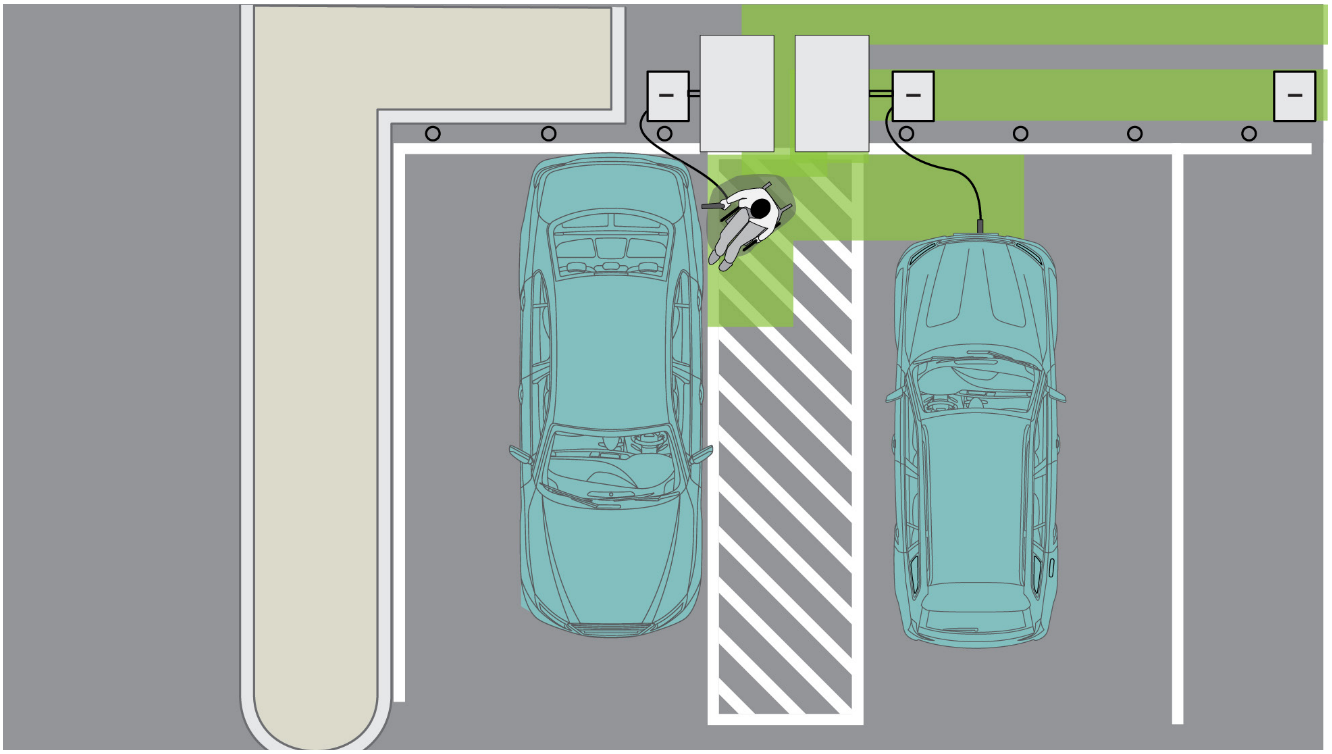
- **Secure Communication:** EV chargers communicate sensitive data to a central system on the cloud for their operation and to offer charging services for the EV drivers. The link between the chargers and this central system must be sufficiently secured to ensure the authenticity, confidentiality, and integrity of the data exchanged. This mitigates the risk of a man-in-the-middle attack.

- **Secure Customer Information:** EV chargers may store sensitive data like personally identifiable information or payment information. This sensitive data should be protected and there are a variety of means to do that. Some options include encryption, role-based access, and limiting the amount of information locally stored on an EV charger.

Accessibility

Charging stations must also be built to be accessible for drivers of all types. One useful resource for best practices in this area is the U.S. Access Board, which provides specific design recommendations for making EV charging compliant with the Americans with Disabilities Act (ADA). As shown in **Figure 10,** site design should incorporate accessible mobility features such as a physical layout to accommodate wheelchairs, walkers, or other mobility devices, and charging connectors and payment mechanisms placed at a height that enables comfortable access for those in wheelchairs, in addition to accessible communication features such as options for deaf users or those hard of hearing.

Figure 10. Two mobility accessible vehicle charging spaces sharing a common access aisle[40]



Developers and site hosts may want to consider designing EVSE stations to include 110V outlets for electric micromobility options such as e-bikes, e-scooters and electric wheelchairs. Providing this additional feature entails a minimal incremental cost and can make the charging station a much more valuable and utilized asset for a larger portion of the local population. This also helps to encourage a reduction in the use of single-occupancy automobiles, relieving road congestion and reducing tailpipe emissions. Particular locations that should be prioritized for inclusion of 110V outlets include those near bicycle facilities, scenic bike routes, and areas with dense bicycle infrastructure as well as those near tourist destinations and transit connections.

Onsite Solar and Storage

An additional site design consideration is the potential for deploying distributed energy generation and/or battery storage at the site. Most commonly this takes the form of onsite photovoltaic solar generation paired with battery storage. This option entails additional upfront costs for the solar, storage, related equipment (e.g., inverter, AC disconnect), and installation, but can help to reduce operating costs. Onsite solar generation offsets usage of electricity from the grid while onsite storage enables reducing or avoiding higher-priced electricity during peak periods as well as mitigating the cost of utility demand charges that are levied based on the maximum power draw at a given time. Developers and/or site hosts will need to consider the particular economics of their EVSE deployment as well as installation feasibility to determine whether or not use of these distributed energy resources will be cost-effective.

[40] https://www.access-board.gov/tad/ev/.

Key Site Design and EVSE Specifications Questions to Address

- What are future charging needs estimated to be, both in the near- and long-term?
- What type of charging will be provided (Level 2, DCFC, combination)? Are networked chargers needed?
- Are the EVSE hardware and software to be deployed compatible with different vendors?
- What is the current electrical capacity at the site? Where is electrical equipment located?
- What layout of EVSE can minimize trenching and conduit runs to reduce costs?
- Are accessibility considerations being sufficiently accounted for? Would all types of EV drivers be able to use the site's chargers in the planned layout?
- Is this site a good candidate for inclusion of 110-volt outlets to enable access by electric micromobility devices?
- How will the site be future proofed?
- Should onsite solar and storage be included in the project?

Utility Engagement

Local electric utilities play a critical role in supporting EVs and EVSE, and need to be engaged early and often throughout the development of EVSE sites. Utilities are responsible for both delivering the electricity required to power EVs and developing and maintaining the electric grid through which this power is delivered, including the service connection to individual sites. Utilities and/or their regulators also set electricity rates, which in turn determine site hosts' costs for operating the chargers and providing electricity to drivers. Additionally, utilities are sometimes the owner and operator of EVSE stations themselves.

Electricity Costs

Electricity rates vary depending on the electric utility and the specific tariff in which a customer is enrolled. For most customers there are three components to an electricity rate to consider:

- **Basic charge** ($/month): a fixed amount that does not vary month-to-month. These charges are the minimum cost of service regardless of energy used and are intended to recover the utility's fixed, customer-specific costs, such as the electrical meter, billing, and customer service.

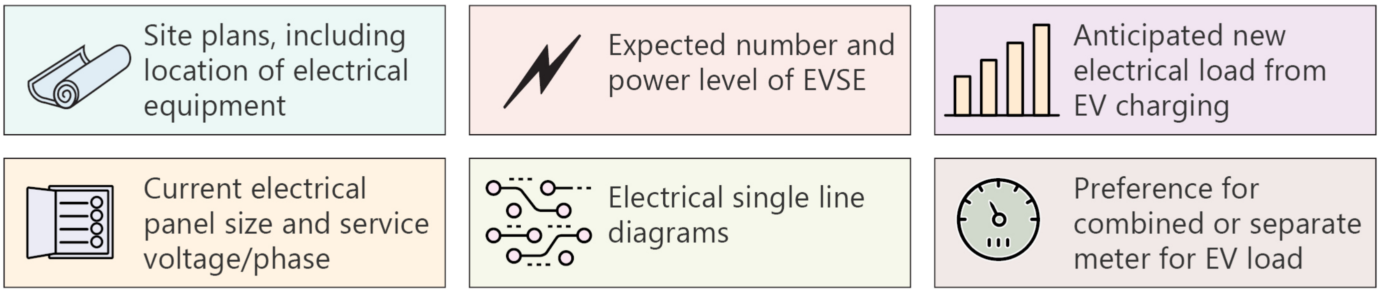
- **Energy charges** ($/kWh): assessed per unit of electricity based on the volume of kWh consumed, multiplied by the relevant price of energy during the billing period. The price of energy ($/kWh) will vary by type of customer (e.g. residential, commercial or industrial) and may also vary by time of day.

- **Demand charges,** ($/kW): assessed based on the maximum volume of kWh consumed in any specified interval (typically 15 minutes) during the billing cycle. Demand charges usually apply to commercial and industrial customers who tend to have high peak power demands. Rate structures may include different demand rates during different times, such as peak and off-peak hours. These charges are intended to recover the utility's costs of operating the electric grid, which must be sized to allow customers to draw the maximum amount of power they need at a given time. They incentivize customers to spread their energy usage over time. Demand charges can comprise a significant portion of commercial customers' electricity bills. Utility-sponsored managed charging and/or pairing charging stations with technologies such as solar photovoltaic (PV) and storage, can help reduce demand charges by avoiding peak charging above a certain level.

Site hosts and/or project developers must work directly with the local utility to ensure the chargers being deployed can either be accommodated by the site's existing electric service capacity or upgraded. Engaging with the utility early in the project is critical to ensuring realistic timelines and project plans are put in place, since interconnection and service upgrade processes can take longer than many project developers anticipate. Site hosts and developers should, early on, identify the right point of contact at the local utility and the overall process for interconnection or service upgrades.

Site hosts and/or project developers should provide as much information as possible to utilities early in the development process. Utilities need similar information to complete the permitting applications required by many jurisdictions, although with more of a focus on the electric power implications. As illustrated in **Figure 11,** typical data required includes site plans; expected number and power level of EVSE; electric panel size and service voltage/phase; electrical single line diagrams; and anticipated new electrical load.

Figure 11. Typical project information required by utilities

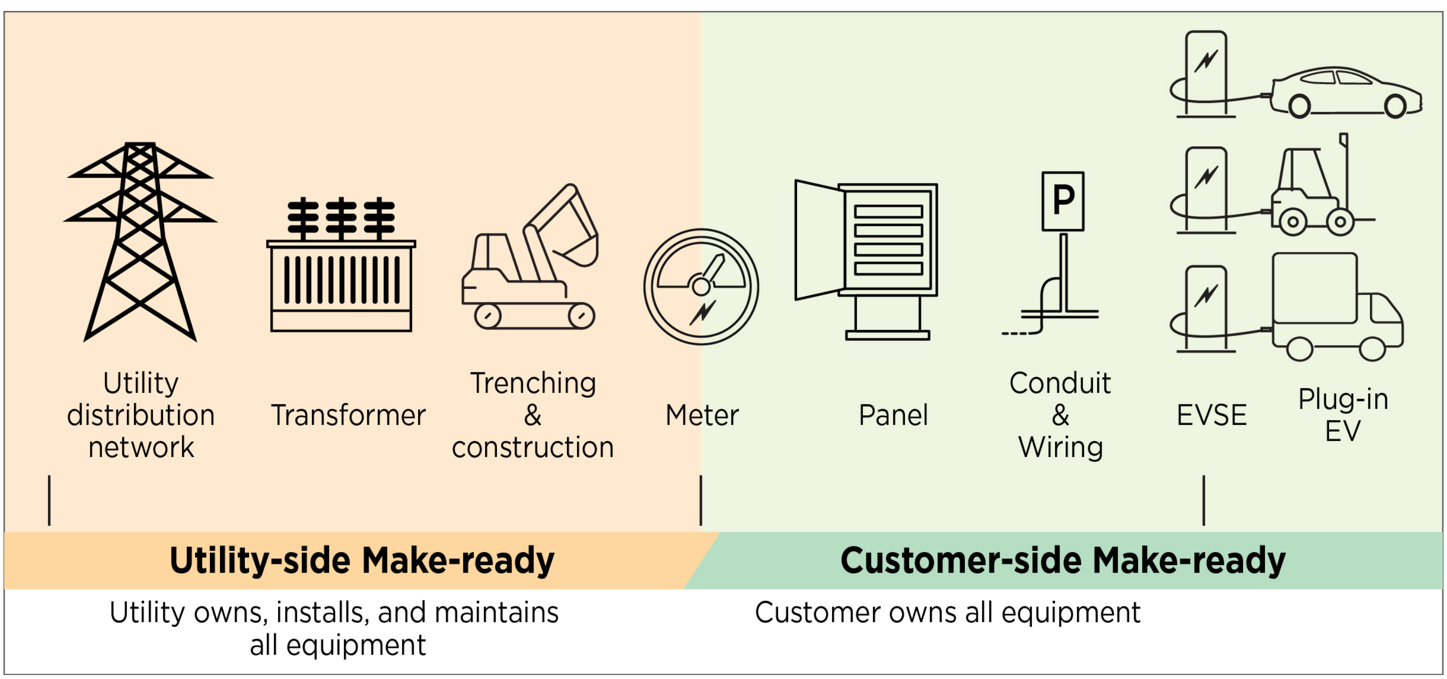


If site hosts plan to install a small initial number of EV chargers with a larger expansion in the future then this information should be conveyed to the utility early on, in the interest of future proofing the investments in electrical infrastructure. It is more cost effective to put larger electric service capacity in at the outset rather than to re-do electrical work several years later when additional EVSE are deployed.

Make-Ready Infrastructure and Oregon Utility Programs

One key way in which utilities support EVSE is through the development of some or all of the electrical infrastructure required to "make-ready" the site for EV charging. **Figure 12**[41] shows that the utility-side make-ready includes the electrical equipment connecting the distribution system (the local electric grid) to the customer's meter. Customer-side make-ready infrastructure includes the equipment from the meter up to the EVSE.

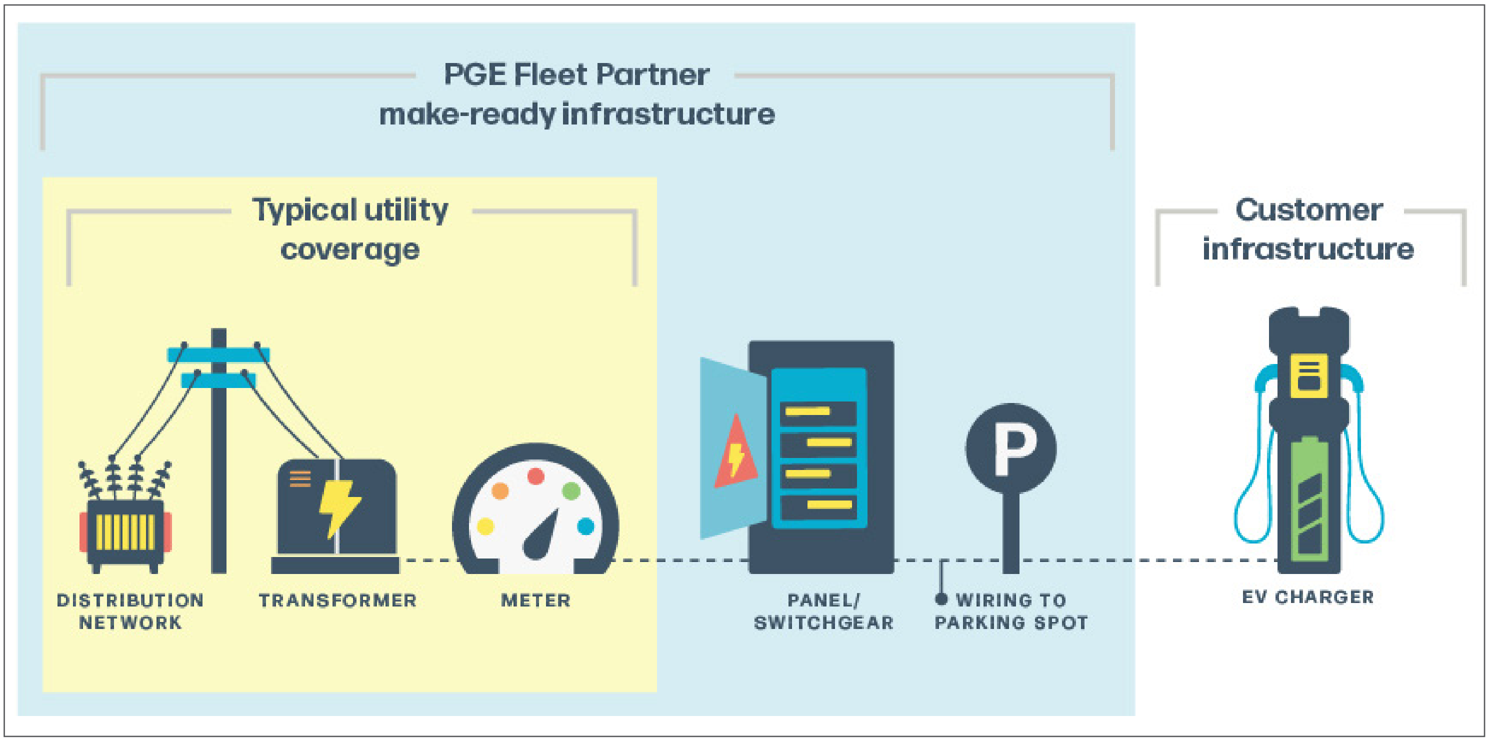
Figure 12. Make ready infrastructure for EV charging[42]



[41] *Jessica Russo, NRDC. https://www.nrdc.org/experts/miles-muller/ca-approves-new-rules-support-ev-charging-infrastructure.*
[42] *ibid.*

Many utilities in Oregon offer make-ready programs through which some or all of the installation, ownership, and/or maintenance cost of customer-side make-ready infrastructure is covered by the utility. For example, in PGE's Fleet Partner program, PGE installs, owns, and maintains both the utility- and customer-side make-ready infrastructure, with most of the costs covered through an incentive to the fleet customer based on anticipated energy usage over a ten-year period (see **Figure 13**). Other utilities, such as Pacific Power, cover the utility-side make-ready through line extension policies that reduce the costs the customer bears for utility-side upgrades. Customer-side make-ready incentives are available for fleet customers as a custom incentive up to a specific cap. Line extension policies and customer-side make-ready incentive programs are sometimes paired, depending on the utility.

Figure 13. PGE Fleet Partner Program



Local governments, site hosts, and EVSE developers should work with the local utility to understand their process for interconnecting EVSE and upgrading electrical service if needed, and also to explore what incentives and other supporting programs might be offered. **Table 10** provides an overview of several example utility programs in Oregon; for a more complete list please visit the Go Electric Oregon website. This table is illustrative and not comprehensive. Many utilities offer managed charging, transportation electrification grants, and other programs, which change over time. Consulting the local electric utility prior to development, to learn about current incentives, is advisable.

Table 10. Examples of Oregon Electric Utility Light-Duty EV Charging Programs[43]

Utility	Program	Type	Overview
Portland General Electric	Fleet Partner	Make-ready	Fleet program through which PGE installs, owns, and maintains customer-side make-ready infrastructure, including incentive to cover most costs.
	Level 2 Charger Rebate	Rebate	Upfront rebates for residential and commercial installation of Level 2 EVSE.
Pacific Power	Level 2 Charger Rebate	Rebate	Upfront rebates for residential and commercial installation of Level 2 EVSE.
	Fleet Make Ready Pilot	Make-ready	Utility-side make ready and customer-side make ready incentives available for fleet customers.
	Transportation Electrification	Grants	Support many transportation electrification project types including infrastructure, vehicles, workforce development, studies and more.
	Managed Charging	Load Management	Provides incentives to customers to redirect the time the car charges to off-peak times.
Eugene Water and Electric Board	Smart Charge	Rebate	Upfront rebates for multifamily residential, commercial, or fleet installation of publicly accessible Level 2 and/or DCFC EVSE.
Central Electric Co-op	EV Program	Rebate	Upfront rebates for installation of Level 2 EVSE.
Tillamook PUD	EV Charger Rebate Program	Rebate	Upfront rebates for residential and commercial installation of Level 2 EVSE.

Last updated: 7/28/2023

Key Utility Engagement Questions to Address

- What is the process for EVSE interconnection and/or electric service upgrades at your electric utility?
- How long do these processes take? Who is the key point of contact?
- Are there grant funding or other EVSE deployment incentive opportunities offered by your electric utility?
- What electric rates does your utility offer? Are there EV-specific options that can help reduce costs?

Ensuring Equitable Access to EV Charging

EV charging needs to be accessible to all Oregonians, so all can participate in, and benefit from, the transition to electric vehicles. Local planners and policymakers will want to consider how best to focus and prioritize equitable access to EV charging within their communities.

Oregon-based Forth Mobility defines equitable access to EVSE as "universal access to the necessary infrastructure to support the use of an EV."[44] The type of charging access will not be identical for all residents—for example, many residents of single-family homes will charge vehicles using their own dedicated EVSE in a driveway or garage, while residents of multi-family homes may be more likely to use shared

[43] *To find a more extensive list of incentives please see the Electric Utilities section on Table 16.*
[44] https://forthmobility.org/storage/app/media/Reports/forth-report-centering-equity-in-charging-1.pdf.

chargers in a building's parking lot or shared garage, or to use EVSE at an off-site charging hub. However, the goal should be to provide appropriate forms of access to EV charging to all residents.

Providing this universal access will look different in different geographies and communities, but several useful strategies are broadly applicable:[45]

- Engage with the community and conduct a community needs assessment to understand what types of EVSE are most important to different groups, targeting broad representation to ensure accuracy of results. Examples of charging types might include access to charging for personal vehicles at home; workplace charging at office buildings; charging at common destinations such as grocery stores or libraries; charging for electric micromobility options; or charging for electric public transportation.
- Prioritize accessible and affordable public charging in the right-of-way for areas with larger concentrations of multi-family housing, where residents are less likely to have access to dedicated home charging. Depending on the level of demand, DCFC may be a good option for this use case given the ability to rapidly recharge vehicles.
- Provide focused incentives and/or financing options for lower income residents to help address the upfront costs of EVs and EV charging.
- Conduct education and outreach campaigns to provide community members with basic information on EVs and EV charging options, and to dispel common misconceptions.

The EV Infrastructure Planning Map developed in tandem with this Guide is a useful resource for planners and other stakeholders in Oregon when considering how and where to make equitable investments in EVSE. The mapping tool allows users to compare different parts of a local area using a variety of metrics covering housing, demographics, and mobility patterns, and includes a number of equity-focused indicators. For additional detail on this tool, please see the discussion on strategic planning and prioritization in Chapter 5 (Planning and Deployment Approach).

Additional Equity-focused EV Charging Resources

- Centering Equity in Charging Investments to Accelerate Electrification—Forth Mobility
- Siting Electric Vehicle Supply Equipment (EVSE) with Equity in Mind—American Council for an Energy-Efficiency Economy
- Policies for a Mature, Flourishing Equitable EV Charging Ecosystem—International ZEV Alliance

Key Equity Questions to Address

- What groups should be included in planning discussions to ensure an approach to EVSE development that is inclusive of the entire local community?
- What types of charging are most important for local residents, employers, and visitors?
- Where is charging needed?
- Are there parts of the local area that need additional attention (e.g., may not be high priority for private sector investments) and hence need more priority given to EVSE investments?
- What unintended impacts might arise from the EVSE planning? How can these issues be addressed or prevented?

45 https://zevalliance.org/wp-content/uploads/2021/10/mature-ev-charging-ecosystem-nov21.pdf.

Deploying EV Charging at Specific Locations

The following sections describe some of the common challenges encountered when deploying EVSE at several different location types—multi-family housing (MFH), workplaces, public Level 2 charging destinations, and public DCFC sites—as well as potential solutions to overcome these issues.

While the challenges vary somewhat across these different location types, jurisdictions can encourage deployment at these locations through a number of strategic actions that are generally applicable, as described in **Table 11**.

Table 11. Strategies for Jurisdictions to Support EV Charging Deployment

Strategy	Charging Location			
	MFH	Workplace	Public L2	Public DCFC
Establish EVSE deployment targets that include specific goals for different location types.	✓	✓	✓	✓
Ensure charging is deployed at MFH of all types, including in diverse socioeconomic parts of the local area.	✓			
Consider specific deployment targets for curbside charging to provide market certainty for EVSPs.			✓	
Provide incentives such as upfront or reimbursable rebates to cover the cost of EVSE and/or installation, especially when such programs are not offered by the local electric utility.	✓	✓	✓	✓
Provide higher incentives for sites in disadvantaged communities which can help to provide EV charging for a broader group of residents and/or employees.	✓	✓	✓	✓
Provide educational and outreach materials for prospective building owners, managers, or site hosts, including the end-to-end process for developing EVSE in compliance with local requirements.	✓	✓	✓	✓
Develop streamlined permitting processes for EVSE, including tailored processes for different locations (e.g., MFH residential vs. public L2), as needed.	✓	✓	✓	✓
Work with the local electric utility to explore EV rates that do not impose large demand charges, which can make costs unsustainable at low utilization rates.				✓

Multi-Family Housing

Providing charging at Multi-Family Housing (MFH) is critical to enabling larger portions of the population to drive EVs. Charging EVs at home is one of the most cost-effective options, both for individual drivers who benefit from relatively inexpensive retail residential electricity rates and also for society as a whole. This is because costs to the utility for supporting at-home Level 1 or Level 2 charging are generally low relative to other options such as high-powered DCFC. The majority of light-duty EV charging currently takes place at home with 80 percent being a commonly referenced figure[46,47,48]. However, while home charging is often straightforward in single-family dwellings that have off-street parking or a garage, it is more difficult to charge at home for residents of multi-family housing. Accordingly, it is important that local planners in areas with large numbers of MFH units focus on this type of charging and that potential site hosts such as MFH owners have access to tailored resources for overcoming the challenges to deploying EVSE at these sites. The following information aims to provide an overview of the challenges and potential solutions with links and references to additional resources that may be useful.

The general steps that MFH owners or building managers may wish to take to develop EV charging at their buildings include:

- Survey tenants about current and anticipated future demand to determine the scale of the deployment, including potential type and speed of chargers.
- Assess the property's electrical capacity and the electrical equipment layout in relation to parking spaces, often with the help of an electrical contractor.
- Coordinate with the electric utility on the interconnection and service upgrade process as well as incentives and any programs for make readies or line extensions.
- Decide on an EVSE business model, ownership structure, and approach to cost and revenue sharing.
- Work with an electrician and/or EV charging provider to develop designs and complete the installation.
- If using networked chargers, continue an ongoing relationship with the third party network service provider.

This step-by-step process may appear straightforward but there are a number of specific challenges associated with both EVSE development and operation at MFH which must be addressed to enable effective deployments, as articulated in **Table 12.**

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[46] https://www.nrel.gov/docs/fy21osti/78540.pdf.
[47] https://www.nrdc.org/stories/electric-vehicle-charging-explained.
[48] https://www.canarymedia.com/articles/ev-charging/5-charts-that-shed-new-light-on-how-people-charge-evs-at-home.

Table 12. Primary challenges to installing EVSE at MFH

Challenge	Description
Tracking of electricity usage and recovery of costs	This can be difficult given individual dwelling unit meters are typically far from the parking spaces, requiring either long electrical conduit runs to connect charging stations to individual meters, or an alternative solution.
Deeded or assigned parking spaces	The ideal layout for MFH charging is a clustering of EV charging spaces near the building's electric service panel. However, this generally would require rearranging tenant's spaces in buildings with deeded or assigned parking spaces, which many tenants resist.
Ownership of EVSE	Either the building owner or tenants can own the EV charging equipment itself. Tenants who own their units are generally more willing to invest in EVSE, while renters are less likely to prefer this option as they may not reside in the building long enough to recoup their investment.
HOA rules	Homeowners Associations (HOAs) may have rules that are not as flexible or accommodating as would be ideal for EV charging needs.
Management of electrical load	Charging all vehicles as soon as they're plugged in will often require more electric service panel capacity than is available, requiring costly service upgrades if loads are not managed.

Various strategies can help to overcome the challenges listed in Table 12. The appropriate approach will depend on the building owner's and/or property manager's preferences, the composition of tenants (renters, owners, both), business model and cost expectations, and other factors. Several common solutions are described below:

- Provide charging as an amenity, with costs for EVSE deployment and/or electricity potentially amortized in whole or in part through higher rent or HOA fees.
- When passing costs on to tenants, connect EVSE to individual dwelling meters where possible. Alternatively, provide conduit and wiring to individual parking spaces and allow tenants to provide their own EVSE.
- Where individual metering isn't feasible and the building owner or manager desires to assess a fee, contract with a network service provider to track usage of shared chargers by individual drivers and collect payment for each session. Network service providers charge the building owner a fee for these services, which can be recovered from drivers as part of the pricing structure.
- Employ a load management or rotational charging system to modulate or rotate the power delivered to each vehicle, keeping total electrical demand below a certain threshold. This takes advantage of the fact that many cars will be parked overnight yet don't require that full time to charge because their batteries are not fully depleted; this allows more chargers to be connected to the same circuit without requiring a panel upgrade.
- Provide 110V outlets for Level 1 charging free of charge.
- Utilize mobile charging solutions, which are essentially a battery with charging ports and connectors on wheels, to avoid the need for electrical upgrades and EVSE installation.
- Provide off-site owned and operated charging (e.g., at a charging hub); this solution is generally available to both MFH residents and the public.
- Consider valet EV charging, which may only be viable at high-end MFH residences.
- Use Clean Fuels Program credits to offset cost (Oregon's Clean Fuels Program is discussed in greater detail in the *Supporting Resources and Funding Pathways* section of Chapter 5).

Additional MFH EV Charging Resources

- Multi-Unit Dwelling Electric Vehicle Charging—Center for Sustainable Energy, San Diego Association of Governments
- Vehicle Charging Innovations for Multi-Unit Dwellings (VCI-MUD)—Center for Sustainable Energy, Forth Mobility, Energetics, Clean Cities, U.S. Department of Energy
- Technological Barriers to Electric Vehicle Charging at Multi-Unit Dwellings in the U.S.—Forth Mobility
- EV Charging at Multi-Family Dwellings—Atlas Public Policy
- Plug-in Electric Vehicle Charging Infrastructure Guidelines for Multi-unit Dwellings—Veloz
- Guide to Electric Vehicle Charging in Multi-Unit Residential Buildings—Pollution Probe, The Delphi Group
- AFDC: Electric Vehicle Charging for Multifamily Housing—U.S. Department of Energy, Alternative Fuels Data Center

Key MFH Charging Questions to Address

- How much demand for EV charging is there today, and how will this grow over time?
- Will EV charging be offered as a free amenity, or will residents pay for each session?
- If not offered as a free amenity, how will electricity tracking and metering be handled? Is it feasible to have individually-metered chargers?
- Will networked EVSE be required to help with usage tracking and transactions? Can networked EVSE provide a solution to a number of challenges so that it is worthwhile despite the additional cost?
- Will charging be available only to tenants or also to visitors and other EV drivers?

Workplace EV Charging

Providing charging at workplaces where many employees commute by personal car can be an effective way to incentivize EV ownership, distribute electricity demand more evenly throughout the day, and take advantage of excess renewable energy. The steps employers exploring this option should generally proceed through are shown in **Figure 14** and are similar to those described above for developing MFH charging, albeit focused on employees rather than tenants.

Figure 14. Steps for developing workplace charging

1. Survey Employees to gauge interest in EV charging (today & future). Include commute distance and associated energy needs.
2. Assess facility's electrical capacity and equipment location relative to parking spaces.
3. Engage utility with initial estimate of incremental electric demand. Explore interconnect and service upgrade processes.
4. Decide on EV charging business model, ownership structure, approach to cost and revenue sharing.
5. Explore contractor options for desired business model; receive multiple bids; engage best option.
6. Work with electrician and/or EV charging provider to develop designs & conduct the installation.
7. Develop workplace charging policy, include approach to pricing, accessibility (employees only vs. others), sharing of chargers / expected etiquette.
8. Monitor system use & employee satisfaction, consider policy updates needed.

One of the challenges specific to workplace charging is how to best share stations between employees. Many commutes are not long enough to require a dedicated Level 2 charger for each employee throughout the workday; this presents cost-saving opportunities if multiple cars can share a charger. However, this requires a system or policy for how stations are shared. Options include formal reservation systems, an informal self-management process, which could be facilitated via internal employee communications platforms, or simple time limits, which can include assessing fees for failing to move a vehicle when the limit is reached. An alternative option is to offer Level 1 charging, though this is likely to benefit a smaller subset of drivers due to the limited driving range this can provide to employees.

Another question for employers is whether or not employees will be assessed a fee for using the chargers. Providing charging as a free amenity is a valuable incentive for employees to drive electric, and can help organizations reduce their carbon footprint. Additionally, providing free charging reduces the complexity of the project because tracking of energy usage, billing, and payment requirements are no longer needed (organizations will want to review this amenity in keeping with policies for other amenities).

If some or all costs are passed on to employees it is important to ensure that rates are kept low enough to incentivize use of the chargers, especially when compared to the low cost of home charging which is available to many EV drivers.

Additional Workplace Charging Resources

Plugging in at Work: How to Effectively Install, Share and Manage Electric Vehicle Charging Stations—Veloz

Key Workplace Charging Questions to Address

- What is the total charging demand from employees, both today and in the future? Can some needs be met with Level 1 charging?
- Will employees be charged a fee for using the workplace chargers?
- What policies need to be put in place to ensure vehicles don't remain parked beyond their needed charging time? Who will be responsible for enforcement?
- Will chargers be available to employees only, or to the general public as well? Is there opportunity to use the chargers outside of typical work hours for the public or another group (e.g., fleets or neighborhood residents that need to park and charge overnight)?

Public Level 2 and DCFC Charging

Providing publicly available Level 2 and DCFC charging at businesses, civic centers, and other local destinations is an important part of developing a comprehensive charging ecosystem. These public destinations allow drivers to recharge while going about their day rather than through dedicated home or workplace charging. Public charging options are also an important part of enabling EV usage for those that do not have easy access to charging at home or at work. Additionally, these deployments are a valuable option for both businesses and local governments to drive economic growth by helping to attract new or more frequent customers, visitors, and tourists.

Compared to MFH and workplace charging deployments, public charging can be developed at a broad range of location types including retail establishments such as grocery or convenience stores, civic centers such as libraries or town halls, public rights-of-way, parking lots and garages, transit centers and airports, and other common destinations within a community. As a result, best practices for public charging deployment are more varied than the focused practices highlighted above for MFH and workplace charging. However, several high-level considerations are important to plan around.

Dwell Time

Determining the right power level for public EVSE deployments should be based on the anticipated average "dwell time "of vehicles at that location, which is the length of time the vehicles are parked in the charging space. For locations where visits are relatively short such as grocery or convenience stores, DCFC or higher power Level 2 EVSE are usually appropriate as they can provide sufficient energy despite the brief window vehicles are plugged in. For destinations where visitors generally remain for longer periods of time such as libraries, shopping malls, parking garages and curbside parking, Level 2 chargers will often be sufficient and more EVSE can be deployed cost-effectively to simultaneously charge a larger number of vehicles.

Reliability Standards

Public charging stations are the most visible aspect of the EV charging ecosystem. Ensuring high reliability of these stations by making sure they operate as intended virtually all the time is therefore paramount for instilling consumer confidence in this system and ensuring that driving an EV will be as convenient if not more so than driving a conventional internal combustion engine vehicle. Public charging stations should therefore be required to meet high reliability standards, with contractual obligations to ensure that the private companies manufacturing, installing, owning, and/or operating the EVSEs actually provide the level of service desired. The most common reliability metric is "uptime," which reports the percentage of time (often across a month or year) that a given EVSE is operational and able to provide charging services. Importantly, this metric excludes time that the EVSE is out of service due to upstream issues outside of the EV service provider's (EVSP's) control, such as electric utility power outages or internet failures. Public chargers should be required to meet a reliability standard of at least 97% uptime. In other words, on an average day without upstream issues outside of the EVSP's control, the charger would need to be operational and able to provide charging for at least 23.3 hours.

Electricity Supply

Planners, EV service providers, and other stakeholders may wish to consider current electric grid infrastructure when determining where to site public chargers. This is true for both Level 2 and DCFC deployments but can more quickly become problematic for DCFC given their larger power requirements. Areas with sufficient excess electrical capacity will be considerably easier and less expensive to develop than those with limited capacity. Additionally, geographic areas as small as several city blocks can have significant differences in electrical capacity based on the layout of the local distribution grid. These differences are not readily apparent and the local electric utility is typically the only entity with ready access to this information. As emphasized earlier in this chapter, engaging the local electric utility early and often in planning and siting discussions is highly encouraged and can result in more cost-effective and rapid deployments of EVSE.

Public DCFC Deployment Types

Public DCFC can be deployed in several formats. One application can be along highway corridors where the primary intent is to provide rapid charging for longer-distance trips; this is analogous to gas stations sited along interstates and other major highways. Other DCFC deployments can be at public locations such as grocery stores and other destinations where visitors have a trip purpose different from refueling but can still benefit from a rapid charge. A third form of DCFC deployment is at centrally located hubs that offer multiple DCFC ports, possibly in addition to Level 2 ports and 110V outlets for electric micromobility charging. This latter category can be an important part of the solution for EV drivers that lack access to home or workplace charging; it can also support electrification of on-demand ride-hailing companies and drivers by providing fast charging access near the origins and destinations of many of their trips.

Both corridor DCFC and centrally located DCFC hubs are likely to more commonly be owned and operated by third-party EV service providers given their primary focus on EV charging, whereas other public DCFC such as EVSE sited at retail locations may be owned and operated by EVSPs or by site hosts. For corridor DCFC, local planners may wish to ensure that the site design considers all vehicle types that may use the station, providing "pull-through" spaces so that longer vehicles or vehicles towing trailers can still easily access charging ports. Additionally, as medium- and heavy-duty vehicle electrification is anticipated to accelerate this decade, certain stations should be developed to enable larger vehicles to also easily use EVSE, rather than solely designed for light-duty passenger vehicles. Ensuring that pricing is fair and affordable at public charging stations is also an important factor to consider.

Additional Public Charging Resources

A Best Practice Guide for Installing and Operating Public Electric Vehicle Charging Infrastructure—Fuels Institute

Promoting EV Charging Station Installations—NYSERDA

EV Infrastructure Project Planning Checklist—U.S. Department of Transportation

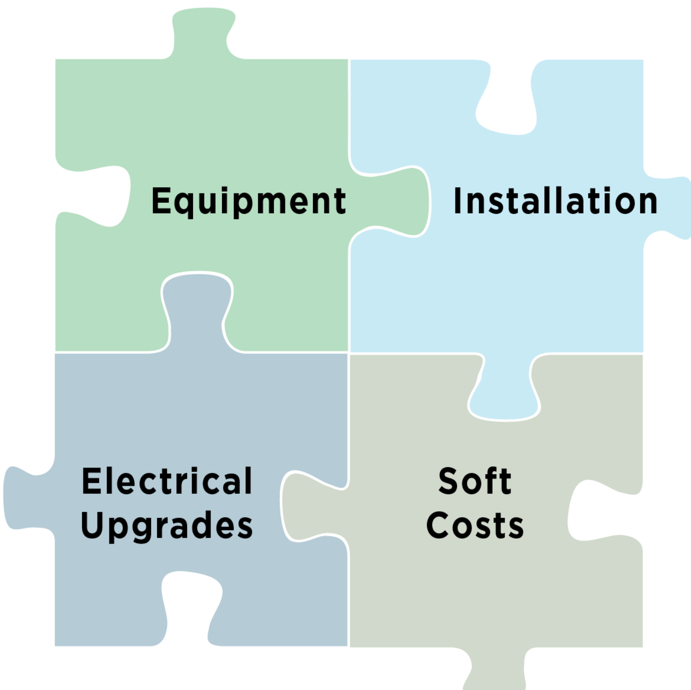
Key Public Charging Questions to Address

- What are common driving destinations within the local area, such as commercial centers, entertainment districts, or tourist attractions?
- What is the average "dwell time" (how long vehicles are parked) at each location, and which EVSE power levels best align with those times? Locations with longer average dwell times can provide sufficient charging using Level 2 EVSE.
- What vehicles will need to use this public EVSE? Is the site design sufficiently accommodating for all vehicle types?
- How will reliability and high "uptime" of EVSE be ensured? What contractual safeguards are being put in place to protect public or private funds from supporting sub-par charging equipment and sub-optimal consumer experiences?
- What type of pricing will be employed, and will it be fair and affordable?
- Are there nearby populations that might benefit from DCFC hubs, such as a high density of MFH residents or TNC drivers?

4. Planning Level Cost Estimates

When planning for EVSE deployments, it can be challenging to estimate all the costs likely to be incurred. Four categories of costs are important to consider: Equipment; Installation (including the customer-side of the meter electrical connection costs); Electrical Upgrades on the utility side of the meter (such as transformers); and Soft Costs (such as site acquisition, permits, easements, environmental review, and other processes). **Figure 15** identifies the four cost categories that contribute to total EVSE deployment cost.

Figure 15. EVSE deployment cost components



This Guide provides in-depth insight to help planners estimate equipment and installation costs. The other two categories of cost—Electrical Upgrades and Soft Costs—are highly variable, site specific, and are not discussed at length in this chapter. Nevertheless, it is critical to consider all four cost categories as EVSE deployment plans are developed. Planners will want to consult with the local electric utility and the authority having jurisdiction (e.g., county or city) early and often during EVSE planning and deployment to better assess costs that may be incurred due to either electrical upgrades or various aspects of soft costs.

In their influential 2019 report on EVSE infrastructure costs[49], Nelder and Rogers distinguished hard costs from soft costs (see **Figure 16**) and noted that, unlike the historical downward trend in hardware costs:

> *"Soft costs for nonresidential charging stations—such as costs of acquiring sites, meeting local building codes, and participating in extended processes for obtaining utility interconnections, easements, and local building permits - are not so easily reduced. Soft costs were frequently cited as more significant cost drivers than charging station hardware. Soft costs were also identified as some of the most problematic and unpredictable costs that developers of charging networks encounter."*

This chapter focuses on hard costs, providing insights into the estimated costs of procuring and installing EVSE in Oregon and reports the cost range for different EVSE power levels. Soft costs and electrical upgrade costs are not explicitly addressed in this chapter. Soft costs are highly variable and are quite sensitive to land acquisition costs, as well as the policies, procedures, and codes of the authority having jurisdiction, agencies and/or utilities involved in the particular EVSE deployment process being contemplated. Even so, they can contribute significantly to the total project cost and are therefore important to keep in mind in any installation effort. Similarly, the potential for electrical upgrades must be assessed when planning to deploy EVSE and can be best understood by working early and often with the local electric utility.

Hard cost ranges for EV charging equipment and its installation—exclusive of soft costs or electric upgrade costs—were developed using estimates from recent research by RMI, the International Council on Clean Transportation (ICCT), the National Renewable Energy Laboratory (NREL), Atlas Public Policy, and feedback provided by informed stakeholders in Oregon. Cost estimates developed in prior years were adjusted to account for inflation. All costs are per charging port[50] unless otherwise noted and are intended as informational, planning level estimates. Cost ranges span the full spectrum of estimates found in the literature reviewed and noted by experts interviewed; importantly, this means that the midpoint or average of the range is

49 Chris Nelder and Emily Rogers, Reducing EV Charging Infrastructure Costs, Rocky Mountain Institute, 2019. https://rmi.org/ev-charging-costs

50 Costs are reported per port, which refers to a dispenser on the EV charging equipment capable of providing the rated electrical power level of the charging equipment to the EV. Charging equipment can include more than one dispenser, but both dispensers may not be able to be operated simultaneously; for example, some DCFC equipment may have two permanently-attached dispensers, one with a CHAdeMO connector and one with a CCS connector. However, only one EV can be charged, using one dispenser, at a given time. Incremental costs for adding a second dispenser are relatively small, and are not addressed in these planning level cost estimates.

not necessarily the "typical" cost seen in the market. Additionally, significant economies of scale may be achievable should multiple EVSE be installed at the same site, and hence the "per port" estimates may decrease with large scale projects. An engineering site evaluation should be completed for budgeting purposes as actual project costs vary significantly based on location characteristics, region, utility service territory, authority having jurisdiction, and prevailing market conditions.

Approximately half of the total cost of deployment is due to the charging equipment, while one-third or more of the cost can typically be attributed to site design, contracting, permitting, and installation. Other costs like line-extension activities and transformer upgrades make up the remainder of the cost. These proportions vary depending on the type of charger being installed.

Hard deployment costs fall into two broad categories, including:

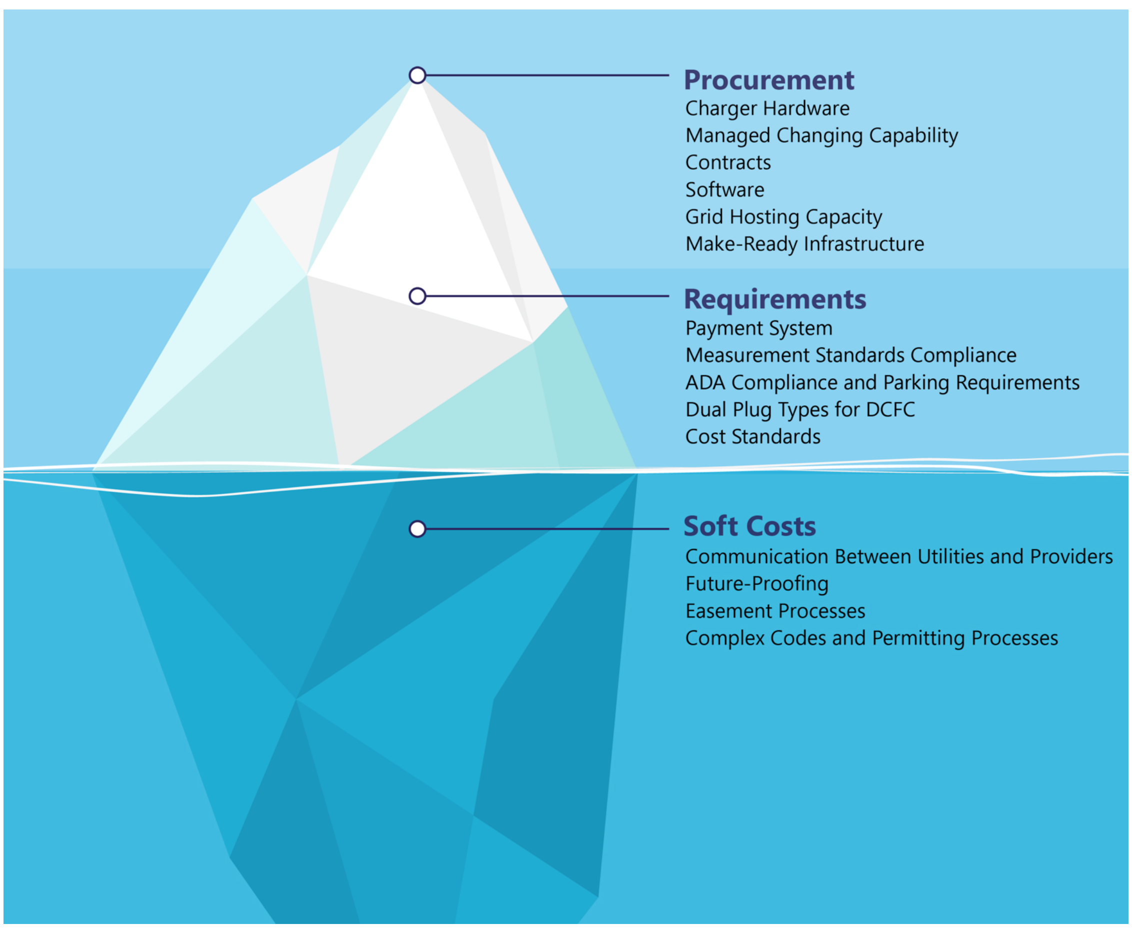
- Equipment costs; and
- Installation costs.

For the purpose of cost estimations in this section, the equipment costs are estimated separately from the installation costs, both of which are discussed in greater detail in the following sections.

Equipment Costs

Charging equipment includes the charger and associated charging plug(s) and cables, the charging pedestal, and wiring. Equipment costs may also include additional elements, such as costs for software, maintenance, and usage contracts associated with the charging service. Equipment costs vary by charger type, power level, and scope of additional services offered. Estimated EV charging equipment costs—spanning the range from no additional services to the full scope of services—by level of charging equipment, are summarized in **Table 13** and 50th and 75th percentile cost ranges are illustrated in **Figure 17.** Levels of charging are discussed in detail, below.

Figure 16. Major cost components of EV charging infrastructure

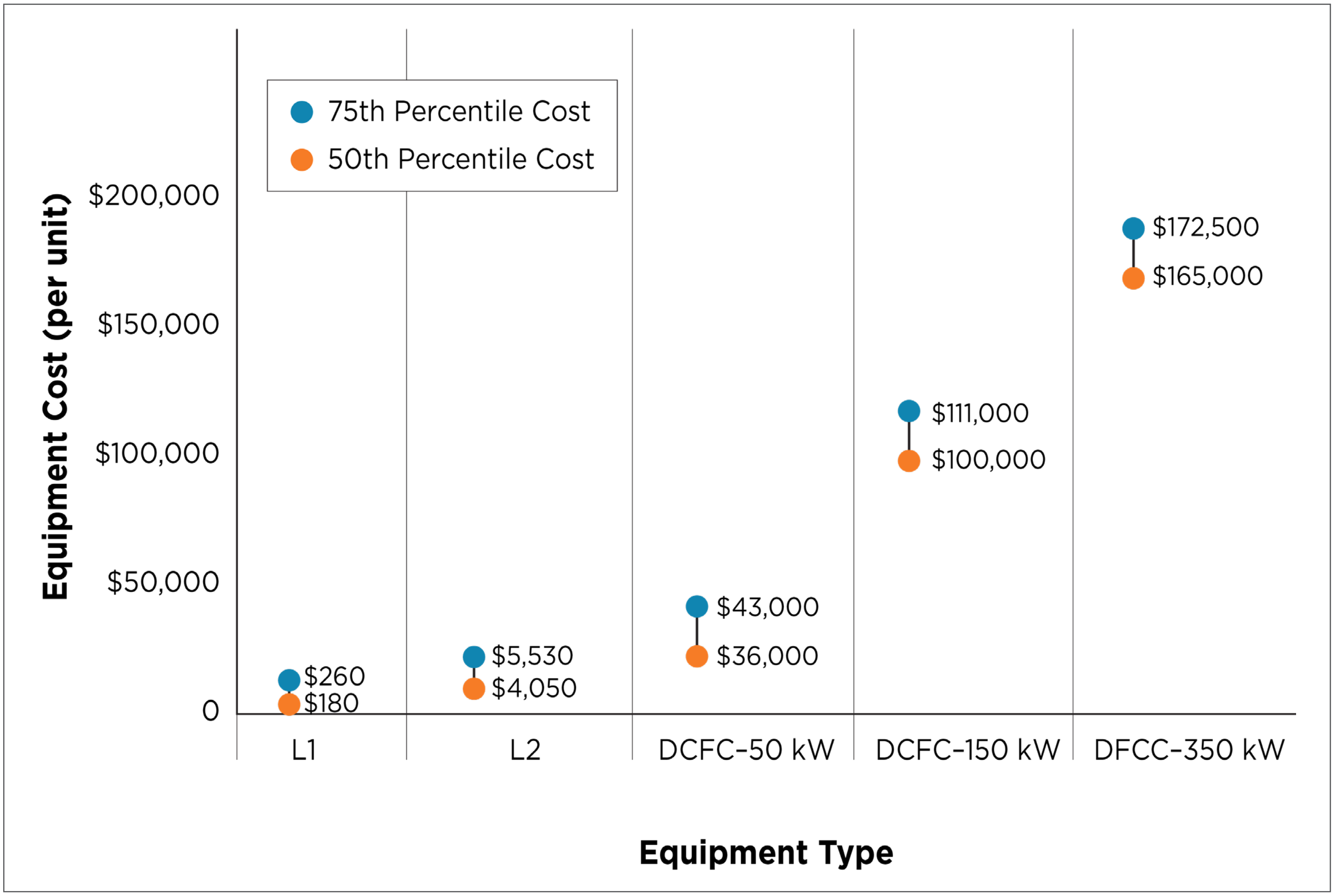


Source: Chris Nelder and Emily Rogers, Reducing EV Charging Infrastructure Costs, Rocky Mountain Institute, 2019. https://rmi.org/ev-chargingcostst.

Table 13. EV charging equipment costs[51]

	L1	L2	DCFC - 50 kW	DCFC - 150 kW	DCFC - 350 kW
Equipment Costs	Up to $350	$1,100 to $7,000	$22,000 to $50,000	$80,000 to $120,000	$150,000 to $180,000

Figure 17. Typical range of EVSE costs



(Last updated 7/28/2023)[52]

Charging equipment and services may be procured under different agreements. Equipment may be bundled with combinations of maintenance, software, data analytics, managed charging capabilities, and communications. Additionally, charging equipment can be procured under a network contract or on an ad-hoc basis. The cost effectiveness of these different packages varies by vendor and the use case of the charging equipment.

[51] *As noted at the beginning of this chapter, the midpoint or average of the cost range is not necessarily the "typical" cost seen in the market, as estimates span the full spectrum of costs found in the literature reviewed and/or experts interviewed.*

[52] *Source: Research from RMI, ICCT, NREL, Atlas Public Policy, and input from Oregon stakeholders; and updated to 2023 dollars to reflect intervening inflation and supply chain impacts.*

Typical Costs Associated with Various Charging Power Levels

Level 1 (L1) charging is typically provided via a cable and connector that can be plugged into the EV and connected to electricity via a standard 15-20 amp, 110 - 120V wall outlet with minimal cost. If a dedicated Level 1 charging port is installed, provision of a charger cable for use at the site may be included, at a cost of up to $350. Level 1 charging stalls or ports are rarely installed as stand-alone units, however access to 110 - 120 volt wall outlets may be desired when supporting EV charging in multi-family housing or workplaces. Site-specific costs for the addition of a 110 - 120 volt outlet will need to be estimated on a case-by-case basis.

Level 2 (L2) chargers typically have a dedicated pedestal or wall mount and need additional wiring for 15 - 80 amp, 240V service. The cost of Level 2 chargers varies according to the hardware's power level, which ranges from 3 to 19.2 kW, and also whether the chargers are networked. Networked chargers are operated by EV service providers and may require additional software, maintenance, and usage contracts, all of which can increase the purchase price of the equipment while providing substantial benefits. For example, a non-networked, two-port Level 2 charger cost approximately $2,000 in 2019, while a similar networked charger was priced at that time at nearly $6,000[53]. These incremental costs pay for additional features and services including payment software, internet connectivity, remote diagnostics, repair, and maintenance and service contracts. Networked chargers may enable operating revenue, electricity cost savings, and customer service benefits.

Direct Current Fast Chargers (DCFC) include the charger which is mounted on a pedestal or base, and incorporate one or two charging dispensers or ports (cables and connectors), and additional wiring. The costs of DCFC equipment vary significantly depending on the power level, which currently ranges from 50 kW to 350 kW. For example, a 50 kW DCFC can be purchased for approximately $50,000 while a 350 kW charger can cost three to four times that amount, as shown in **Table 13.** DCFC are typically part of a charging network; publicly-funded DCFC are often required to be part of a network. Therefore, lower cost non-networked chargers are not usually an option.

[53] *Source: ICCT*

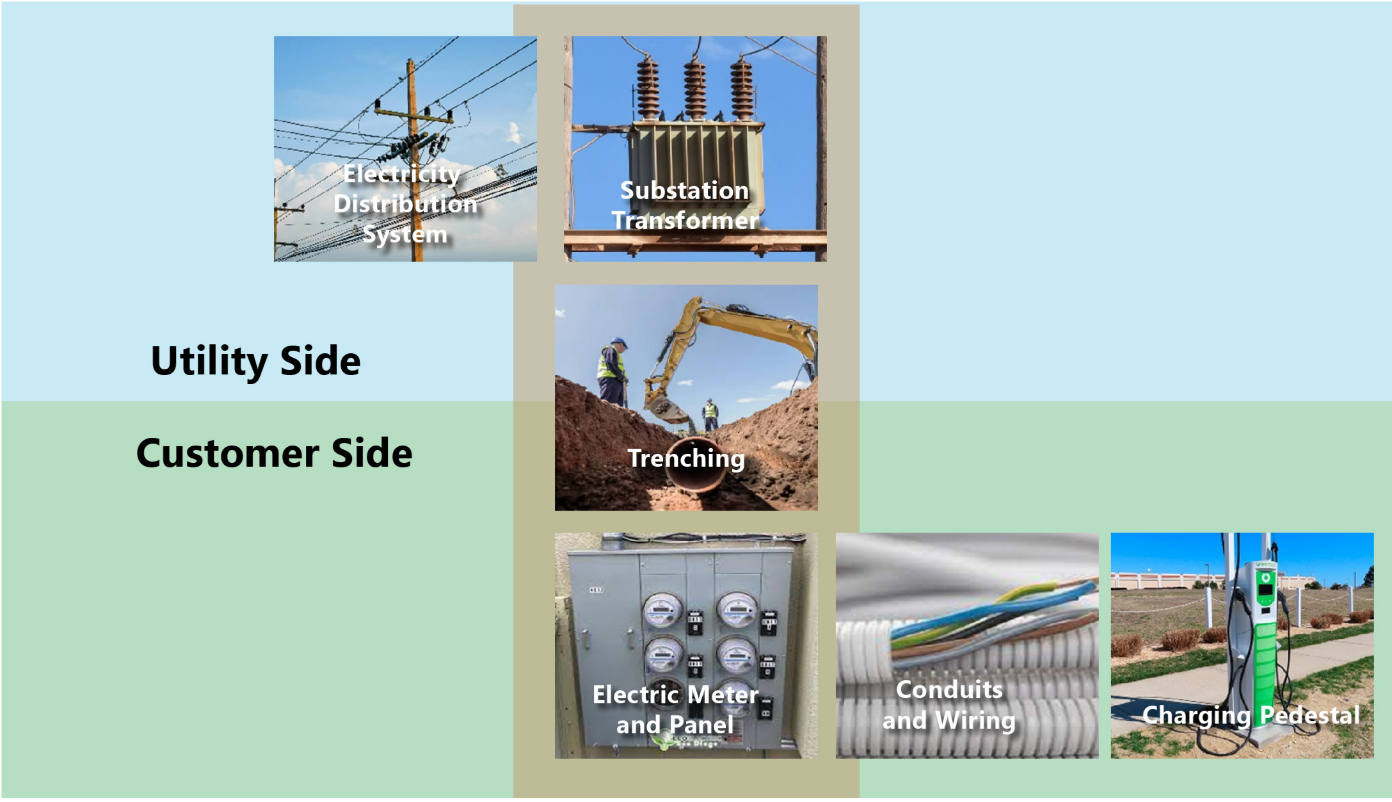
Installation and Electrical Upgrade Costs

Charger installation is most easily understood as incorporating customer-side-of-the-meter costs and utility-side-of-the-meter costs. **Figure 11** and **Figure 12** in the prior section illustrate elements of utility "make ready" support programs, showing project elements that are on the utility side of the meter or the customer side of the meter. The developer of an EV charging site will pay both customer-side-of-the-meter costs, and certain utility-side-of-the-meter costs if a project requires significant utility-side upgrades.

Customer-side-of-the-meter costs typically include construction activities and customer-owned electrical components, as depicted in **Figure 18.** Utility electric grid upgrades may include replacement and/or re-sizing of transformers, substations, and other grid hardware which may also involve construction costs (as shown on the top portion of photos in **Figure 18**). On the customer's side of the meter, upgrades can include installing a new electrical panel, running conduit and new wiring, and installation of the pedestal upon which the EVSE is mounted. Both utility- and customer-side upgrades can entail trenching, coring, boring, and other excavation activities required for properly installing the new equipment, as well as contracting and labor costs. Total installation and upgrade costs generally fall within the ranges shown in **Table 14** and **Figure 19.**

Charger installation and electrical upgrade costs are the most variable of EVSE cost components. The costs associated with each of these installation and upgrade steps depend largely on site specifications, local labor rates, and broader market conditions such as supply chain and material availability.

Figure 18. Components of EVSE Installation



Installation

Level 1 chargers require the least installation services. In some cases, no installation costs are incurred while other installations might only need a simple wall outlet and wiring for dedicated charging outlets, and potentially a dedicated charging cable and connector that can be plugged into an EV. L1 charger installation costs should not exceed $1,000 per port.

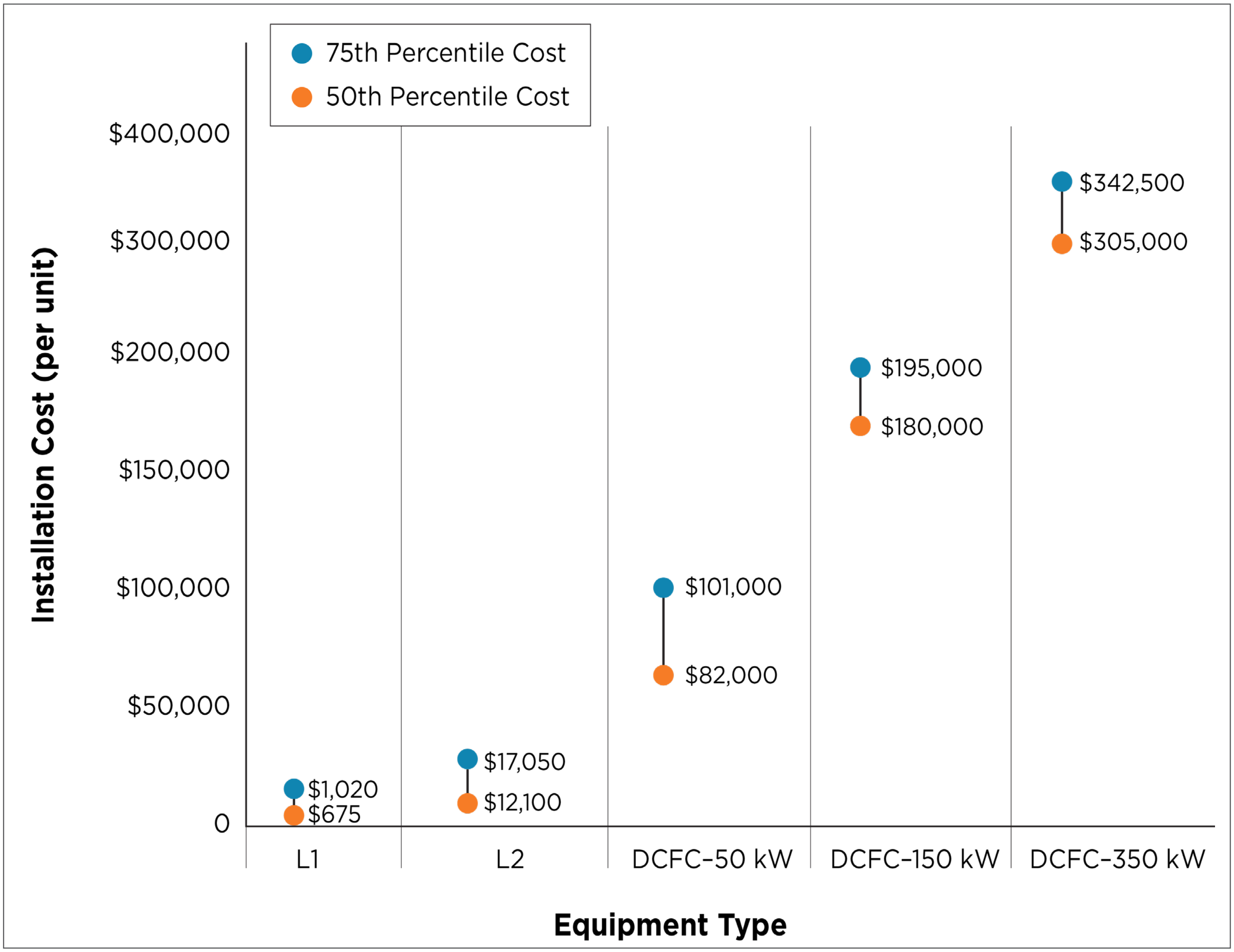
Level 2 chargers require special wiring and may also require excavation and concrete work to prepare the site for the installation of charging pedestals or wall mounts. Installation of new wiring may also require new conduit and connections to the electric meter and panel. Together with associated labor and contracting charges, these costs are expected to be no more than $15,000 per port for an L2 charger. However, economies of scale may significantly reduce per port installation costs if several chargers are to be installed at the same time, at the same site.

DCFC installation costs can be much higher than for L1 and L2 chargers and, in some cases, nearly equivalent to the cost of the equipment. Total per-port installation cost can vary greatly depending on the power level of the chargers and site characteristics. The typical installation cost for these DCFC chargers, at the time of publication, is likely nearer to the 75th or 80th percentile of cost shown in **Table 14** and **Figure 19.**

Table 14. Adjusted equipment installation and upgrade costs[54]

	L1	L2	DCFC - 50 kW	DCFC - 150 kW	DCFC - 350 kW
Total Charger Deployment Cost Ranges	Up to $1,350	$2,200 to $22,000	$44,000 to $120,000	$150,000 to $210,000	$230,000 to $380,000

Figure 19. Typical range of EVSE costs



(Last updated 7/28/2023)

[54] *As noted at the beginning of this chapter, the midpoint or average of the cost range is not necessarily the "typical" cost seen in the market, as estimates span the full spectrum of costs found in the literature reviewed and/or experts interviewed.*

Electrical Upgrades

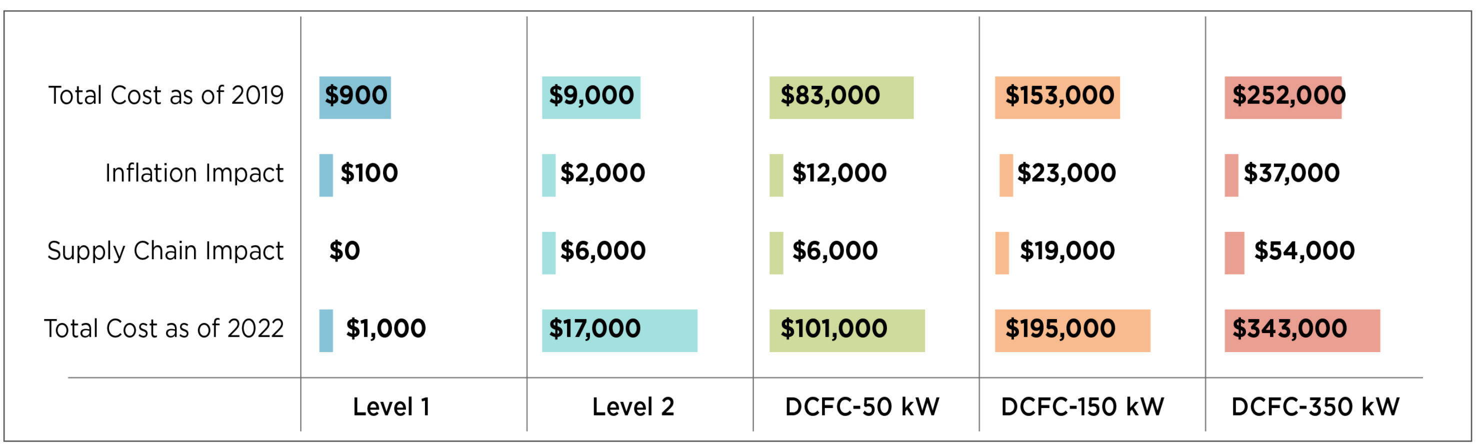
An upgrade of the supporting electric grid infrastructure is sometimes required in conjunction with the installation of EV chargers. Upgrading the electric grid infrastructure may include upgrading to higher amperage wires, higher transformer capacity, or both. This is more common for large installations or higher power L2 and DCFC chargers. Level 2 charger sites requiring transformer upgrades can expect current installation costs to increase by $2,000 - $4,000 per port. Upgrading transformers to support DCFC chargers is more expensive and currently ranges from $40,000 per port for 50 kW chargers to nearly $200,000 per port for 350 KW-capable sites; these cost estimates are in addition to the associated labor, contracting and design costs that will also be incurred. Note that significant economies of scale may be realized; as the installation of numerous DCFC chargers per site increases (and hence the total number of charging ports per site increases), the per port installation costs will decrease, sometimes substantially.

Stakeholder Input

Anecdotal evidence provided by informed stakeholders in Oregon was used to adjust charger cost data to reflect current statewide experiences. These adjustments have been incorporated into the information presented in **Table 14.** Most respondents noted L2 charger installation costs have risen several thousand dollars over the past few years. Transformer costs and the lead time to obtain these key pieces of electrical equipment were also flagged as having increased significantly, affecting budgets, contracting, and project development timelines. However, respondents noted that the relative proportions of equipment to installation costs have remained similar to those reported in academic literature.

The impact of inflation and supply chain disruption on the total estimated cost of installed EV charging infrastructure equipment is incorporated into the illustrative example presented in **Figure 20,** and the breakdown of inflation and supply chain disruption cost impacts from 2019 - 2022 is explicitly incorporated into **Figure 19.**

Figure 20. Impact of economic and market conditions on EVSE cost from 2019-2022

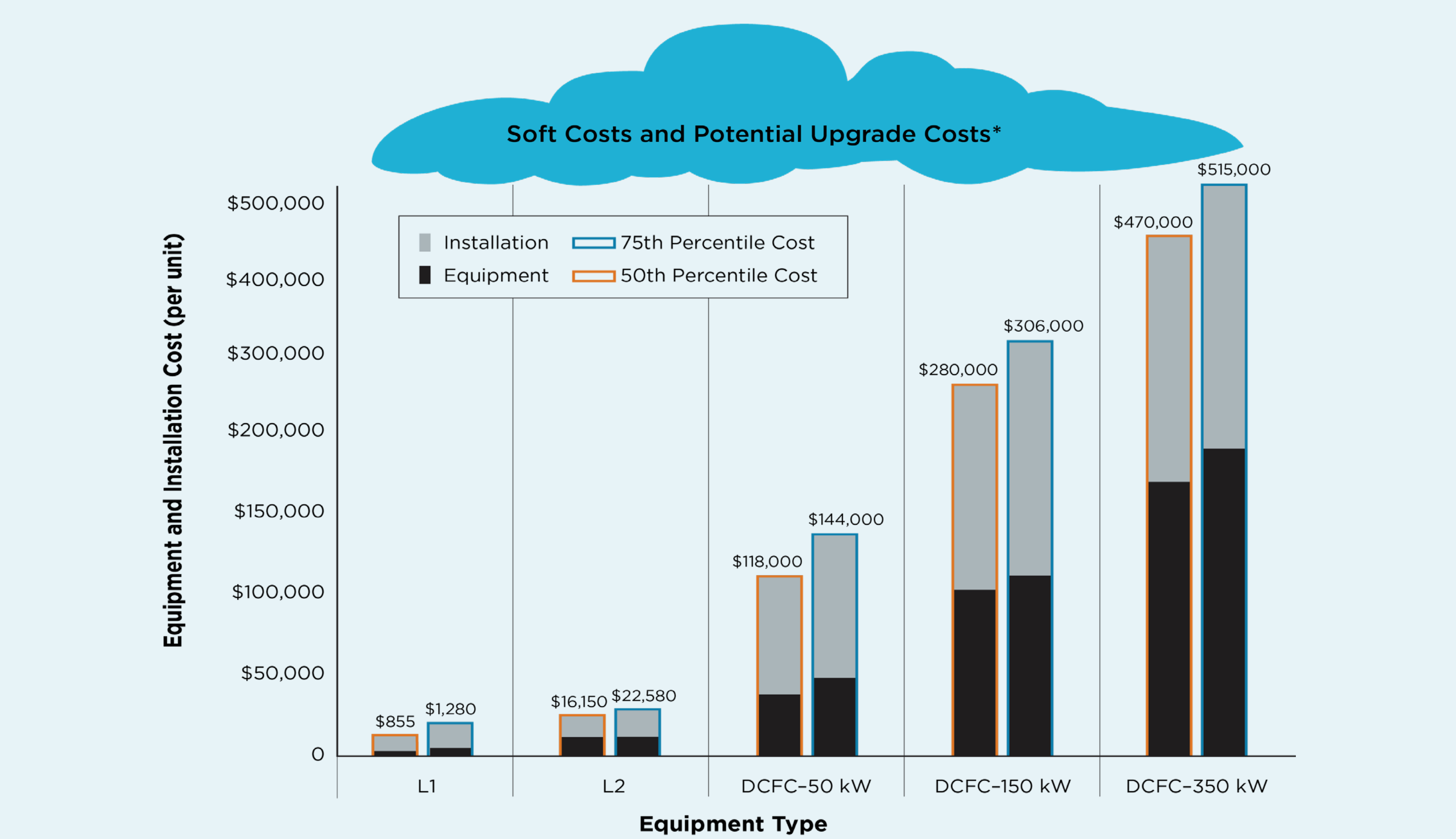


Last updated 7/28/2023

Estimated total costs of installing EV charging equipment at a site

The planning level estimates of the total cost per port of installing EV charging infrastructure at a site are shown in **Figure 21.** Two scenarios are illustrated: (1) estimates of costs using the 50th or low percentile of the cost range, and (2) estimates of costs using the 75th or high percentile of the cost range. If networked charging and additional ancillary services are included in a planned EV charging infrastructure installation, the 75th (high) percentile cost estimates are more likely to reflect real-world experience in Oregon than the 50th (low) percentile cost estimate on a per port basis. However, significant economies of scale can reduce costs if several chargers are installed at the same time, at the same site. Hence, the 50th percentile cost estimates may better approximate per port costs if several chargers are expected to be installed at once. Note that likely costs for electrical upgrades and soft costs are only shown schematically in the figure, to illustrate the need to take these costs into consideration, recognizing that these costs are highly variable and site specific. To better estimate these and other costs, it is important to reach out to utilities and/or authorities having jurisdiction.

Figure 21. Estimated total equipment and installation cost of EV charging equipment at a site



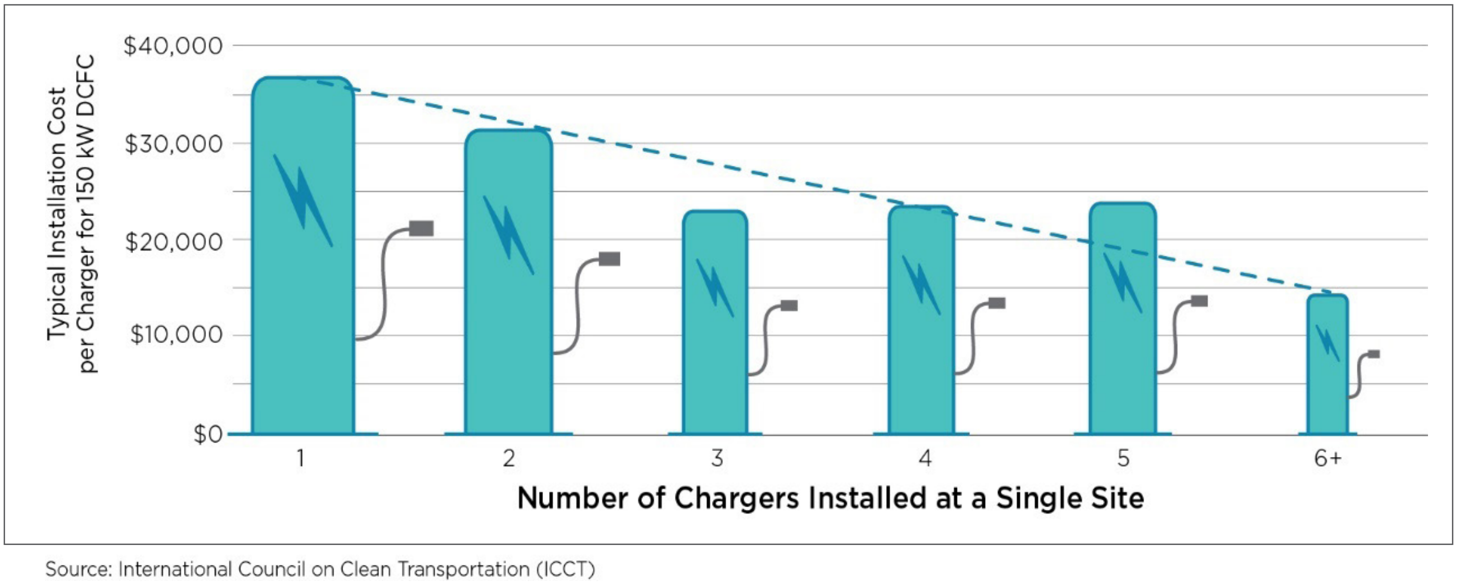
** The soft costs and potential upgrade costs are not included in the graphic's bar charts. As noted in the narrative, these costs can be substantial and need to be considered when planning.*

Sources: RMI, the International Council on Clean Transportation (ICCT), the National Renewable Energy Laboratory (NREL), Atlas Public Policy, and updated for inflation, supply chain constraints, and feedback provided by informed stakeholders in Oregon.

Economies of Scale

Figure 22 summarizes an analysis conducted by ICCT that illustrates the potential impact of lower per unit costs due to economies of scale as the number of chargers included at the same site rises. This analysis illustrates the type of economies of scale that can be realized; however, the installation cost data reflects the numbers found in the ICCT analysis, and does not reflect the composite, inflation-adjusted installation cost estimates presented in other figures in this report. As shown in **Figure 22,** a decrease in per unit costs can be achieved as the number of chargers installed at a particular EV site increases. ICCT estimates that for L2 and DCFC deployments, the per-charger installation cost decreases as the number of chargers per site increases from one EV charger to six EV chargers at a single location; higher numbers of chargers per site do not yield additional savings, and per unit costs remain relatively constant thereafter. These economies of scale are due to distributing the cost of upgraded electrical infrastructure across a larger number of EVSE chargers and ports. Additionally, economies of scale and competitive bidding processes can affect per-unit equipment costs, with larger purchase orders having greater eligibility for bulk discounts. However, the installation cost per charger may increase if the number of chargers is increased to the point of triggering a larger grid-side upgrade requirement.

Figure 22. Effects of project scale on per-charger cost*

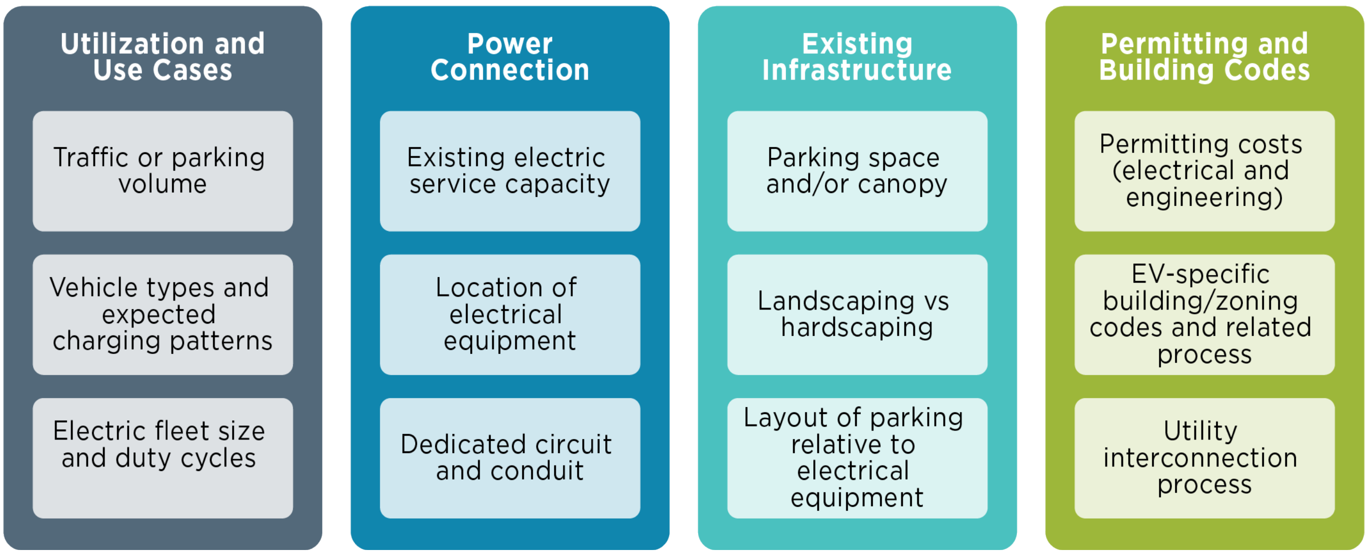


**This figure displays data from ICCT's study, and illustrates the general concept of how economies of scale can reduce per port EV charger installation costs; however, this data is different from cost estimates provided elsewhere in the report, which are a composite of data from several studies, and have been adjusted for inflation, supply chain constraints, and feedback from informed Oregon stakeholders.*

Managing Project Costs

When contemplating the establishment of a new EV charging site, the needed features and services of the charging equipment should first be identified before selecting the charging equipment or site. **Figure 23** highlights several factors related to the anticipated use case, electrical grid, existing parking infrastructure, and building codes to consider when planning for EVSE deployments. Consideration should be given to what elements of a network contract are needed. The site characteristics such as whether there is electrical capacity, the space available, and the proximity to the existing electrical infrastructure should also be considered. These site characteristics impact the availability of futureproofing options, the number of chargers that can be accommodated, and the need for trenching.

Figure 23. Factors to consider for reducing EVSE deployment costs



Site

Site characteristics impact EVSE installation costs. Several specific characteristics to consider include:

- **Proximity to electrical equipment.** Minimizing the distance to service panels, switchboards and electrical meters can help keep costs down.
- **Weather protection and durability.** Equipment in outdoor settings may have additional requirements for weather protection and heavy use.
- **Surface type.** The parking surface (for example asphalt, concrete, or unpaved) impacts the cost of trenching and installing charging and electrical equipment.

Project Scale

Project scale, which is equivalent to the number of chargers at a site, can affect the per-unit cost of EVSE installations. ICCT estimates that for L2 and DCFC deployments the per-charger installation cost decreases as the number of chargers per site increases from one to six, and remains relatively constant thereafter. Project scale is addressed in more detail in an earlier section of this chapter titled *Economies of Scale.*

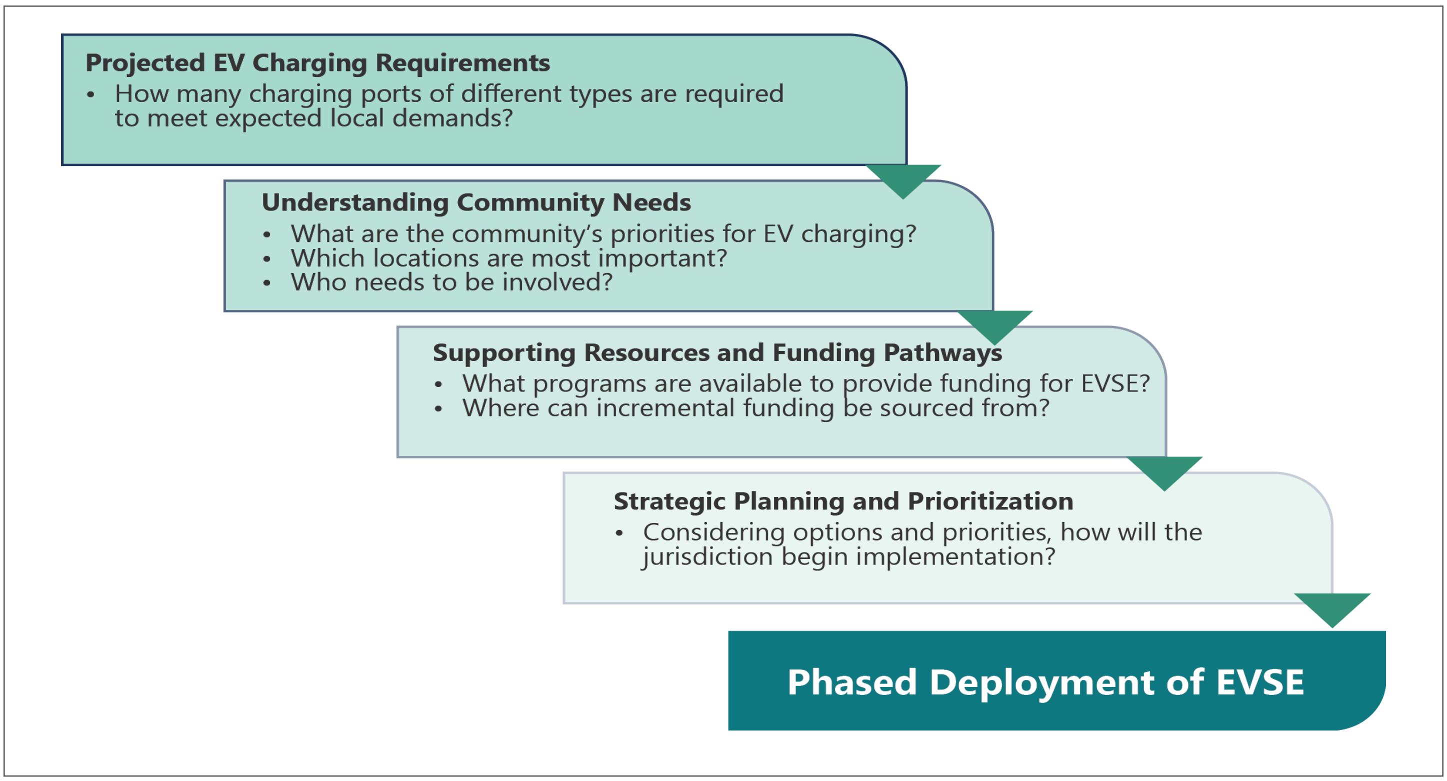
5. Planning and Deployment Approach

The preceding chapters of this report have provided information and resources to support development of EVSE at different location types. This chapter identifies the priority actions that key stakeholders can take to ensure widespread EVSE installation to support rapid EV adoption, so that the state quickly progresses towards and ultimately achieves TEINA EVSE targets.

Elements of Strategic EVSE Deployment

Several key elements are necessary for local leaders to effectively plan for and deploy EVSE as shown in **Figure 24.** This chapter summarizes these elements in an accessible fashion and highlights additional resources that will enable local leaders to strategically develop EVSE within their jurisdictions.

Figure 24. Elements of strategic EVSE deployment



Projected EV Charging Requirements

Understanding how many, and what type of, EV chargers are needed in a specific geography or local jurisdiction in both the near term and in the future can help city, county, utility and other planners make better plans for implementing EV charging infrastructure locally.

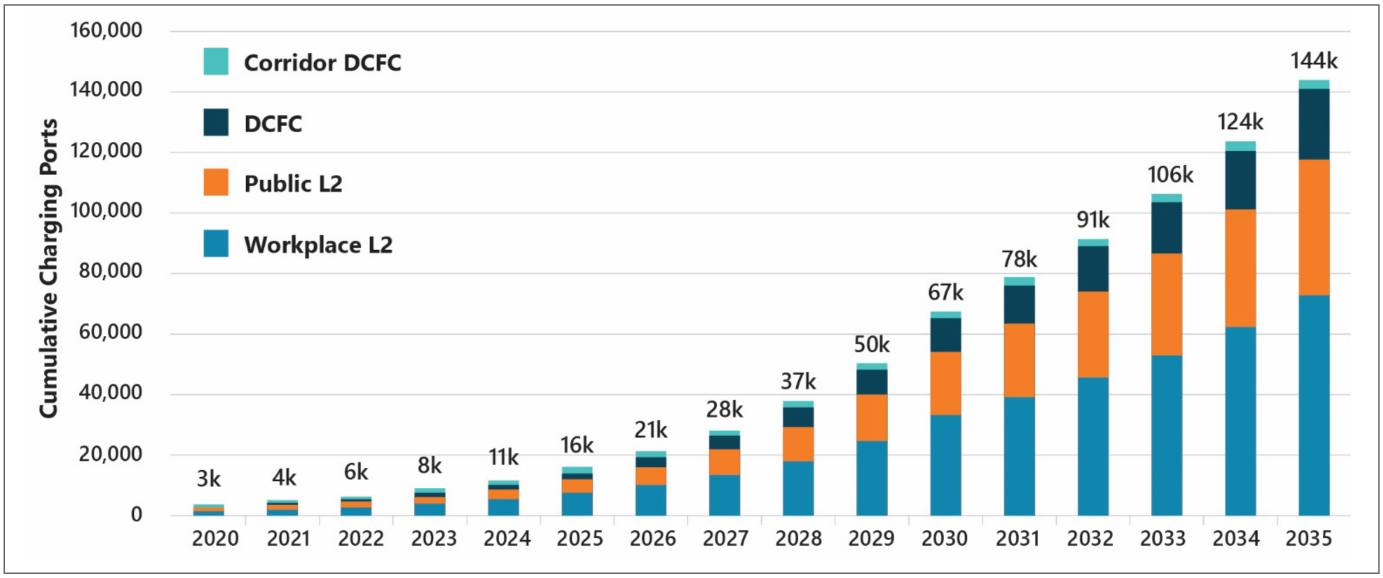
ODOT's Transportation Electrification Infrastructure Needs Analysis (TEINA) developed scenarios to examine Oregon's future needs for EV charging infrastructure, across nine use cases. The Business as Usual Scenario findings summarized in **Figure 25** estimate that:

- By 2025, Oregon will require nearly 12,000 workplace and public Level 2 charging ports and over 4,000 public DCFC charging ports to support anticipated electric cars, SUVs and light-duty trucks.

- By 2030 this need grows to 54,000 workplace and public Level 2 ports, and over 13,000 public DCFC ports, for a total of approximately 67,000 charging ports throughout the state.

- Exponential growth continues under the Business As Usual scenario, reaching an estimated total need of approximately 144,000 charging ports by 2035.
- At the start of 2023, Oregon had approximately 1,580 public Level 2 and 480 public DCFC ports, indicating the rapid pace and large scale of deployment required to meet both near- and medium-term TEINA goals.

Figure 25. Estimated statewide EV charging ports required to meet Oregon light-duty ZEV goals



Last updated 7/28/2023

TEINA Dashboard

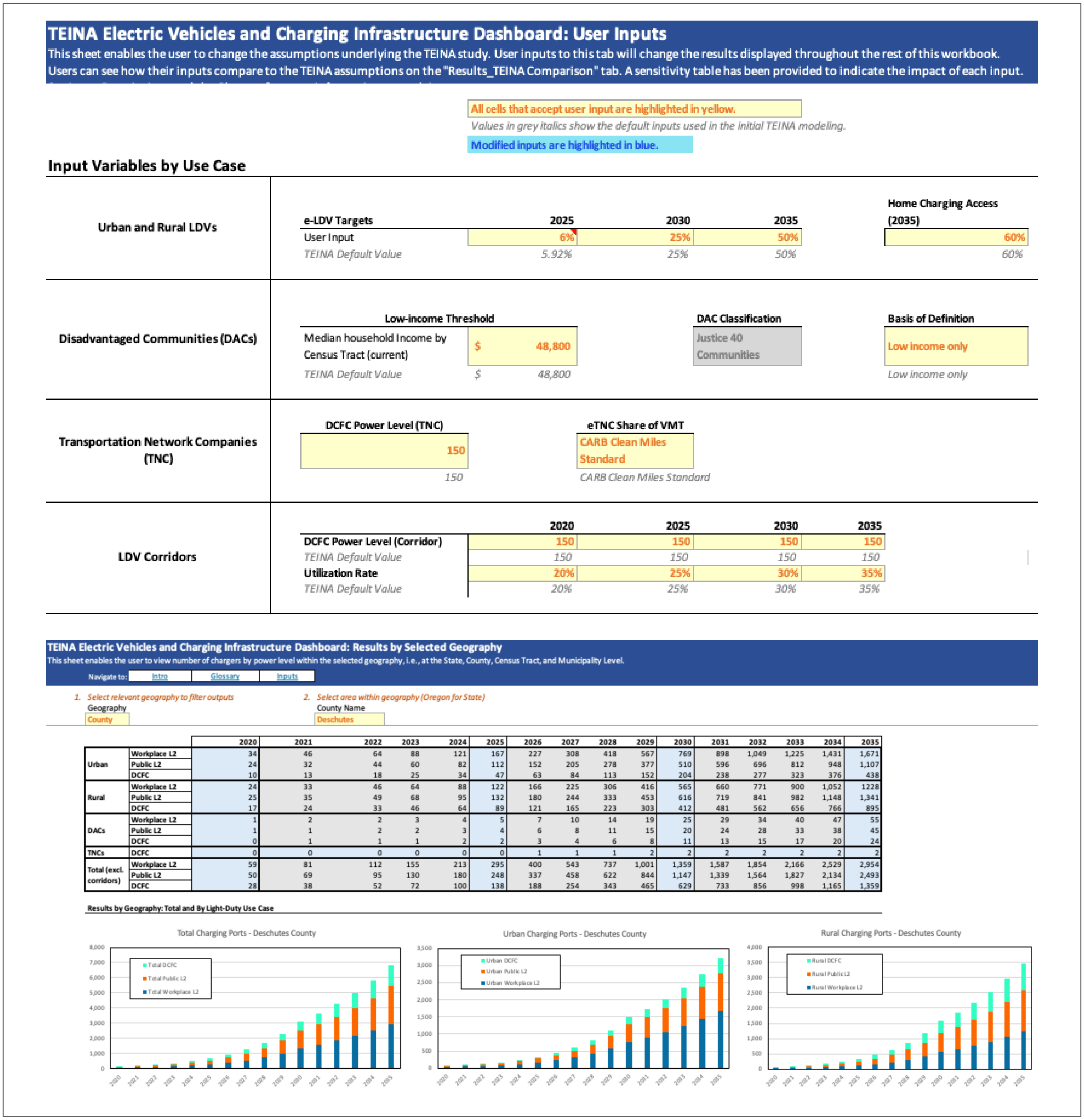
To understand how local projections of EVs in a jurisdiction translate into anticipated numbers of EV chargers needed (what types and when) and compare to the TEINA EVSE estimates for specific parts of Oregon, local decision makers can use the TEINA Dashboard—a user-friendly, Microsoft Excel tool developed by ODOT—to explore the anticipated charging needs in their area.

The Dashboard is structured to allow local planners to focus on specific geographies such as counties, cities, and census tracts to determine anticipated EV charging required for an area from 2020 through 2035. Estimates predict the level of EVSE required in order to support EV adoption in line with Oregon's ZEV goals (incorporated into the TEINA study) of 250,000 registered ZEVs by 2025; both 25% of total vehicle registrations and 50% sales share by 2030; and 90% of new vehicle sales annually by 2035[55]. However, users can also vary inputs to explore how different, local assumptions could impact EVSE needs—for example, adjusting the anticipated level of EV adoption in the local jurisdiction, or the proportion of light-duty vehicles that are expected to be charged at least partially at residences in the local jurisdiction.

Figure 26 highlights two of the primary workbook tabs that will be of interest to local planners, 1) the model inputs tab, where users can adjust several key inputs; and 2) the tab showing results by a user-selected geography (here showing estimated EVSE needs for Deschutes County as an example).

55 *Advanced Clean Cars II regulations have surpassed prior statutory goals, with regulation of 100% of new vehicle sales to be ZEVs in 2035.*

Figure 26. TEINA Dashboard: user interface (top) and example results for Deschutes County (bottom)



		2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034	2035
Urban	Workplace L2	34	46	64	88	121	167	227	308	418	567	769	898	1,049	1,225	1,431	1,671
	Public L2	24	32	44	60	82	112	152	205	278	377	510	596	696	812	948	1,107
	DCFC	10	13	18	25	34	47	63	84	113	152	204	238	277	323	376	438
Rural	Workplace L2	24	33	46	64	88	122	166	225	306	416	565	660	771	900	1,052	1228
	Public L2	25	35	49	68	95	132	180	244	333	453	616	719	841	982	1,148	1,341
	DCFC	17	24	33	46	64	89	121	165	223	303	412	481	562	656	766	895
DACs	Workplace L2	1	2	2	3	4	5	7	10	14	19	25	29	34	40	47	55
	Public L2	1	1	2	2	3	4	6	8	11	15	20	24	28	33	38	45
	DCFC	0	1	1	1	2	2	3	4	6	8	11	13	15	17	20	24
TNCs	DCFC	0	0	0	0	0	0	1	1	1	2	2	2	2	2	2	2
Total (excl. corridors)	Workplace L2	59	81	112	155	213	295	400	543	737	1,001	1,359	1,587	1,854	2,166	2,529	2,954
	Public L2	50	69	95	130	180	248	337	458	622	844	1,147	1,339	1,564	1,827	2,134	2,493
	DCFC	28	38	52	72	100	138	188	254	343	465	629	733	856	998	1,165	1,359

ODOT intends the TEINA Dashboard to be a useful resource for providing local planners and other stakeholders with a detailed perspective on the level of EVSE required in their area to support state EV adoption goals, and also to enable local planners to explore alternative assumptions and assess how that affects the mix of EVSE needed as well as when they will be needed. The TEINA Dashboard breaks out TEINA projections annually (versus milestone years) and enables local projections annually, as well. At the local level it will be essential for decision makers to understand how these estimates of EVSE needs should be met for the specific communities and populations to be served. The TEINA Dashboard is housed on ODOT's Go EV Charge webpage and can be downloaded for use. Instructions for use are included in the Dashboard, and an explanatory video can be found on the webpage.

Understanding Community Needs

Effective planning for EVSE should include consideration of current and anticipated future needs from the local community, as different areas will require both different amounts of EVSE and also deployment at different location types. **Table 15** summarizes the primary characteristics that help to determine the types and locations of EVSE likely to benefit the local population.

Table 15. Community Characteristics to Determine EV Charging Needs

Consideration	Key Question(s)	Implications
Mobility Patterns	What are the primary trip types and destinations for the community? What are the primary modes of transport for residents, visitors, and the local workforce? What vehicle types are prominent?	Distance traveled for typical trips is a key input for understanding charging needs. Longer average trip length requires more and/or higher power EVSE. Level of reliance on single-occupancy vehicles directly affects the need for light-duty EV charging. Higher reliance on personal cars translates to more or higher power EVSE for those vehicles. Denser urban areas can reduce charging needs by promoting public transit, shared mobility options, and active modes of transportation. Transit stations can also serve as charging hubs to support electric multimodal trips. Areas with a high concentration of specific vehicle types (e.g., pickup trucks towing trailers) may require specific charging station layouts.[56] Stations accommodating larger vehicles should include pull-through charging spaces.
Land Use and Housing Composition	How urban, suburban, or rural is the area? What proportion of housing is single- vs. multi-family units?	EVSE deployments in rural areas may face more technical constraints if/where the electric grid and telecommunications infrastructure is less developed.[57] Utility engagement is critical for understanding capacity and project timelines. Areas with more multi-family housing may require dedicated programs to provide charging for residents, either on-site or through additional public or shared charging. Off-site options can include longer dwell time locations where Level 1 and 2 charging will be sufficient; EVSE sited in the public right-of-way; and/or DCFC hubs developed to augment residential charging in areas with high housing density. Residents of more rural areas may drive longer distances and therefore may require more frequent non-residential charging. Options include additional workplace charging (Level 1 or 2) as well as public Level 2 and DCFC.

[56] https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-planning/planning-types.
[57] https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-planning/planning-types.

Table 15. Community Characteristics to Determine EV Charging Needs (cont.)

Consideration	Key Question(s)	Implications
Local Economy	What are the main sources of economic activity in the area? Are there emerging industries or other opportunities that will change the local economy? How does this impact travel patterns and mobility needs? Are there large public or private fleets located/operating in the area?	Job centers and/or large employers such as office parks, shopping malls, and industrial or manufacturing hubs provide opportunities for concentrated deployments of workplace charging. Local planners may wish to engage employers and collaborate to develop charging solutions that can benefit the local workforce. Areas with significant tourism will need to develop EVSE for visitors, who often have distinct travel patterns and charging needs from residents and employees.[58] Charging stations can also help to attract visitors or other customers to retail locations, providing a new source of revenue for local businesses. A large proportion of fleet charging will take place at dedicated depots; however, depending on fleet operating patterns, additional public charging may be required. Planners may wish to consult fleet operators in the area to understand their needs and expectations for EV charging.
Equity	Are there marginalized or disadvantaged populations in the community? What are the specific needs and characteristics of these populations? Do certain areas of neighborhoods lack EVSE, creating "charging deserts" that need to be addressed?	The needs of disadvantaged populations should be prioritized to ensure the entire community can benefit from the transition to EVs. Planning for EVSE deployment should include early and ongoing engagement with representatives of any marginalized populations. Public funding—whether federal, state, or local—will often be needed to develop EV charging options for communities less likely to be served by the private sector absent policy and/or funding support. Local planners may wish to prioritize development of EVSE that improves charging access for marginalized communities, including targeting charging deserts that limit residents' ability to benefit from EVs. Design of EV charging locations must account for the needs of individuals with disabilities. Pricing of EV charging services must not be cost-prohibitive for lower income community members.
Climate and Weather	What types of inclement weather are common? Does the area experience extreme temperatures throughout the year?	Charging locations should provide adequate shelter from common weather conditions. More EVSE may be required in areas with extreme temperatures due to decreased battery efficiency.

[58] https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-planning/planning-types.

Supporting Resources and Funding Pathways

Once community needs have been assessed, local planners may wish to identify supporting resources and funding for deploying EVSE. Many federal, state, and utility programs are currently providing support for the deployment of EVSE in Oregon. These resources—financial and otherwise—will be critical for enabling local governments to spur development of EVSE within their jurisdictions. **Table 16** summarizes many of the programs, policies, and resources available to local planners and EVSE developers to support EV charging deployment.

Table 16. Programs and Policies Supporting EVSE Deployment in Oregon

Program or Policy	Implementer[59]	Type	Overview
Federal			
National EV Infrastructure Program (NEVI)	Joint Office of Energy and Transportation (JOET)	Formula Funding	Federal formula program allocating funds to state Departments of Transportation for development of DCFC along major highway corridors. Oregon will receive $52 million over five years, for a total of $65 million including the required 20% non-federal match. See Oregon's initial NEVI plan here.
Carbon Reduction Program	ODOT	Grant Funding	The Bipartisan Infrastructure Law (BIL) will provide Oregon $82 million over five years to fund projects that reduce greenhouse gas emissions from transportation. Of that $82 million, ODOT is conducting a $24 million grant program over two years for areas of the state with less than 200,000 residents. The program can fund alternative fuel projects, including public EV charging, hydrogen, natural gas and propane fueling and zero-emission equipment and vehicle purchases.
Charging and Fueling Infrastructure Grants (IIJA Section 11401)	US Department of Transportation (USDOT)	Grant Funding	$2.5 billion, five-year competitive grant program for public entities (e.g., states, local governments, metropolitan planning organizations, Tribes) to apply for funding to develop EV charging or other alternative fueling stations. 50% of total program funding must go to the community grant portion, which prioritizes deployment in rural and low to moderate income communities. The remaining program funding is available for development of EVSE or other alternative fueling stations along designated Alternative Fuel Corridors.
Energy Efficiency and Conservation Block Grants (EECBG)	US Department of Energy (USDOE)	Grant Funding	The IIJA Section 40552 provides $550 million for the EECBG Program for fiscal year (FY) 2022, to remain available until the funds are expended. The program is designed to assist state, local governments, and Tribes implementing strategies to reduce energy use, to reduce fossil fuel emissions, and to improve energy efficiency through grants. The purchase and installation of EV charging stations and equipment is considered an eligible activity.

[59] **JOET**: *Joint Office of Energy and Transportation* | **FHWA**: *Federal Highway Administration* | **IRS**: *Internal Revenue Service* | **ODOT**: *Oregon Department of Transportation* | **DEQ**: *Department of Environmental Quality* | **ODOE**: *Oregon Department of Energy* | **COU**: *Consumer-Owned Utility* | **OPUC**: *Oregon Public Utility Commission* | **IOUs**: *Investor-Owned Utilities* | **PGE**: *Portland General Electric.*

Table 16. Programs and Policies Supporting EVSE Deployment in Oregon (cont.)

Program or Policy	Implementer[59]	Type	Overview
Port Infrastructure Development Program (PIDP)	USDOT	Grant Funding	PIDP is a discretionary grant program in which funds are awarded on a competitive basis to projects that improve the safety, efficiency, or reliability of the movement of goods into, out of, around, or within a port. In FY 2023, the BIL appropriated $450 million to the PIDP. An additional $212,203,512 was made available to the program under the FY 2023 Consolidated Appropriations Act, resulting in a total of $662,203,512 in FY 2023 PIDP grant funding. Eligible projects must be located within or outside the boundary of a port and directly relate to port operations or to an intermodal connection to the port. Grants may be made for capital projects that will be used to improve the safety, efficiency, or reliability of EV charging or hydrogen refueling infrastructure for drayage and MHD trucks and locomotives that service the port and related grid upgrades.
Alternative Vehicle Refueling Tax Credit	Internal Revenue Service (IRS)	Tax Credit or Direct Payment	Up to 30% tax credit for residential and commercial charging stations that meet certain qualifications, with maximum values of $1,000 and $100,000, respectively. Available to tax-exempt entities (e.g., local governments) through "direct pay" provisions.[60]
State			
Community Charging Rebates (CCR) Program	ODOT	Incentive	Rebate-based program providing reimbursable cash incentives for public and private entities to install Level 2 charging at public parking locations and at multi-family housing. Multiple rounds of funding; initial round $1.75 million, launched June 2023.
Clean Fuels Program	Oregon Department of Environmental Quality (DEQ)	Incentive	Market-based credit and debit system for reducing the carbon intensity of transportation fuels in Oregon over time. The Clean Fuels Program (CFP) provides a mechanism for operators of EV charging stations to earn significant revenues, depending upon the carbon intensity of electricity provided, and accordingly serves as an important incentive for deploying EVSE.
Transportation Electrification Plans	Oregon Public Utility Commission (OPUC) & Investor Owned Utilities (IOUs)	Investment; Incentive	Triennial plan submission to OPUC by IOUs, proposing programs and investments to support transportation electrification.
Public Purpose Charge Schools Program	Oregon Department of Energy (ODOE)	Incentive	Incentive program supporting EV and EVSE procurement (and energy efficiency investments) by school districts within PGE and PacifiCorp service territories.

[60] *Maximum commercial tax credit only available for EVSE deployments in rural or low-income census tracts.*

Table 16. Programs and Policies Supporting EVSE Deployment in Oregon (cont.)

Program or Policy	Implementer[59]	Type	Overview
TEINA Report and Supporting Tools	ODOT	Information & Education	Analysis of EVSE needs required to meet state ZEV adoption goals, including the TEINA Dashboard and online EV Infrastructure Planning Map to enable local planners to prioritize charging deployment.
Consumer-Owned Utility (COU) EV Mapping Project	ODOE	Information & Education	Mapping and planning tool for COUs that shows general locations of where EVs are charging on their systems, using utility distribution system data and ODOT vehicle registration data.
Data and Educational Resources	ODOE	Information & Education	ODOE provides various datasets and other informational resources through its EV Dashboard, Go Electric Oregon website, Biennial ZEV and Energy reports.
Electric Utilities			
Residential and Business EV Charging Rebates	PGE	Incentive; Drive Change Fund	Rebates for Level 2 EVSE and panel upgrades for residential customers, and for Level 2 or DCFC EVSE for commercial customers.
Residential EV Charging Rebates and Business Grants	PacifiCorp	Incentive; Oregon Electric Mobility Grant	Rebates for Level 2 EVSE for residential customers—including multi-family housing owners, and business customers as well as grant funding for studying, planning, promoting, or deploying EVSE.
Residential and Business EV Charging Rebates	Multiple COUs and Co-ops	Incentive	Public utilities throughout Oregon offer EVSE charging incentives; a complete list can be found on the Go Electric Oregon website. Several incentives offered by specific utilities are noted below, in this table.
Fleet Partner Program	PGE	Incentive, Technical Assistance	Program providing technical assistance, custom make-ready incentives, and design / construction services for fleets.
CEC Electric Vehicle and Charger Rebate Program	Central Electric Co-op	Incentive	Rebates for Level 2 EVSE and panel upgrades for residential customers, increased incentives for BPA qualified Level 2 EVSE.
EV Charging Station Rebate	Central Lincoln PUD	Incentives	Rebates for Level 2 EVSE for residential and business customers.
Commercial and Workplace Charging Incentive	City of Ashland	Incentives	Rebates for Level 2 EVSE for commercial and workplace charging stations.
Level 2 (240V) Electric Vehicle Charger Rebate	Columbia River PUD	Incentives	Rebates for Level 2 EVSE (customer type either residential or commercial not specified).

Table 16. Programs and Policies Supporting EVSE Deployment in Oregon (cont.)

Program or Policy	Implementer[59]	Type	Overview
CPI Residential EV Rebate	Consumer Power, Inc.	Incentives	Rebates for Level 2 EVSE for residential customers.
Rebates for Your Home: Level 2 Electric Car Charger	Emerald PUD	Incentives	Rebates for Level 2 EVSE for residential customers.
Smart Charger Rebates	Eugene Water and Electric Board	Incentives	Rebates for Level 2 and DCFC EVSE for residential and commercial customers.
Residential EV Charging Program	Midstate Electric Cooperative	Incentives	The utility will provide a Level 2 EVSE to residential customers with compliance of the programmatic requirements.
Residential Level 2 Electric Vehicle Charger Incentive	Salem Electric	Incentives	Rebates for Level 2 EVSE for residential customers
Residential Level 2 Electric Vehicle Charger Rebate	Springfield Utility Board	Incentives	Rebates for Level 2 EVSE for residential customers,
Residential and Commercial EV Charger Rebate	Tillamook PUD	Incentives	Rebates for Level 2 EVSE for residential and commercial customers.

Last updated: 7/28/2023

At the federal level, two recent pieces of federal legislation have provided renewed funding opportunities for EVSE deployment. The Infrastructure Investment and Jobs Act (IIJA) of November 2021 established a $5 billion program for deploying DCFC along highways throughout the U.S., the National EV Infrastructure program, or NEVI, of which Oregon will be receiving $52 million over five years. Additionally, the IIJA dedicated $2.5 billion for a competitive, five-year Charging and Fueling Infrastructure grant program, which public entities can use to deploy EVSE or other alternative fueling stations. This program is split into two portions, the Corridor Charging Grant program and the Community Charging Grant program, which focus on developing EV charging or other alternative fueling stations along designated Alternative Fuel Corridors and within communities, respectively. A minimum of 50% of the $2.5 billion ($1.25 billion) must be spent developing EV charging or other alternative fueling infrastructure within communities, with priority given to rural areas, low- and moderate-income neighborhoods, and communities with a low ratio of private parking spaces.[61] More recently, the Inflation Reduction Act of August 2022 renewed and expanded the Alternative Fuel Vehicle Refueling Property Credit, which provides a tax credit of between 6% and 30% for residential and commercial charging stations located within low-income or non-urban census tracts, with maximum values of $1,000 and $100,000, respectively. Importantly, despite being tax-exempt entities, local governments can take advantage of this incentive through direct pay provisions[62].

[61] https://www.transportation.gov/rural/ev/toolkit/ev-infrastructure-funding-and-financing/federal-funding-programs.
[62] https://www.irs.gov/credits-deductions/elective-pay-and-transferability-frequently-asked-questions-elective-pay and https://www.irs.gov/newsroom/irs-releases-guidance-on-elective-payments-and-transfers-of-certain-credits-under-the-inflation-reduction-act.

The state of Oregon is also providing financial, technical, and educational support for EVSE in recognition of the rapid scaling required to enable EV adoption in line with legislated goals. In addition to administering and distributing the NEVI funds provided by the federal government for DCFC corridor charging, ODOT has launched a Level 2 charging incentive—the Community Charging Rebates (CCR) program—which provides cash incentives for installing Level 2 charging in publicly accessible locations and at multi-family housing. Additionally, the Department of Environmental Quality administers Oregon's Clean Fuels Program, a market-based credit and debit system which provides significant revenues for operators of EV charging stations. The Oregon Public Utility Commission regulates investor-owned utilities and approves the development of the regulated utilities' Transportation Electrification plans designed to support the transition to electric transportation in their service territories. Finally, the Oregon Department of Energy produces key reports on electrification and shares information and educational resources with the public as part of their specialization as data and analysis experts for both EVs and electricity.

ODOE's Electrification Resources

The Oregon Department of Energy (ODOE) also plays a key role in transportation electrification by serving as a central hub for EV and electrification data. ODOE uses its data on EV adoption—by population, income, race and dwelling—to better understand adoption trends and inform policy discussions to address equitable access to EVs. ODOE has also developed several resources to educate Oregonians, increase awareness of EVs and their benefits, and provide tracking and trending data to assess Oregon's progress on its goals.

- ODOE's Go Electric webpage provides insight on EVs, charging, incentives, and benefits.
- The Biennial Zero Emission Vehicle Report (BiZEV) assesses the state of transportation electrification in Oregon such as EV adoption, demographic analysis of EV adopters, and the efforts of electric utilities to meet the state's future EV needs. The next BiZEV will be published on September 15, 2023.
- The Biennial Energy Report (BER) includes policy analyses on options to reduce emissions from the transportation sector, and an overview of EVs, fuel cell EVs, and charging stations. The next BER will be published on November 1, 2024.
- ODOE's Dashboard displays data on EV registrations and charger locations as well as a cost and emissions analysis tool for drivers.
- Through its Consumer Owned Utility EV Mapping Project, ODOE maps EVs in consumer-owned utility territories, providing critical data that will better enable utilities to plan for distribution system upgrades and prepare their local grids for rapid EV adoption. The project is available to any COU at no cost, through ODOE's application portal.
- ODOE tracks and posts the generation resources used to supply Oregon's electricity. The Electricity Resource Mix is published annually, and the information presented informs the emissions reductions associated with charging an EV in Oregon.
- ODOE's Alternative Fuel School Bus Cost Analysis Tool helps school districts assess fuel and maintenance savings by switching to electric or other alternative fuel school buses.
- ODOE will be developing an Oregon Statewide Energy Strategy that will identify pathways to achieving the state's energy policy objectives, informed by robust stakeholder engagement, and serving as a resource over time through continued analysis and engagement to help the state achieve emissions reductions in line with state energy and climate policy goals.

DEQ's Clean Fuels Program

Oregon's Clean Fuels Program (CFP) provides an important incentive for deployment of EV charging in the state. The Department of Environmental Quality (DEQ) has administered this program since its inception in 2016. The program requires regulated parties to reduce the average carbon intensity of their fuels over time using a market-based system of credits and deficits to cost-effectively reduce greenhouse gas emissions. Importers of some fuels such as gasoline and diesel are required to participate in the program while parties involved in producing or distributing alternative fuels may elect to participate. **Table 17** summarizes how different fuels are treated in the program.

Table 17. Oregon Clean Fuels Program

CFP Participation	Fuel	Participating Party
Mandatory	Gasoline, diesel, ethanol, biodiesel, renewable diesel	Importer
Voluntary	Fossil-based natural gas and propane	Owner of dispenser
	Renewable natural gas and propane, and sustainable aviation fuel	Producer or importer
	Electricity	charger owner or electric utility
	Hydrogen	Owner of fuel

Regulated entities must demonstrate compliance with the CFP's declining carbon intensity schedule on an annual basis. DEQ approves fuel-specific carbon intensities and those that are lower than the annual intensity standard generate credits, while those that are higher generate deficits. Both are measured in metric tons of greenhouse gas emissions. Regulated entities must retire enough credits to offset the number of deficits they have generated. This can happen by the transfer of credits from a registered party or by purchasing them.

Producing or dispensing lower carbon fuels—such as electricity dispensed from a charger—generates CFP credits. When sold, they create an incentive that helps to offset the costs of developing and operating EV charging stations. Credit prices vary based on market dynamics (i.e., credit supply and demand), but the value provided to charger owners and other eligible electricity credit generators is substantial. DEQ publishes credit prices on a monthly basis at this website.

There are three types of clean fuels credits: 1) base credits; 2) incremental credits; and 3) advance credits.

- **Base credits** are calculated as the difference between the carbon intensity of gasoline (for light-duty vehicles) or diesel (for medium- and heavy-duty vehicles) and the utility's electricity mix.
- **Incremental credits** are generated when qualifying renewable energy certificates (RECs) are purchased and retired, which brings the carbon intensity of electricity to zero.
- **Advance credits** are the result of an agreement made between DEQ and a public entity such as a transit agency, school district, a local government, or a tribe to generate up to 6 years' worth of credits at the beginning of a project. The amount of advance credits is calculated by estimating the amount of electricity that will be dispensed to a fleet over the specified longer period of time and are paid back on a quarterly basis until the advance reaches zero. Advance credits are also eligible for projects that are funded under the Bipartisan Infrastructure Law such as the National Electric Vehicle Infrastructure program.

Electric Utilities and Oregon Public Utility Commission

Oregon's electric utilities are also providing various forms of support for EVSE. Both public and investor-owned utilities (IOUs) throughout the state are offering incentives for EVSE, and some also provide rebates for new electric panels given this electric service upgrade is frequently required by the new load from EV charging. Many of the electric utilities' supportive efforts are noted in **Table 16**:

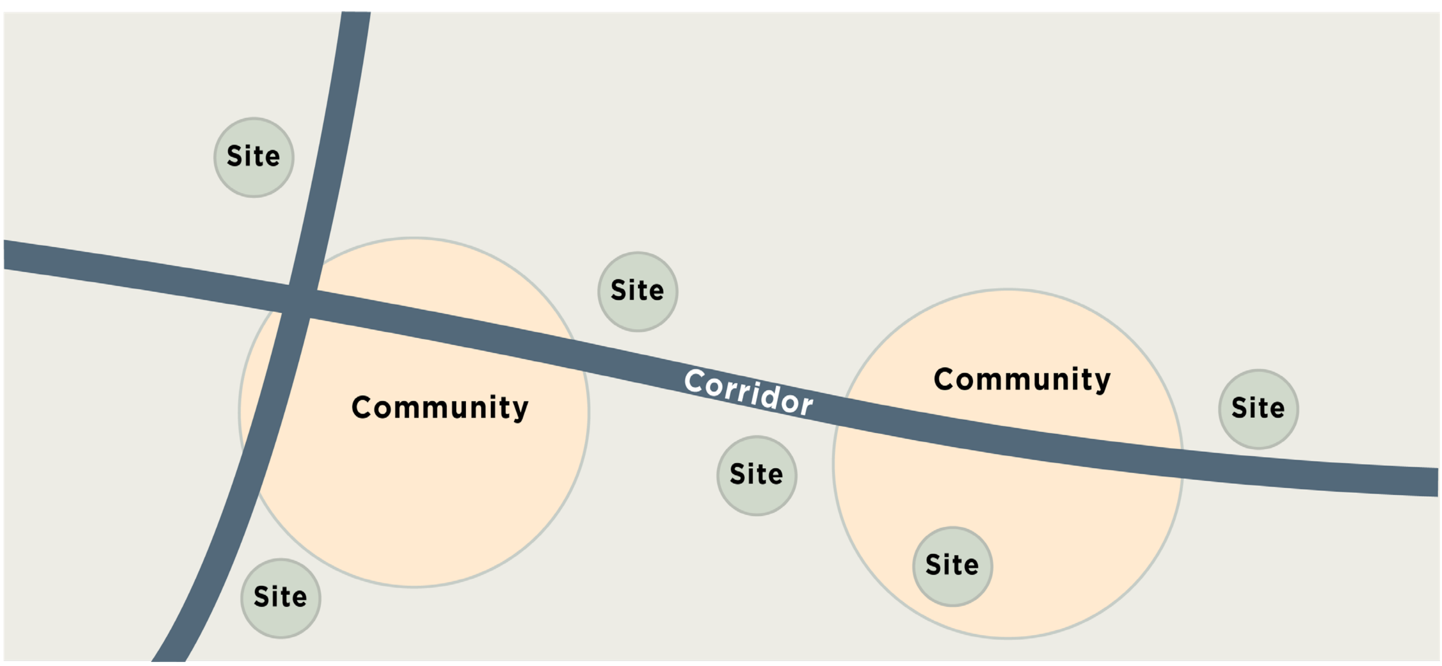
Programs and Policies Supporting EVSE Deployment in Oregon. Additionally, the Oregon Public Utility Commission requires the state's three electric IOUs to submit triennial Transportation Electrification Plans, which propose programs and investments to support EV adoption and charging infrastructure support in their service territories.

Strategic Planning and Prioritization

Equipped with information and answers derived from the previous three steps—projecting EV charging requirements; understanding community characteristics to determine specific needs; and identifying funding and other supporting resources—local planners can develop a strategic plan for prioritizing EVSE deployment in their area. As discussed in Chapter 3, this strategic planning will be most effective if incorporated into broader planning initiatives such as general, capital improvement, climate action, and transportation improvement plans. Information from this Guide's companion resources and tools (including the TEINA Dashboard), as well as insights from a community needs assessment, can help inform the specific approach that will best suit local conditions.

As part of this holistic planning, local governments may wish to consider the EVSE needs in their area as an integrated system. The U.S. Department of Transportation provides a useful comparison of how different types of EVSE planning and deployment interact and overlap at the local level (**Figure 27**). A holistic, strategic plan should consider the distinct needs and considerations for different types of EVSE development within the same region or area, identifying synergies as well as potential areas of conflict (e.g., compounding impacts on the local electricity distribution system).

Figure 27. Community, Corridor and Site

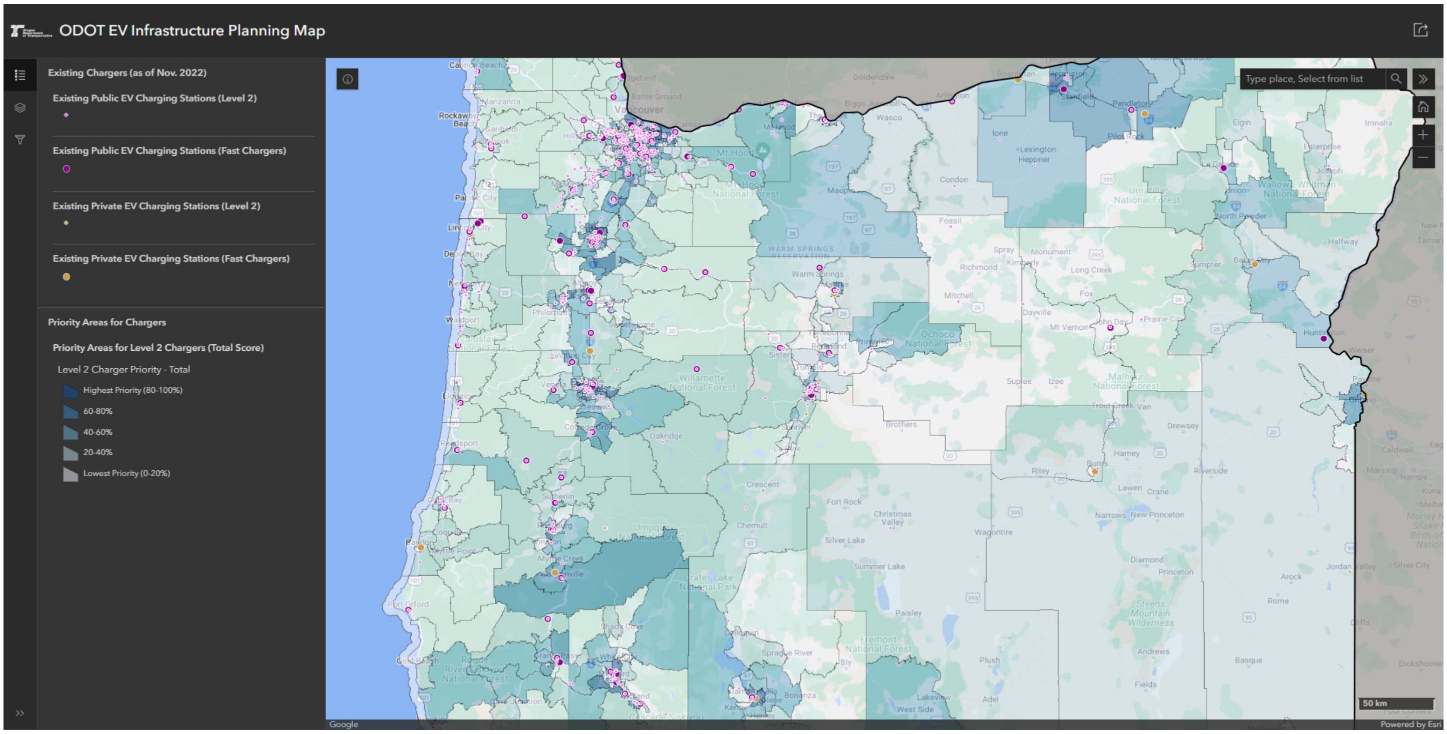


EV Infrastructure Planning Map

To enable local governments to more easily prioritize EVSE deployments within their jurisdictions, ODOT has developed an EV Infrastructure Planning Map, an image of which is presented in **Figure 28,** that planners can use to combine the elements described throughout this chapter. The [EV Infrastructure Planning Map] is a GIS-based online application that allows users to view EV infrastructure prioritization scores for L2 and DCFCs in each Oregon census tract. An example output from this tool is presented in **Figure 28**. The tool provides several important pieces of information necessary for effectively developing a strategic prioritization approach, including two levels of EVSE planning:

- Multiple mapping layers of contextual data, such as vehicle registrations and vehicle miles traveled; housing characteristics; population and employment density; several different equity indicators; and the location of high-traffic activity centers.
- Two different layers of EVSE Priority Areas—one each for public L2 and public DCFC. Priority Area scores incorporate numerous metrics from the contextual data layers—such as existing EVSE; vehicle registrations; vehicle miles traveled; density of multi-family housing; air quality; and composite equity indicators—into a prioritization calculation which ranks and weights different factors to provide planners with a detailed sense of where different types of EVSE are most needed within their jurisdiction.

Figure 28. ODOT EV Infrastructure Planning Map



This tool is intended for use by state and local agencies; municipal planners; EVSPs; electric utilities; commercial businesses; landowners and developers; and other stakeholders to provide insight into the equity impact, charging gaps, and expected utilization of EVSE installed in each census tract through the EVSE Priority Area layers. The Priority Area scores are based on independent equity, gaps, and utilization scores, which are further calculated using relevant census-level metrics as described in **Table 18.** These metrics are scored using a quantile classification method across all values for each metric, assigning a score out of 100% in increments of 25% to each tract based on the quantile in which the specific value falls. For example, total light duty vehicle registrations by census tract in Oregon fall between 0 and 9,944, with quartile values of 2,440, 3,200, and 4,200. A census tract with 2,700 vehicle registrations would thus be allocated a vehicle registration score of 0.5 as the value falls within the second quartile (Q2).

Table 18. Priority Area Scoring

	Scoring Metrics	Descriptions
Utilization	Vehicle Registrations	All registered passenger vehicles
	Vehicle Miles Traveled (VMT)	Total highway VMT (Level 2) and long-distance highway VMT (DCFC).
	Activity Centers	Presence of business centers, park-n-rides (Level 2), and rest stops (DCFC).
Charging Gaps	Multi-family Housing (MFH) Demand	Number of MFH Units
	TEINA 2025 Port Needs	Share of 2025 TEINA Level 2 or DCFC ports achieved
	Multi-family Housing (MFH) Density	Share of total housing units classifying as MFH
Equity	PM 2.5	PM 2.5 ppm concentration
	Ozone	Ozone concentration
	Disadvantaged Communities (DAC)	ODOT DAC Classification (Med-High or High)

While ODOT has provided the Priority Area scores in this tool as a useful planning resource, the inclusion of various contextual layers is intended to allow planners to more easily hone in on the siting considerations most important to their community. For example, denser urban areas with high concentrations of MFH will require more public or community charging than areas with larger concentrations of single-family homes. This is shown in the Priority Area mapping layers but local planners may wish to further emphasize community charging hubs or MFH deployments, depending on the characteristics and needs of residents, employees, and visitors. For more information on how to use the EV Infrastructure Planning Map, ODOT has published a User Guide and Methodology document as well as an explanatory video, available on ODOT's GO EV Charge webpage.

6. Priority Focus Areas for EVSE

Achieving Oregon EV drivers' EVSE needs and local and statewide transportation electrification goals will take concerted effort and collaboration between many different entities, including not only state and local agencies, but also tribal governments, community-based and other nongovernmental organizations, private sector players such as EV service providers and EVSE manufacturers, grocery and convenience store owners, gas stations, electric utilities, and building developers, among others. In the interest of aligning these diverse players around a common set of priorities, this chapter lays out several of the EVSE deployment types and locations which have strong potential for both expanding EV charging access to more Oregonians and catalyzing more rapid transformation of this market.

Infrastructure Deployment Priority Actions—TEINA 2021

The 2021 TEINA report concluded with three categories of infrastructure implementation priorities:

- Focus on light-duty zero emission vehicle EVSE for urban, rural, and corridor use cases.
- Support on-site depot charging for public and private fleet electrification.
- Plan for and support medium- and heavy-duty zero emission vehicle charging.

Because this Guide focuses specifically on light-duty ZEVs, this chapter provides additional detail on several of the priority implementation opportunities within the first of the three categories above. Within that category the TEINA report segmented recommendations into different priorities for urban, rural, and corridor charging, following several of the primary light-duty EV use cases explored in that analysis. Addressing equity by providing additional charging access for disadvantaged communities—another critical consideration in the TEINA analysis—is incorporated within the recommendations for urban and rural charging deployment, as is the specific use case of transportation network companies (TNCs). **Table 19** provides a summary of these EVSE deployment priorities.

Table 19. TEINA Infrastructure Deployment Priority Recommendations

Light-duty EV Use Case	Recommendation
Urban	Develop Level 1 and Level 2 community charging sites (long duration charging; important for MFH residents).
	Locate public Level 2 and DCFC on public property with existing power capacity, especially in low-income, BIPOC, and disadvantaged communities.
	Prioritize workplace charging at large and women/minority-owned employers.
	Address urban charging deserts by prioritizing urban DCFC hubs that serve multiple needs (MFH, TNC drivers)
Rural	Address rural charging deserts by prioritizing rural corridor, tourism, destination, and public Level 2 charging.
	Focus on Level 2 charging ports within rural communities and at key tourism destinations.
Corridor	Expand Oregon's highway corridor DCFC network across all federal and state highways, considering especially BIPOC access to long-distance travel.

Since the publication of the TEINA report, two landmark pieces of legislation have been passed by the U.S. Congress—the Infrastructure Investment and Jobs Act and the Inflation Reduction Act—both of which include significant support, funding mechanisms, and/or incentives for deploying EVSE. Additionally, as highlighted in the previous chapter, there are multiple Oregon and utility funding opportunities and support mechanisms to help pay for and deploy EVSE, making the current moment a unique opportunity for public and private stakeholders to collaborate and significantly expand the EV charging ecosystem in Oregon.

Understanding how many and what type of EV chargers are needed in a specific geography or local jurisdiction, in both the near term and future, can help city, county, utility and other planners make better plans for implementing EV charging infrastructure locally. The TEINA Dashboard and the EV Infrastructure Planning Map are tools developed by ODOT that can aid in this process[63].

Based on both anticipated impact and risk of underinvestment absent focused attention, stakeholders will want to specifically prioritize deploying EVSE following several of the TEINA priorities, specifically at multi-family housing, workplaces, and in current charging deserts. The following sections describe the specific actions that different parties can take to support these deployments, all of which are critical to success.

Light -duty Vehicle Implementation Priorities for EVSE

Develop programs and policies to support EV charging at multi-family housing.

While TEINA focused primarily on public and workplace charging needs, a fundamental assumption in that analysis was that a large share of EV drivers would have access to home charging—90% in 2020 (45,000 home charging ports), dropping to 60% by 2035 (1.5 million home charging ports). According to the U.S. Census Bureau's 2021 American Community Survey, approximately 390,000 (21%) of Oregon's 1.84 million total housing units are in a building with three or more units.[64] To ensure that a high proportion of Oregonians have access to home charging, significant effort is therefore required to provide EVSE at multi-family housing throughout the state. There are several key actions that should be taken to enable this; these are itemized in **Table 20**.

63 *For more information on how to use the TEINA Dashboard and the EV Infrastructure Planning Map, ODOT has published a User Guides, Methodology documents, as well as video tutorials, available on ODOT's website -- GO EV Charge.*

64 *https://data.census.gov/cedsci/table?q=DP04&g=0400000US41.*

Table 20. Deploying EVSE at Multi-Family Housing

Action	Key Player(s)
Dedicate funding for developing EVSE at MFH, prioritizing areas with larger proportions of low-to-moderate income residents.	ODOT, OPUC, electric utilities, local and tribal governments
Provide additional education and outreach to building owners/managers.	ODOE, ODOT, EV advocates, local planners and tribal governments
Develop MFH products, services, and marketing materials and initiate campaigns to engage building owners and/or developers throughout Oregon.	EVSPs, EVSE manufacturers, EV advocates
Increase technical assistance from electric utilities for building owners/managers exploring MUD charging deployment.	OPUC, electric utilities
Survey residents to understand interests, familiarity, and future plans regarding EVs and EV charging.	Building owners and developers

Promote workplace charging to provide low-cost, long-dwell time non-residential charging.

Outside of residential charging, workplaces represent a location where vehicles are often parked for many hours at a time, offering the opportunity for low power (Level 1 or Level 2) charging. Additionally, for employees with working shifts during daytime hours workplace charging provides the opportunity to charge vehicles with renewable energy from solar generation, lowering both costs and emissions relative to other times of the day. **Table 21** identifies the actions that can be taken and many of the key players that will likely be involved in the deployment of EVSE at workplaces.

Table 21. Deploying EVSE at Workplaces

Action	Key Player(s)
Dedicate funding for developing EVSE at workplaces, especially those with employees more likely to live in MFH and therefore more frequently requiring away-from-home charging.	ODOT, OPUC, electric utilities, local and tribal governments
Implement policy initiatives such as tax credits or other incentives to encourage private employers to deploy EVSE at workplaces.	State legislature, local and tribal governments
Provide additional education and outreach to employers and employees (who can advocate for workplace charging programs).	ODOE, ODOT, EV advocates, local planners and tribal governments
Increase technical assistance from electric utilities for employers exploring workplace charging deployment.	OPUC, electric utilities
Develop workplace charging products, services, and marketing materials and initiate campaigns to engage building owners, office managers, and/or developers throughout Oregon.	EVSPs, EVSE manufacturers, EV advocates
Survey employees to understand their level of interest in EV charging and anticipated use of this benefit.	Employers, building owners, office managers

Develop EVSE in current charging deserts.

Filling in gaps in charging access both supports EV adoption and also often increases the equity of the transition to EVs. Addressing these gaps early by prioritizing charging deserts for EVSE deployment through strategic plans will enable more rapid, equitable, and higher levels of EV adoption. **Table 22** identifies the actions that can be taken and many of the key players that will likely be involved in developing EVSE within urban charging deserts.

Table 22. Developing EVSE in Urban Charging Deserts

Action	Key Player(s)
Dedicate funding for developing EVSE in current charging deserts, with a priority focus on filling gaps in low-income, underserved, or otherwise disadvantaged communities.	ODOT, OPUC, electric utilities, local and tribal governments
Set curbside charging deployment goals within planning initiatives to align priorities and signal commitment to the private sector. Focus goals (or portion of goals) specifically on current charging deserts.	Local and tribal governments
Survey residents in charging deserts to understand what types of charging (e.g., Level 2 vs. DCFC; curbside vs. destination) would be most welcome.	Local and tribal governments, EVSPs, electric utilities
Create programs to develop community charging sites as an alternate option for MFH residents.	Local and tribal governments, electric utilities
Conduct outreach and marketing efforts to potential site hosts in charging deserts, such as grocery or convenience stores and gas stations.	EVSPs

Conclusion

Oregon has set ambitious yet critical goals for transitioning the state's light-duty vehicles from internal combustion engines to zero emission alternatives. A large portion of these ZEVs is expected to be composed of battery electric or plug-in hybrid electric vehicles, necessitating a large-scale buildout of supporting EVSE.

Deploying sufficient EVSE to support this transition is a large undertaking, and one that hasn't been completed at scale anywhere due to the relative nascency of the EV market. However, successfully deploying this infrastructure is critical and can be achieved through collaboration, shared goals, and a commitment to catalyzing the growth of transportation electrification in the state. Working collaboratively to make this a reality is an imperative for not only the transportation sector but for the state to succeed in its ambitions for reducing climate impacts and transitioning to a low-carbon economy.

To catalyze the next steps in this effort and support collaborative efforts towards a large scale infrastructure deployment effort, ODOT developed this *Guide for Oregon EV Charging Deployment.* The information contained in this Guide covers many of the key topics related to developing EVSE and specifically how to do so strategically, cost-effectively, equitably, and in a coordinated fashion. With the information contained in this Guide and supporting tools including best practices, policy recommendations, and a wealth of additional external resources referenced throughout, ODOT aims to better position the diverse mix of entities undertaking EV charging infrastructure development in Oregon for rapid deployment of the necessary EVSE throughout the state, planned for thoughtfully and inclusively and implemented effectively and equitably, to enable all Oregonians to benefit from the transition to an electric transportation future.

Appendix A: Acronyms

Acronym	Term
ADA	Americans with Disabilities Act
AHJ	Authority Having Jurisdiction
BEV	Battery Electric Vehicle
COU	Consumer-Owned Utility
DCFC	Direct Current Fast Charging (or Charger)
DEQ	Oregon Department of Environmental Quality
EV	Electric Vehicle
EVSE	Electric Vehicle Supply Equipment
HOA	Homeowners Association
IIJA	Infrastructure Investments and Jobs Act (a.k.a., Bipartisan Infrastructure Bill)
IRA	Inflation Reduction Act
IOU	Investor-Owned Utility
L1	Level 1 EV Charger (or Charging)
L2	Level 2 EV Charger (or Charging)
MFH	Multi-Family Housing
NEVI	National Electric Vehicle Infrastructure Program
ODOE	Oregon Department of Transportation
ODOT	Oregon Department of Energy
OPUC	Oregon Public Utility Commission
PGE	Portland General Electric
POU	Publicly-Owned Utility
TEINA	Transportation Electrification Infrastructure Needs Analysis 2021
ZEV	Zero Emission Vehicle

Appendix B: Cost Estimation Methodology

Literature Review

Cost estimate data was sourced from peer studies previously conducted by RMI, NREL, and ICCT. These sources break down costs into individual components (equipment, installation, and upgrades). Components of the cost categories and level of detail on cost sensitivities are not homogeneous across these studies, so the numerical results were collated and categorized in order to be comparable. The summary equipment and installation costs are shown in **Table 23.**

Table 23. Literature review of EVSE cost ranges

		L1		L2		DCFC - 50		DCFC - 150		DCFC - 350	
		Low	High	Low	High	Low	High	Low	High	Low	High
Equipment	ICCT	-	-	$938	$3,127	$28,401	$ 28,401	$75,000	$75,000	$140,000	$140,000
	RMI	-	-	$2,500	$4,900	$20,000	$35,800	$75,600	$100,000	$128,000	$150,000
	NREL	-	-	$3,500	$3,500	$38,000	$38,000	$90,000	$90,000	-	-
Installation	ICCT	$400	$600	$987	$1,441	$10,492	$26,306	$11,018	$27,621	$15,215	$38,144
	RMI	-	-	$7,000	$7,000	$62,700	$62,700	$75,500	$75,500	$138,200	$138,200
	NREL	-	-	$2,500	$ 2,500	$20,000	$20,000	$60,000	$60,000	-	-

Inflation Adjustment

The sources used in the development of **Table 23** were published in 2020 and earlier. Accordingly, the cost values were adjusted for inflation to provide a more realistic present-day perspective. The inflation rates shown in **Table 24** were taken from the Consumer Price Index (CPI) and applied to the cost estimates according to the year of each study reviewed.

Table 24. US inflation rates 2020-2022 (CPI)

	Inflation rates
2020	1.23%
2021	4.70%
2022	8.34% As of August 2022

Expert Input

Additional adjustments were made to the costs in **Table 23** in light of the unprecedented impact of the COVID-19 pandemic on supply chains and other economic factors. Due to the lack of availability of real-time costs, informed stakeholders working on EVs and EVSE in Oregon were engaged and asked to provide input on how recent costs have differed from those in the pre-pandemic research reviewed. This input was collected primarily in the form of anecdotal evidence and summarized as expert input from stakeholders to be incorporated into the final cost estimates. The following adjustments were made:

- Equipment costs: The upper end of the Level 2 equipment costs was increased by 20% to reflect inflationary impacts on the cost of charging pedestals, driven in large part by supply chain issues due to the COVID-19 pandemic's effects on international trade. Similarly, the upper end of the DCFC equipment costs for 50 kW and 150 kW costs was increased by 50-60% to account for current market prices.
- Installation costs: The upper end of Level 2 installation costs was increased by a factor of 10 to account for significantly higher experienced costs described by stakeholders. Similarly, DCFC installation costs for 350 kW chargers were increased by 25% to account for higher electrical upgrade and wiring costs for these high-powered chargers.

Stakeholders noted that transformer costs and lead times have increased sharply due to supply chain issues, leading to higher electric utility costs (sometimes by as much as 50%) and contractual costs. Installation of a high-power electronics cabinet, and access to electric panels of sufficient capacity further lead to high installation and grid upgrade costs. Experts interviewed suggested that considering the growth of these costs over the past couple of years, EV charging costs have been and can be expected to rise in the near future. However, with the expected large deployment of EV chargers in the coming years, economies of scale may somewhat help to alleviate these cost increases.

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