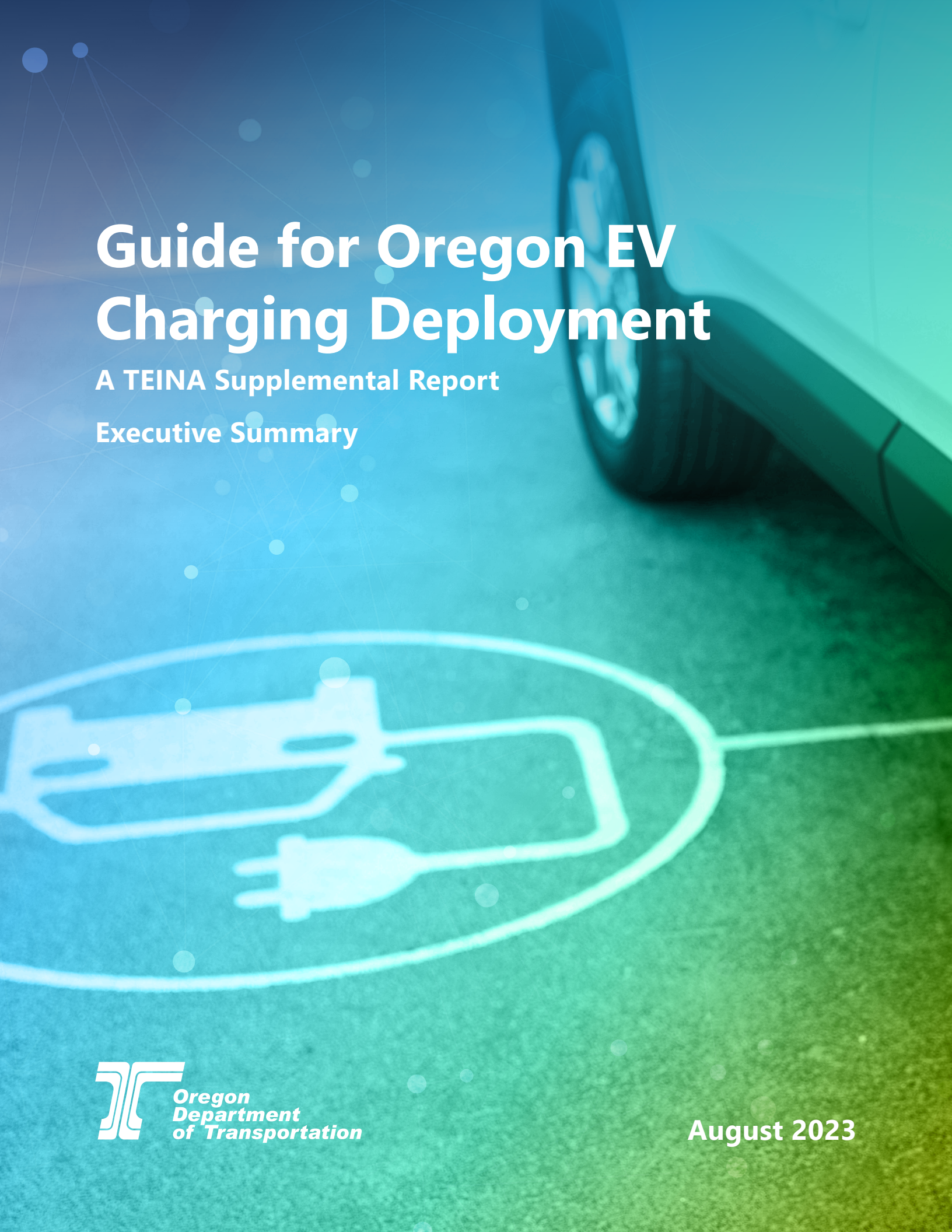


Guide for Oregon EV Charging Deployment

A TEINA Supplemental Report

Executive Summary

Oregon Department of Transportation

August 2023

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.

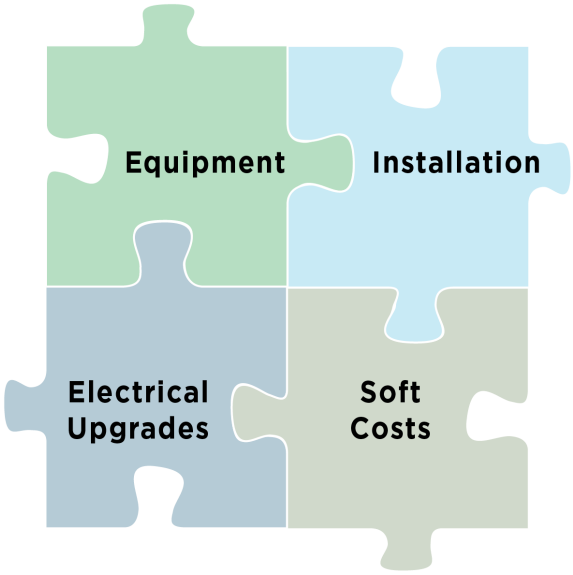
Table 2. Strategies to Support EV Charging Deployment at Different Locations

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.

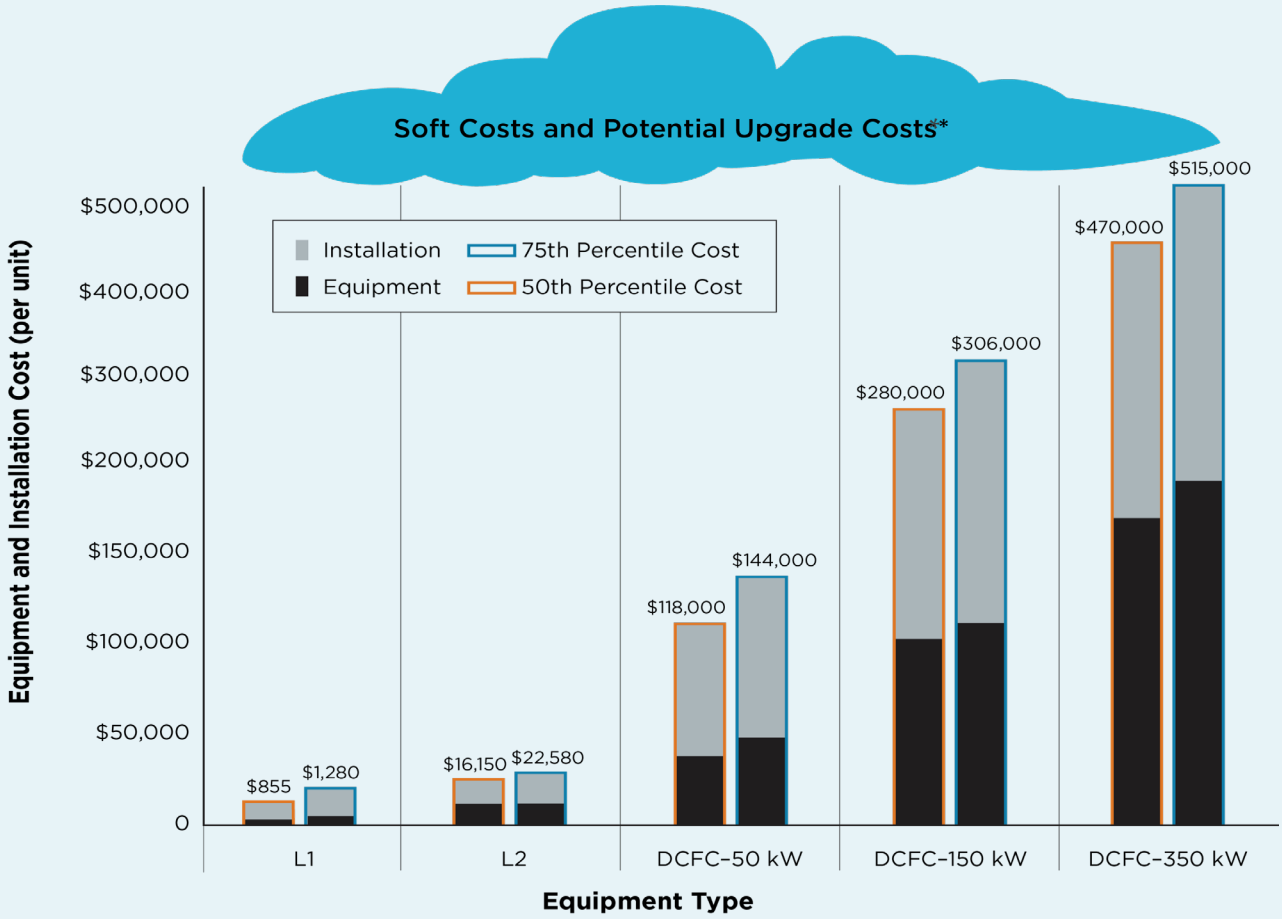
Figure 1. EVSE deployment cost components



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.

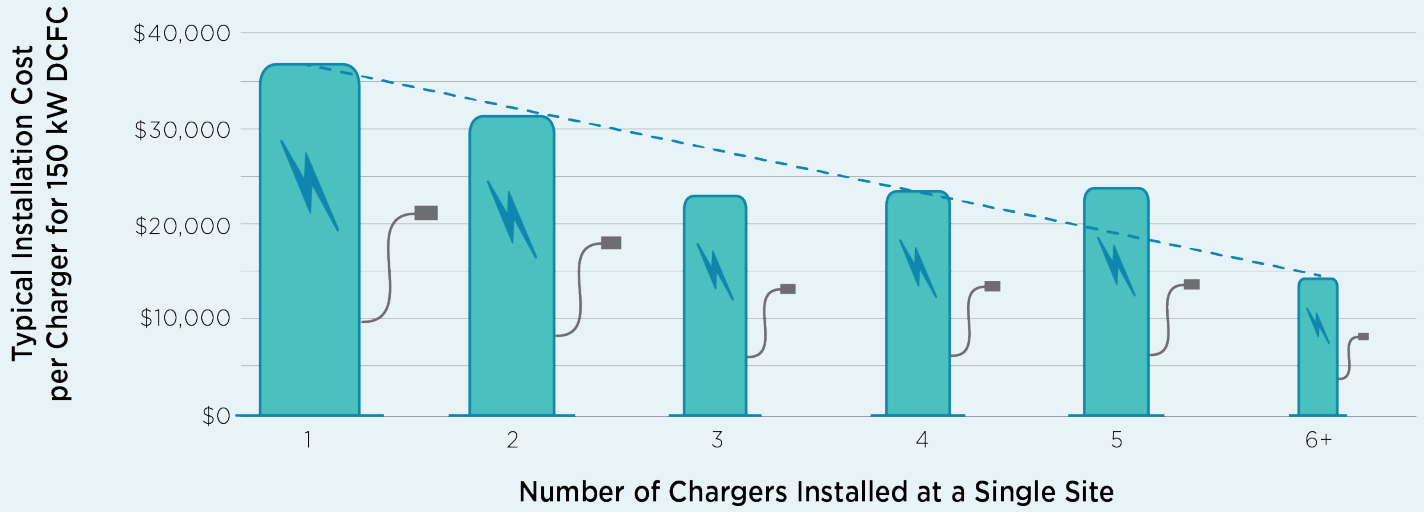
Managing Project Costs

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*



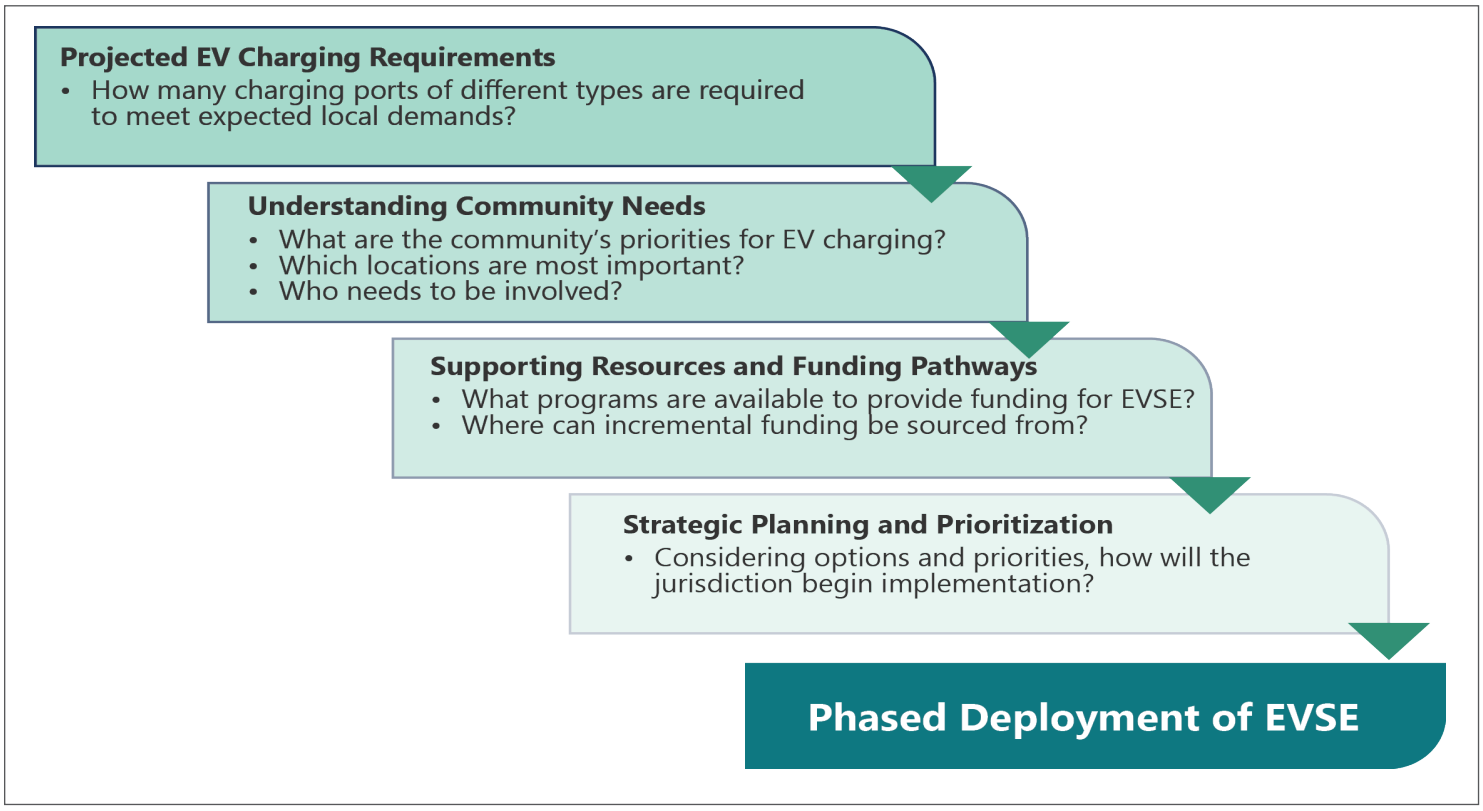
Source: International Council on Clean Transportation (ICCT)

**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.

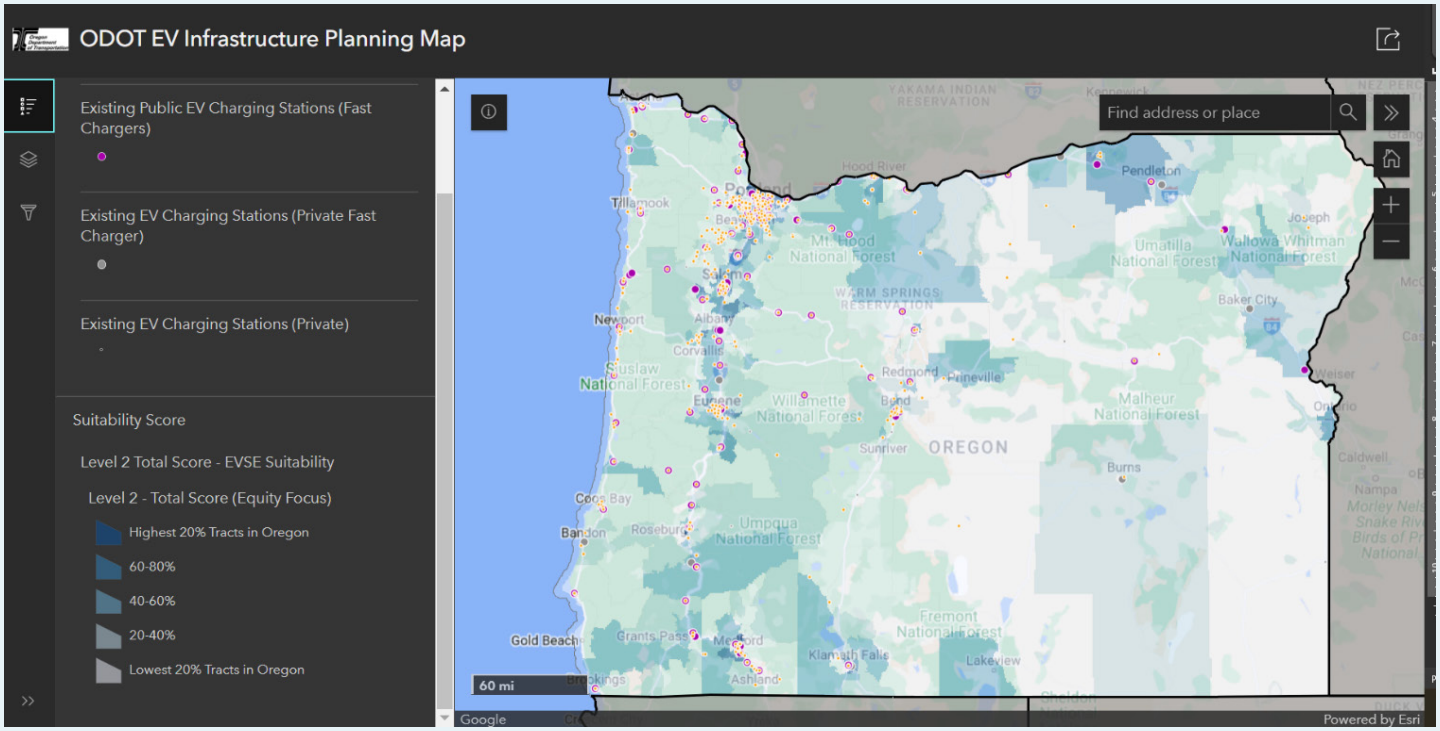
The state of Oregon is also providing financial, technical, and educational support for EVSE deployment in recognition of the rapid scaling required to enable EV adoption in line with legislative and regulatory goals. This includes ODOT's funding for fast-charging along corridors (via the National Electric 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.

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