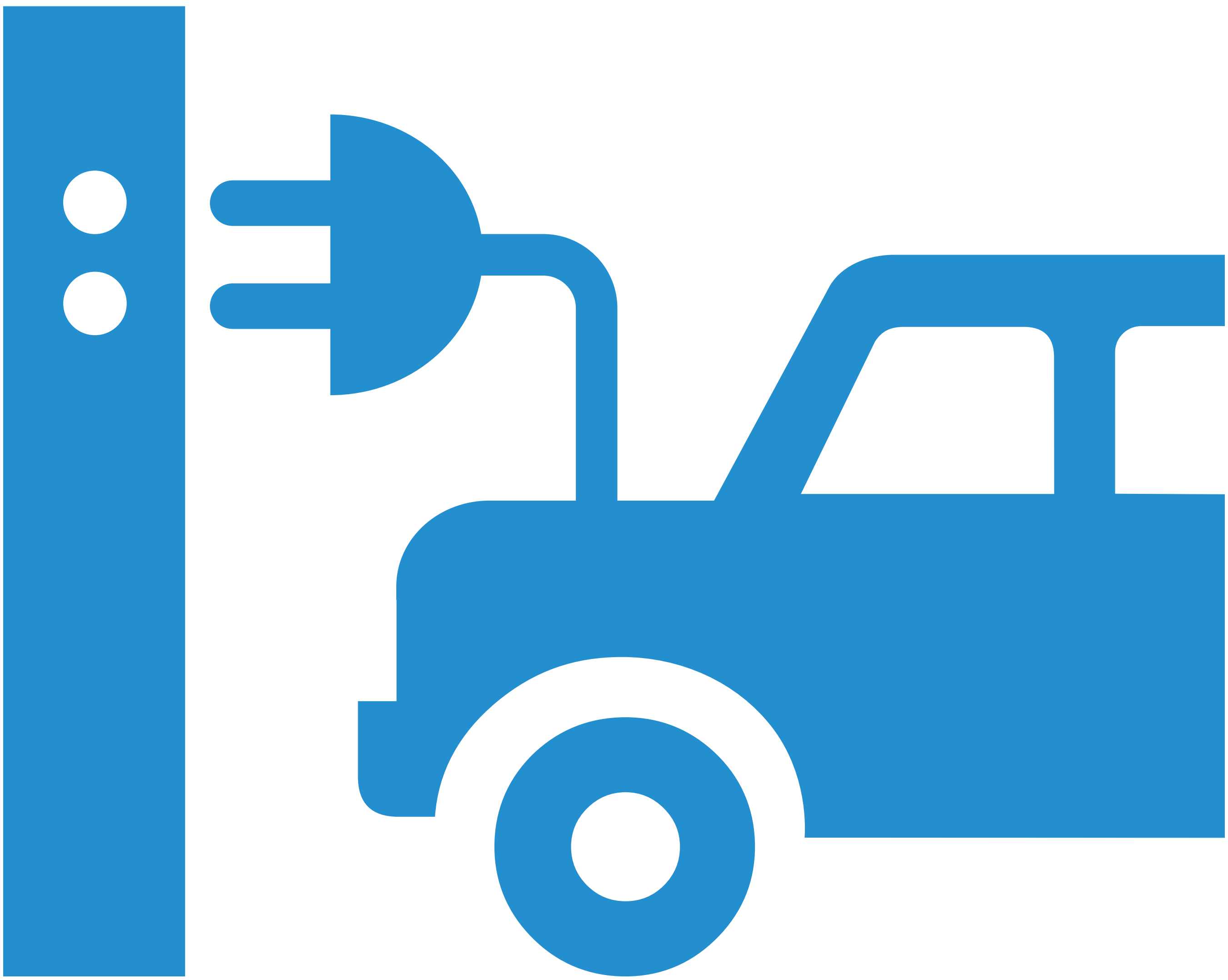
Seattle Department of Transportation

EVSE ROADMAP FOR SHARED MOBILITY HUBS



Funded by Department of Energy Grant EE-0008261, "Making the Business Case for Smart, Shared, and Sustainable Mobility Services"

Seattle Department of Transportation

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Definitions

Car share – A system in which a fleet of cars (or other vehicles) is made available for use by members of the car share group in a wide variety of ways. Car sharing provides an alternative to car ownership where: (a) persons or entities that become members are permitted to use vehicles from a fleet on an hourly basis; (b) vehicles are available to members in parking spaces at dispersed locations or facilities; and (c) no separate written agreement is required each time a member reserves and uses a vehicle.

Direct Current (DC) fast chargers – A device used to recharge an Electric Vehicle that meets the definition of "DC Level 1," "DC Level 2," or "DC Level 3" as defined in Standard J1772 of SAE International or an equivalent power output level, and which is listed under the applicable UL Standards and requirements or the equivalent listing by a nationally-recognized testing laboratory. DC fast chargers convert Alternating Current (AC) into Direct Current (DC) to deliver vehicle charging at powers from 50 to 100+ kW. DC fast chargers can charge most vehicles up to 80% capacity in less than 30 minutes and are commonly used for public charging.

Displacement Risk Index – The Displacement Risk Index was developed through the Growth and Equity Analysis of the City of Seattle's 2035 Comprehensive Plan, which was published in May 2016. The index identifies areas of Seattle where displacement of marginalized populations may be more likely. It combines data about demographics, economic conditions, and the built environment into a composite index of displacement risk. For the purpose of the EVSE Roadmap, "high displacement risk" areas were any areas that scored at least 70 percent or higher on the index.

Electric Vehicle (EV) - Any vehicle that operates, either partially or exclusively, on electrical energy from an off-board source stored on-board for motive purpose.

Electric Vehicles Supply Equipment (EVSE) – A unit of fueling infrastructure that supplies electric energy for the recharging of electric vehicles, such as plug-in electric vehicles, including electric cars, neighborhood electric vehicles, and plug-in hybrids. EVSE is also referred to as an EV charging station and EV charging infrastructure.

Level 2 Chargers (L2) - A device used to recharge an electric vehicle that meets the definition of "AC Level 2" as defined in Standard J1772 of SAE International or an equivalent power output level, and which is listed under the applicable UL Standards and requirements or the equivalent listing by a nationally-recognized testing laboratory. Level 2 chargers offer charging through 240V (typical in residential applications) or 208V (typical in commercial applications) electrical service. L2 chargers can charge most vehicles in six to eight hours. Most homes have 240V service available, and because AC Level 2 equipment can charge a typical EV battery overnight, it will commonly be installed at EV owners' homes for home charging. Level 2 equipment is also commonly used for public charging.

Public right-of-way (ROW) - The strip of land platted, dedicated, condemned, established by prescription, or otherwise legally established for the use of pedestrians, vehicles, or utilities.

Ride-hailing – Ride-hailing services connect riders with drivers via online and mobile applications to provide point-to-point mobility.

Shared Mobility Hubs – A Shared Mobility Hub is a place where transportation connections, travel information, and community amenities are aggregated into a comfortable, seamless, understandable, and on-demand travel experience. Shared Mobility Hubs are generally located with major transit facilities and places where frequent services intersect to allow easy transfers between mobility services. In addition to transit, Shared Mobility Hubs may include legible connections to car share, bike share, bike parking, TNC pick-up and drop-off, kiss-and-ride, freight delivery, as well as connections to local bike and pedestrian routes. They also can include placemaking and placekeeping programming to help them function as vibrant community spaces rather than just "through" spaces. The planning and design of Shared Mobility Hubs will use a hierarchical approach to designate curb space use near the hub area. That hierarchy will maximize access to the Shared Mobility Hub using a people-first approach.

Shared Mobility Services – In this document this term refers to shared passenger vehicle services, including car sharing and ride-hailing services.

1 INTRODUCTION

The Seattle Department of Transportation (SDOT), in close collaboration with other City and external partners, developed this Electric Vehicle Supply Equipment (EVSE) Roadmap for Shared Mobility Hubs ("EVSE Roadmap") to provide improved connections to public transit via electrically-powered shared mobility services such as car share and ride-hail services.[1] This EVSE Roadmap outlines an initial regional strategy for Seattle to test an innovative method to increase EV adoption in shared mobility services and is part of a broader multi-regional project supported by the Department of Energy (DOE)'s Office of Energy Efficiency and Renewable Energy entitled, "Making the Business Case for Smart, Shared, and Sustainable Mobility Services".[2,3]

From October 2018 – September 2020, SDOT and its City and regional project partners will use this document to guide EVSE deployment efforts at Shared Mobility Hubs and evaluate and adjust the region's strategic deployment plan. The deployments will take place in two year-long phases, with Phase 1 results directly informing deployment plans for Phase 2. For this reason, the EVSE Roadmap currently focuses on Phase 1 deployment selections, provides initial guidance and considerations for Phase 2, and may be adjusted at any time. Additionally, this EVSE Roadmap incorporates stakeholder feedback through focus groups and surveys, lessons learned, and data-driven decision-making processes to help inform EVSE deployments at Shared Mobility Hubs beyond the grant period and for other cities of similar size and complexity.

The implementation plan described here is a partnership between the public and private sectors, supported by grant funding and cost share, and not an internal SDOT program. SDOT, as the lead grant recipient, serves as the regional project manager and project partners are responsible for the programmatic implementation of their responsibilities outlined in Section 4.1 in alignment with the guidance provided in this EVSE Roadmap.[4]

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[1]This document describes an innovative project strategy designed to test methods and assess the effectiveness of these methods over a pre-determined project period. The strategy will be evaluated regularly, may be adjusted throughout the project period, and may be modified based on key learnings from the project. The strategies described were developed based on established City policies, but the contents of this document do not represent City of Seattle policy or the policy of any City department including the Seattle Department of Transportation and Seattle City Light. If a conflict occurs between this document and applicable policies, laws, codes, ordinances or regulations, the most stringent and legally binding requirement will govern and supersede the content of this document to afford the City maximum benefits. Learnings from this project may inform future City policy and investment choices. In this case, pilot partners and other entities outside the City can provide input and feedback, but the City will make all policy choices itself.

[2]This material is based upon work supported by the U.S. Department of Energy's Office of Energy Efficiency and Renewable Energy (EERE) under the Vehicles Technologies Office (VTO) Deployment Award Number DE-EE0008261.

[4]This EVSE Roadmap strategy and delegation of responsibilities amongst project partners is subject to change throughout the project period and represents one of many potential implementation models for future electrification efforts the City may pursue.

MULTI-REGIONAL GRANT OVERVIEW

Four U.S. cities have joined together to demonstrate the potential for electric shared mobility services. With funding from the U.S. Department of Energy and a team of valuable partners, "Making the Business Case for Smart, Shared, and Sustainable Mobility Services" aims to accelerate the adoption of electric vehicles in shared mobility applications and to establish best practices that can be used by others around the United States. The project, led by the City of Seattle and Atlas Public Policy, brings together the U.S. Department of Energy's Energy Efficient Mobility Systems program and major industry stakeholders with the cities of Seattle, New York, Portland, and Denver to test different electric, shared mobility interventions.

In the Seattle region, the Seattle Department of Transportation is partnering with Seattle City Light, Office of Sustainability & Environment, ReachNow, Eluminocity, and other shared mobility service providers to significantly increase the supply of publicly available DC fast charging stations throughout the City with a specific focus on integration with 20 of the City's shared mobility hubs, and monitoring the impact of a more robust charging network on shared mobility operations. SDOT, as the lead grant recipient and in alignment with its role managing the City's transportation systems, manages the project's overall implementation and coordination amongst project partners.

The EVSE Roadmap is an initial strategy to electrify shared mobility services through the deployment of EVSE at or near Shared Mobility Hubs. The strategy will be evaluated and potentially updated to account for new and emerging aspects of EVSE planning. This document does not represent City of Seattle policy or the policy of any City department.

1.1 Barriers to Increasing Adoption of EVs in Shared Mobility Services

Current barriers to the electrification of shared mobility services include high vehicle costs, a lack of awareness around EVs, limited access to home charging, and a lack of reliable public charging which causes drivers "range anxiety." The lack of a consistent network of easily accessible and public EVSE limits the ability for ride-hailing services and car share providers to substantially increase their EV fleets. The core objectives of the EVSE Roadmap were developed to address these key concerns.

1.2 Guiding Policies, Research, and Objectives

A number of policy documents guided the development of objectives for the EVSE Roadmap which align with the overarching EV Shared Mobility project goal to "accelerate the adoption of electric vehicles in shared mobility applications and to establish best practices that can be used by others around the United States."

The following City of Seattle documents informed the development of the EVSE Roadmap's objectives:

- Office of Sustainability & Environment's (OSE) 2017 Drive Clean Seattle Implementation Strategy
- Seattle Department of Transportation's (SDOT) New Mobility Playbook
- Office of Planning & Community Development's (OPCD) Seattle 2035 Growth and Equity Strategy
- SDOT's Electric Vehicle Charging the Right-of-Way (EVCROW) Program – SDOT Pilot Permit Program Requirements
- City of Seattle's Equity and Environment Agenda

In addition, the Environmental Justice Committee's Recommendations for the Drive Clean Seattle initiative (November 2016 and March 2017) informed the development of the EVSE Roadmap and project objectives.

HUMAN-CENTERED DESIGN RESEARCH

In July – September 2018, SDOT worked with a human-centered design consultant to conduct generative exploratory studies aimed at understanding where and how to site electric vehicle (EV) charging stations, with a focus on equitable deployment in communities of color and low-income communities. The consultant conducted shared mobility driver interviews, community stakeholder interviews, and led a validation/participatory design workshop. Key learnings from these activities informed the development of the EVSE Roadmap, including the model metrics and weighting development and the Equity & Displacement Considerations Section (Section 5).

WHAT IS A SHARED MOBILITY HUB?

A Shared Mobility Hub is a place where transportation connections, travel information, and community amenities are aggregated into a comfortable, seamless, understandable, and on-demand travel experience. Shared Mobility Hubs are generally located with major transit facilities and at places where frequent services intersect to allow easy transfers between mobility services. In addition to transit, Shared Mobility Hubs may include legible connections to car share, bike share, bike parking, ride-hail pick-up and drop-off, kiss-and-ride, and freight delivery, as well as connections to local bike and pedestrian routes. They may also include placemaking and placekeeping programming to help them function as vibrant community spaces rather than just "through" spaces. The planning and design of Shared Mobility Hubs will use a hierarchical approach to designate curb space use near the hub area. That hierarchy will maximize access to the Shared Mobility Hub using a people-first approach. SDOT has identified over 100 recommended Shared Mobility Hub locations which were used for this analysis. These locations are subject to change based on future analysis and development.

WHY SHOULD THEY BE ELECTRIFIED?

Shared Mobility Hubs are central to SDOT's strategy to shape shared mobility options so that they serve the City's climate, transportation equity, and demand management goals. The Shared Mobility Hub program leverages shared mobility to **enhance transit** access and ridership, reducing harmful emissions and transportation costs for the people of Seattle. Without the Shared Mobility Hub Program, shared mobility providers could build services to supplant transit, increasing harmful emissions and transportation costs. By electrifying shared mobility options with charging infrastructure as a part of the Shared Mobility Hub implementation plan, SDOT can further reduce emissions by accelerating adoption of electric vehicles among shared mobility providers.

Individual policies and objectives from each of the supporting documents informed the development of the following four primary project objectives of the EVSE Roadmap:

- Remove barriers to EV adoption, and increase the potential of EV adoption/use in ride-hail and car share services
- Incorporate community input when deploying EV charging sites to avoid exacerbating displacement of racial minorities and low-income households
- Improve public health by reducing emissions, improving air quality and addressing climate change
- Improve safe and accessible connections to transit, which provides access to services, employment, and education

1.3 Building the Public EV Charging Network

EVSE resources deployed through this project can strive to complement additional private sector investments as feasible and provide enhanced EV charging network coverage and more equitable access across the City, particularly in locations that can serve shared mobility services. By placing EVSE strategically to serve key Shared Mobility Hubs, the regional implementation plan described in this EVSE Roadmap aims to provide electrified shared mobility options for first- and last-mile connections to transit and test the effectiveness of this strategy on increasing EV shared mobility connections to hubs, EV adoption rates among shared mobility services, and the replacement of traditional vehicle miles traveled (VMT) with electric vehicle miles traveled (eVMT).

EVSE could be sited through this project at off-street or on-street locations. On-street locations would be coordinated and permitted via SDOT's Electric Vehicle Charging in the Right-of-Way (EVCROW) permitting pilot, while off-street locations would be coordinated between the EVSE provider and private site hosts. Sites will be discussed and agreed upon among relevant project partners to be in alignment with the objectives of this EVSE Roadmap and the broader DOE grant project.

DC FAST CHARGERS VS LEVEL 2 CHARGERS

Early in the process of developing the EVSE Roadmap Strategy, the project team determined that DC fast chargers should be prioritized over Level 2 (L2) chargers. This decision was largely based on the expected use of charging infrastructure by ride-hail and car share providers and only refers to EVSE prioritization within the context of this project. Their operational models (both for drivers and fleet support technicians) benefit from a network of DC fast chargers to enable quick turnover of vehicles and to ensure the vehicles are in service for a majority of the time.

While L2 chargers do have a potential use case for ride-hail drivers at their place of residence, the priority focus was on DC fast chargers to address the major gaps in the DC fast charger network and fulfill Seattle's intervention strategy for the project to electrify Shared Mobility Hubs. Additionally, as vehicles with greater range[5] continue to enter the EV marketplace, the long-term demand may shift toward DC fast chargers to enable quick charging to complete a day's activities, and to allow multiple vehicles to use one charger per day.[6] Prioritizing DC fast chargers establishes a network of locations that are more adaptable to future EVSE technology and user expectations for charging infrastructure.

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[5]Typical range for newer EV models now is between 200-250 miles. An average ride-hail driver drives between 100 and 200 miles per day. Source: Rocky Mountain Institute, 2018 (https://rmi.org/ride-hailing-drivers-ideal-candidates-electric-vehicles/)
[6]Given the charge time of 6 to 8 hours for L2 for a typical EV, each L2 charger likely only serves a maximum of two vehicles per day. A DC fast charger can charge a typical EV on average within 30 minutes and therefore can serve multiple vehicles, allowing the city to build the network out to scale.

2 EVSE DYNAMIC SITING MODEL

The first step to establishing the EVSE Roadmap for the DOE project was to build a prioritization model (GIS-based) for siting EVSE at Shared Mobility Hubs. The EVSE Dynamic Siting Model is a guiding mechanism to inform the prioritization of Shared Mobility Hubs for EV charger placement that incorporates a data-driven process to balance a variety of project objectives. The dynamic nature of the model allows it to adapt to updated datasets and to allow for real-time evaluation of different prioritization scenarios. This section of the EVSE Roadmap documents the EVSE Dynamic Siting Model, including its development process, the input and output data, and the final model framework.

2.1 Model Objectives and Priorities

A thorough literature review, combined with stakeholder engagement and a synthesis of existing City policy, allowed the project team to identify four key prioritization categories for EVSE placement for this project. Relevant data were selected to enable the EVSE Dynamic Siting Model to prioritize EVSE where ride-hail and car share vehicle demand was high, a gap in the EVSE network existed, and deployment of the EVSE could be both equitable and result in a positive impact on a community. A full list of the documents reviewed to inform the model development process is included in **Appendix A**.

The data focused around four key prioritization categories that aligned with the EVSE Roadmap's objectives and included the following:

1. **EV Network Development** – identifies Shared Mobility Hubs that are in locations with a less established network of EV chargers, particularly DC fast chargers, and which support EV charging behavior based on user feedback
2. **Equity & Environmental Justice**[7] – identifies Shared Mobility Hubs that can address air quality and environmental justice objectives by identifying areas of historical underinvestment and that face inequitable environmental burden from air and noise pollution
3. **Shared Mobility** – identifies Shared Mobility Hubs to serve locations with current high market demand for ride-hailing and carsharing services and potential future market demand
4. **Gaps in Transit Access** – identifies Shared Mobility Hubs with relatively poor connecting transit service and low vehicle ownership to enable better first-last mile connections to high-capacity transit

An additional layer applied outside of the prioritization model calculation is the Displacement Risk layer. This layer is based on the Displacement Risk Index developed through the Growth and Equity Analysis of Seattle's Growth Strategy. For the purpose of the EVSE Roadmap, the Displacement Risk layer flags

[7]We recognize that historically disinvested communities are correlated with those both currently experiencing displacement and at risk of experiencing future displacement. To avoid exacerbating ongoing displacement, potential sites in areas with high displacement risk will be identified so project partners can be cognizant of this sensitivity and work to mitigate displacement risk in their efforts as feasible. SDOT's suggested research-based approach to mitigating displacement risk will be outlined in its EVSE Equity Toolkit (currently in development).

areas that were defined by a score of 70 percent or higher on the index. The application of the layer identifies potential Shared Mobility Hubs targeted for electrification that fall within areas with a high risk of displacement so that project partners can be cognizant of this sensitivity and work to mitigate displacement risk in their efforts, as feasible.

Publicly available and regionally or nationally-based data sources were prioritized for inclusion in the model to ensure the model could continuously be updated and to allow for potential expansion to other cities and regions in future efforts. Identifying appropriate data sources was the first step in an iterative model development process that incorporated a number of checkpoints with stakeholder review. The model design process to develop a working EVSE Dynamic Siting Model from raw data is described in the following section.

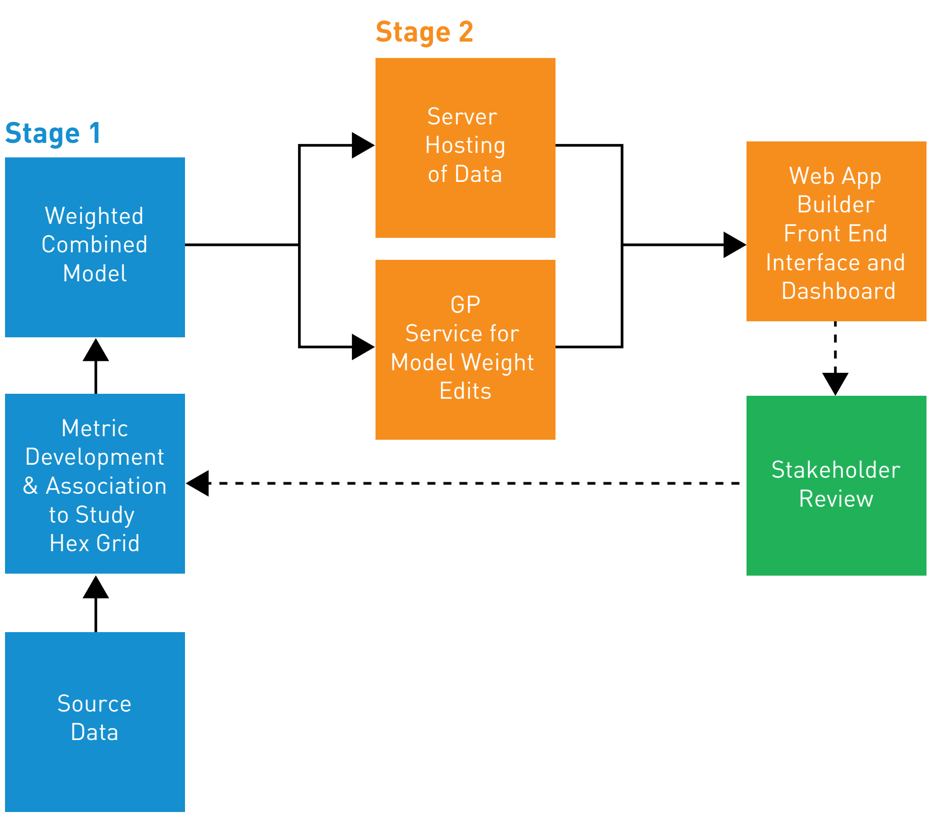
2.2 Design Process

The siting model design process is depicted in **Figure 1**. A detailed description of the process is included in **Appendix B**. Details on the specific metrics and final outputs are included in the "Final Model Framework" section.

2.3 Final Model Framework

The final siting model used a variety of datasets from various sources and levels of aggregation to develop 11 distinct metrics across the four key prioritization categories that were combined to determine an overall EVSE Prioritization Score. The selection of data and metrics was based on feedback provided by ride-hailing drivers, human-centered design research, stakeholder feedback, and a thorough literature review on the fundamentals of shared mobility, EV charging, and travel behavior. Prior research on EVSE siting often incorporated estimated installation costs in the prioritization process.

FIGURE 1: SITING MODEL DEVELOPMENT DIAGRAM



Stage 1: Represents an analysis process of data collection, data processing, metric development, and initial model criteria weighting based on initial research and feedback from stakeholder review.

Stage 2: Represents a deployment of backend and front-end technologies to host analysis results, background data, and geoprocessing services to provide a tool and dashboard for users to interact with the data.

Costs were not included in the final model framework as the site-specific costs for installation will be assessed and borne by the EVSE provider, who selects sites to electrify in alignment with this EVSE Roadmap and the DOE grant objectives. As previously described, the data was organized into four prioritization categories that addressed the primary objectives of the EVSE Dynamic Siting Model. A detailed description of the 11 metrics, along with their justification, methodology, and other considerations is included in **Appendix B**.

2.4 EVSE Network Development Guidelines

A key metric in the EVSE Dynamic Siting Model is the summary of existing EV charging locations, specifically DC fast charger locations. Identifying the specific methodology to create the EV charging location metric required an understanding of how operational considerations might guide the structure of an optimal EV charging network. To resolve suitable locations for EVSE, a 10-acre hex grid was developed for the City of Seattle. The distance across a 10-acre hex grid is roughly two city blocks, comparable to the car share proximity described in a later section. This hex grid is the final study geography that was used to bring together all the inputs for final scoring in the EVSE Dynamic Siting model.

Table 1 highlights the key questions addressed through literature review and feedback provided by ride-hail drivers, car share fleet managers, and other stakeholders. New understanding from this information resulted in the EV charging metric methodology that sets priorities on areas with less than four DC fast charging locations within a half-mile of a given hex grid.

TABLE 1. KEY QUESTIONS RELATED TO EVSE NETWORK PRIORITIES

Question	Response
What are the key issues shared mobility EV drivers face that may guide EV charging location siting principles?	Sometimes a charging space is occupied (for an unknown time) and chargers are unreliable and often broken.[8] Drivers prefer multiple chargers in one location to minimize the risk of a charging being unavailable when they need it. Additionally, many drivers don't have access to home charging and would rely on the public EV charging network.[9]
How many chargers should be located at one site?	An optimal number would be between two and four chargers per site based on reliability of access, efficiencies of connecting to the grid, and the feasibility of identifying the needed space requirements.[10]
What is the optimal density of chargers within a neighborhood or city?	Depots of two to four chargers can serve an area approximately within a half-mile of the depot.[11] It is optimal to site additional depots of chargers at least a half-mile away from one another.

[8]Based on SDOT's Human-Centered Design interviews with current EV drivers for ride-hailing companies and shared mobility service providers
[9]Based on SDOT's Human-Centered Design focus group with current EV drivers for ride-hailing companies
[10]Based on stakeholder feedback from EVSE provider and shared mobility service providers
[11]Based on stakeholder feedback from shared mobility service providers and Alternative Fuel Data Center estimates of charging requirements for the Seattle region. https://www.afdc.energy.gov/evi-pro-lite

2.5 Weighted Combined Model

The metrics were combined by using a weighting system to favor important factors in scoring the hex grids. The weighting criteria were developed through literature review, stakeholder feedback, and an iterative process to ensure the model was representing reasonable results. With 11 metrics, a baseline weighting would apply an approximately nine percent weight to every metric. However, based on the weighting development process, certain metrics warranted a higher or lower weight, both because of the importance of the metric and to account for potential correlation between the metrics. **Table 2** summarizes the metrics, their weighting in the model, and the rationale for the weights.

2.6 EVSE Dynamic Siting Model Results

The final EVSE Dynamic Siting Model results for the EVSE Prioritization Score are shown in **Figure 2**. The next section describes the procedure for interpreting the model results to prioritize Shared Mobility Hubs for electrification. In general, the following areas show a higher priority for EVSE according to the selected metrics and metric weights for this project:

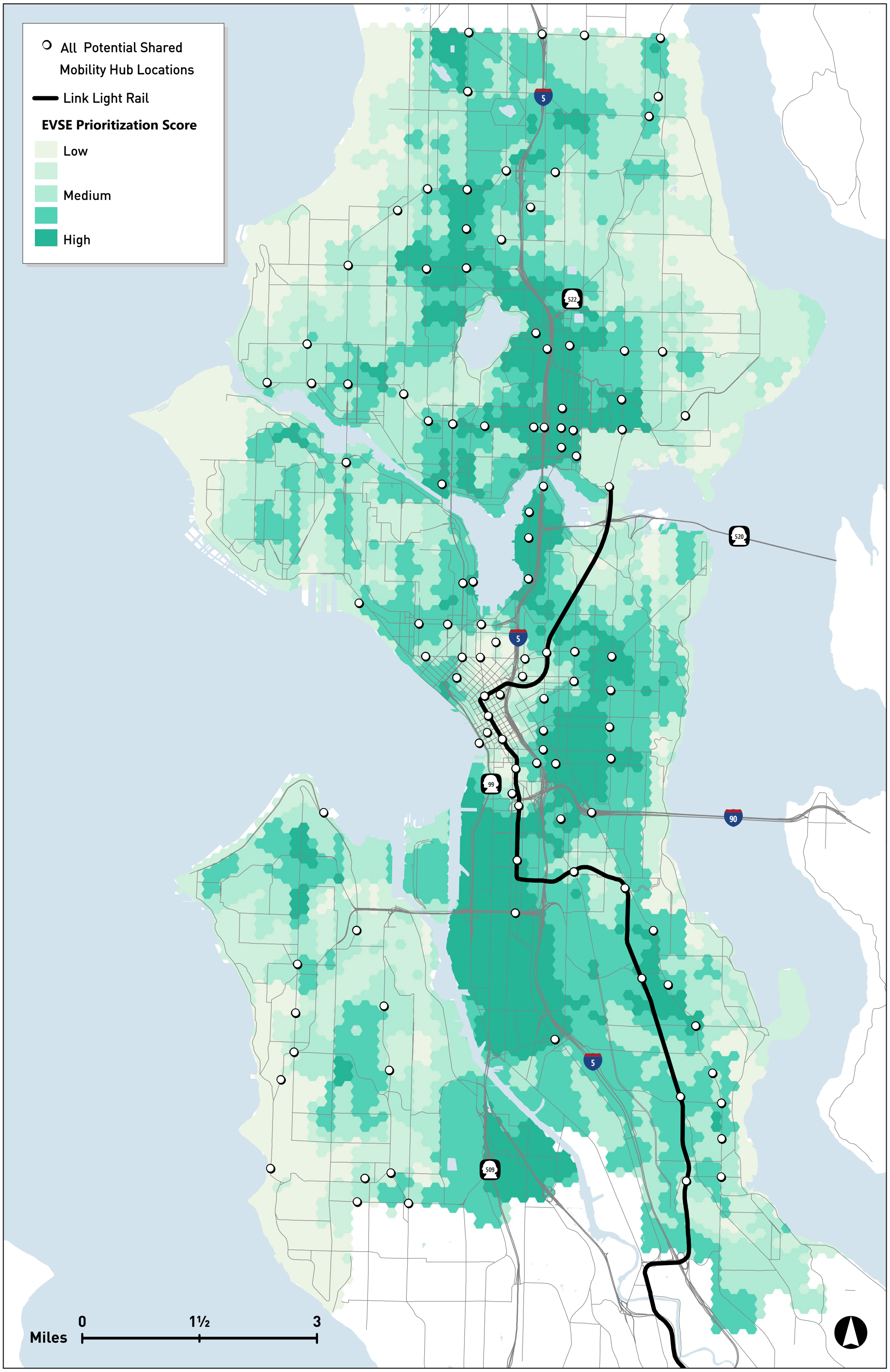
- Along portions of the I-5 corridor, reflecting the higher priority for access to freeways and a lack of existing EV chargers.
- Along the existing and future light rail alignments in the Rainier Valley, Downtown Seattle, Capitol Hill, and North Seattle neighborhoods of the U District, Ravenna, and Northgate. This reflects some areas with poor first-last mile connections to light rail, higher shared mobility activity, and higher density of retail amenities. In general, all of these areas except Downtown Seattle and portions of Capitol Hill have a low density of EV chargers.
- Some portions in Ballard, Fremont, Lake City, and West Seattle based on gaps in the EV charging network and higher scores for shared mobility.

TABLE 2. FINAL PRIORITIZATION CATEGORY AND METRIC WEIGHTING

Prioritization Category	Metric	Metric Weight	Metric Inclusion and Weighting Rationale	Combined Weight
EV Network Development	Existing EV Charger Locations[12]	30%	Provides information about existing chargers to prioritize gaps in the EV charging network and is the key metric driving the prioritization (ensuring coverage of the city).	40%
	Accessibility to Major Highways[13]	5%	Key element identified from ride-hail drivers to prioritize easy-to-access charging locations, but had strong correlation with Parking Turnover Index/Ride-hail Demand/Car share Demand metrics.	
	Retail Amenities[11]	5%	Key element identified from ride-hail drivers to prioritize areas with amenities that can be used while they wait for vehicles to charge. Lower weighting because of correlation with Parking Turnover Index.	
Equity & Environmental Justice	Low-income Households[14]	5%	This metric helps to create a proxy for communities that have historically experienced disinvestment. Strong correlation with Minority Household metric	20%
	Minority Households[12]	7.5%	This metric helps to create a proxy for communities that have historically experienced disinvestment. Strong correlation with low-income household metric, however Seattle's Environmental Justice principles place higher focus on race over income.	
	Traffic Pollution Index[15]	7.5%	This metric uses high Vehicle Miles Traveled (VMT) locations as a proxy intended to prioritize areas bearing inequitable environmental burdens that can be partially addressed by higher EV adoption.	
Shared Mobility Demand	Parking Turnover Index[16]	7.5%	On-street parking regulation and off-street parking pricing serve as proxies for higher vehicle turnover, thus implying opportunities for current and future shared mobility demand. Directly correlated with Car share Demand, Ride-hail Demand and Retail Amenities metrics.	20%
	Ride-hail Demand[14]	6.25%	Primary demand metric for shared mobility, however directly correlated with Car share Demand and Parking Turnover Index.	
	Car share Demand[14]	6.25%	Primary demand metric for shared mobility, however directly correlated with Ride-hail demand and Parking Turnover Index.	
Gaps in Transit Access	Low-frequency Transit Access[17]	15%	Proxy for increased need for a vehicle to provide first-last mile access to high-capacity transit, including ride-hail/car share.	20%
	Zero Vehicle Households[11]	5%	Proxy for higher propensity to benefit from transit access via shared mobility services. Lower priority than Low-frequency Transit Access metric.	
EVSE Prioritization Score		Combined score based on weighting of prioritization categories		100%

[12]Source: Alternative Fuels Data Center
[13]Source: Open Street Map
[14]Source: United States Census Bureau
[15]Source: Environmental Justice Screen (US Environmental Protection Agency)
[16]Source: Seattle Department of Transportation
[17]Source: General Transit Feed Specification

FIGURE 2: EVSE DYNAMIC SITING MODEL RESULTS



3 SHARED MOBILITY HUB PRIORITIZATION

Converting the results of the EVSE Dynamic Siting Model to a prioritization of Shared Mobility Hubs involved considering the hex grids around each hub and adjacent hubs. Specifically, each Shared Mobility Hub was given the average score of the hex grids within a two-block radius (approximately 660 feet).[18] Additionally, given that some Shared Mobility Hubs are within a half-mile of another hub, adjacent hubs were aggregated to provide one representative location for EVSE siting prioritization purposes.[19]

The top 35 locations were then identified and discussed with project partners to develop a list of Shared Mobility Hubs to prioritize for electrification during Phase 1 deployments (October 2018-September 2019) and potential hubs to electrify in Phase 2 deployments (October 2019-September 2020). Guidance around selecting sites (e.g. parking spaces to electrify) at prioritized hubs is included in Section 4.

3.1 Limitations of the Model

The model was developed to provide a consistent, data-driven approach to develop initial prioritization areas for EVSE. There are limitations and blind spots as no model can account for all objectives and potential criteria. In reviewing the model, some limitations emerged, including:

- The inability to account for other transportation demand factors, such as the Water Taxi, the Ferry System, or potential changes to the transportation network, such as the viaduct removal.
- The need identified through stakeholder feedback to site some charging locations at the north and south ends of the city to provide opportunities for ride-hail drivers and car share users entering and leaving the city. Many ride-hail drivers that operate in the City of Seattle do not live in the city itself, but in neighboring regions, or they provide trips across City boundaries; for example, to and from the Seattle-Tacoma International Airport.
- The model doesn't identify an optimal citywide EVSE network layout and therefore it requires an iterative approach to understand how prioritizing one location may deprioritize another location.
- Areas west of the main I-5/light rail corridor (such as Ballard and West Seattle) don't appear as prioritized because of the limitations of access from the freeway, however ride-hail driver feedback has stated a need to have EVSE in those areas to ensure coverage.
- The Displacement Risk layer included to flag areas for further consideration was developed in 2016 and may be out of date in areas across the city. EVSE deployments in areas of high displacement risk should be evaluated on a case-by-case basis to determine best practices for implementation.

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[18] Given that many metrics already incorporated a search radius of half-mile or greater, the smaller search radius of hex grids for Shared Mobility Hubs was used to provide a larger difference in scoring between the hubs for prioritization. The results would appear closer together as the search radius expanded.
[19] For example, in the University of Washington area, there are six Shared Mobility Hubs within a half-mile radius of one another with similar EVSE Prioritization scores.

- The model doesn't identify areas of planned EVSE deployment.
- Installation costs were not considered in the model because costs and complexity for installation can vary significantly between different blocks or even locations on the same block. Rather, the model focused on identifying high-level prioritization areas, with the understanding that specific costs would be determined by the EVSE provider during actual siting assessment.

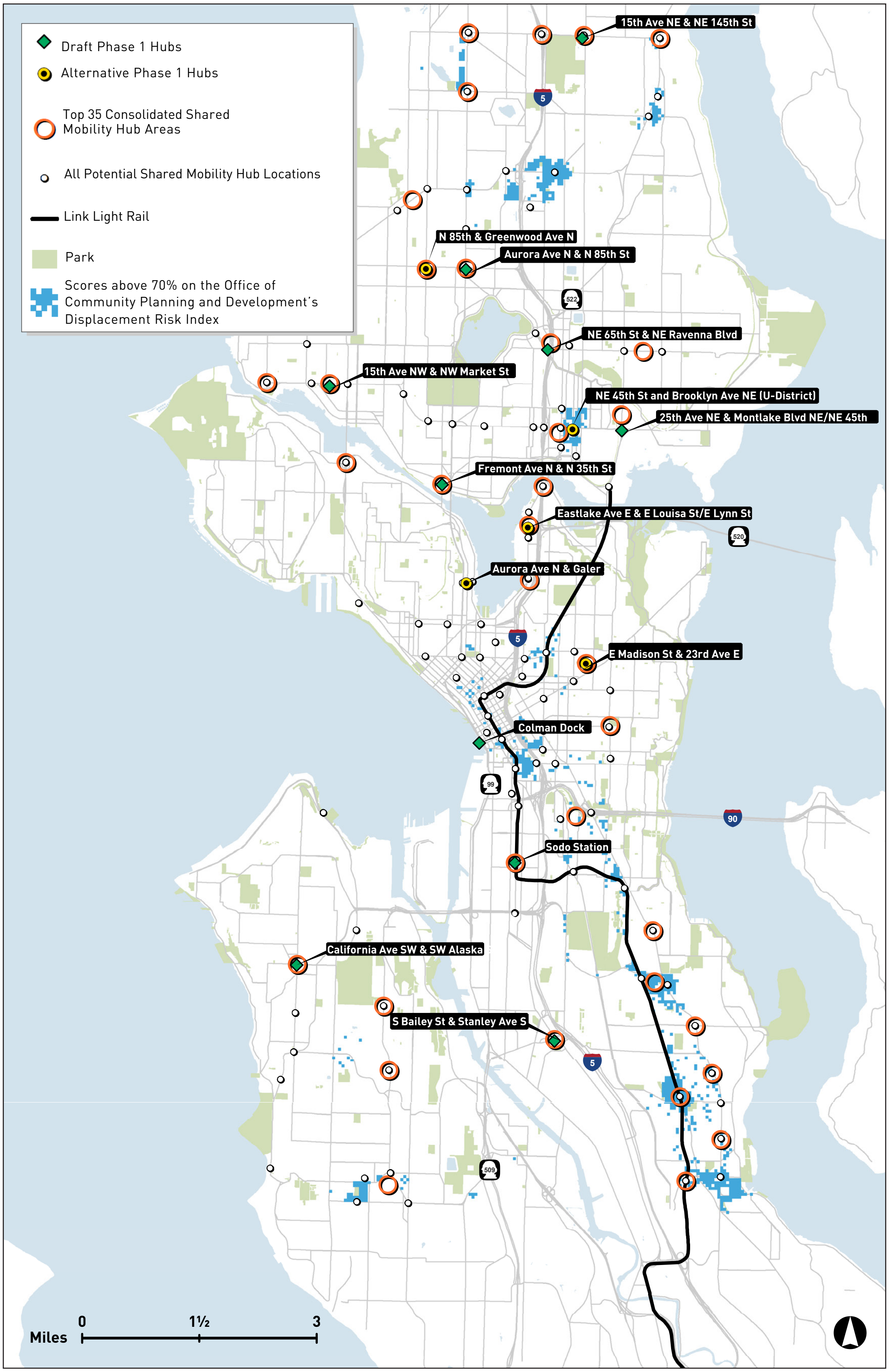
3.2 Phase 1 Deployment – Top 10 Shared Mobility Hubs

Developing the first phase of Shared Mobility Hubs for EVSE deployment involved reviewing the highest ranked Shared Mobility Hub areas and identifying logical locations to ensure expanded coverage and increased density of the EVSE network. Generally, Shared Mobility Hubs scoring in the top 30 percent were considered for electrification and if a location was selected, other locations within one-half mile were deprioritized for Phase 1 deployments. A collaborative multi-week process with city stakeholders and private partners included a detailed review of the top scoring sites to determine potential site priorities and alternatives for specific areas. Additional context was provided by stakeholders to overcome some of the limitations of the model described above. For example, large upcoming transportation projects were considered in the siting prioritization in order to align installations with planned construction projects. Additional considerations in developing the priority list for Phase 1 deployment included identifying areas of high displacement risk.[20] Generally, Shared Mobility Hubs that had high EVSE Prioritization Scores but fell within an area of high displacement risk (greater than 70 percent on the Displacement Risk Index) were not included in the priority list for Phase 1 deployment but will be prioritized for Phase 2 deployments. Over the next year, parallel outreach and engagement efforts on electrification will be conducted and will allow project partners to better understand how to equitably deploy EVSE in these areas without potentially exacerbating displacement risks. More detail on the equity considerations of EVSE deployment is included in Section 5. The one exception to this is the University District Shared Mobility Hub, which was included as an alternative location for Phase 1 deployments and is flagged by the Displacement Risk layer. The University District has a large student population with lower incomes, but also higher scores for the Shared Mobility Demand prioritization category, implying climate benefits could be achieved with near-term electrification efforts.

At the end of the process, all project partners involved in EVSE deployments reached a consensus on the top 10 prioritized Shared Mobility Hubs and five alternatives for implementation of the Phase 1 EVSE deployments. As Phase 1 hubs are evaluated for specific site feasibility, some alternative areas may be implemented in Phase 1 and some Phase 1 top priority hubs may be rolled over into Phase 2. **Figure 3** highlights the chosen 10 Shared Mobility Hubs for Phase 1 deployment along with five alternative locations.

[20]As measured by the Displacement Risk Index developed for the Growth and Equity Analysis of the Seattle 2035 Comprehensive Plan

FIGURE 3: SHARED MOBILITY HUB EVSE PHASE 1 SITES AND ALTERNATIVES



4 IMPLEMENTATION PLAN

Selecting Shared Mobility Hubs for electrification is the beginning of an effective EVSE strategic deployment plan. A process and timeline for the actual siting and installation of EVSE involves a coordinated effort to assess infrastructure feasibility, engage appropriate community members and stakeholders, and select final sites (e.g. parking spaces) for EVSE deployment. The steps required to complete these tasks are highlighted in the following section.

4.1 Partners and Responsibilities

The efforts described in this EVSE Roadmap will be carried out by SDOT and its partners described below.[21] Successful implementation of the program relies on strong collaborative partnerships, clearly distinguished roles and responsibilities, frequent and open communication, and methods for tracking deliverables and success throughout the project period. SDOT will develop Subrecipient Agreements and Memorandums of Understanding with official project partners included in the DOE grant, and other partners as appropriate. The roles and responsibilities of each entity are explained below, and **Table 4** summarizes how the roles fit within the primary phases of the project.

Seattle Department of Transportation (SDOT) - SDOT serves as the project manager, and works with project partners to develop the EVSE Roadmap, manage its implementation, and evaluate its success throughout the project period. SDOT will help facilitate necessary conversations between project partners, city stakeholders, and community stakeholders to guide the implementation of the regional strategy outlined in this EVSE Roadmap. SDOT will work with the EVSE provider to develop appropriate wayfinding signage to accompany the EVSE. SDOT will coordinate regional project partner meetings which will occur quarterly (at a minimum) and serve as the line of communication between the Seattle region and other regional partners, as well as the Department of Energy. SDOT holds the funding agreement with the Department of Energy and executes other contracting mechanisms with project partners and additional partners as appropriate. SDOT will not own or have any legal interest in the equipment installed through this agreement.

EVSE Provider - The EVSE provider is responsible for the programmatic implementation of EVSE deployments to serve shared mobility services in the Seattle region. The entity will provide feedback on the EVSE Roadmap and prioritized Shared Mobility Hub list, selecting and securing EVSE deployment sites (e.g. parking spaces) in alignment with the EVSE Roadmap and DOE grant objectives, securing appropriate permits and host agreements with site owners, and installing, maintaining, and operating EVSE deployed. The EVSE provider will own and operate all equipment installed through this agreement and is responsible for complying with terms, conditions, and continuing control obligations for federally funded equipment. The EVSE provider is also responsible for providing EVSE usage data and working with project partners and

[21]This delegation of responsibilities amongst pilot partners and the list of pilot partners is subject to change throughout the pilot period and represents one of many potential implementation models for future electrification efforts the City may pursue.

other entities to find collaborative solutions to evaluate and enhance the program's success over the project period.

Seattle City Light (Electric Power Utility) – Close coordination with the electric service provider is critical to the efficient and successful implementation of EVSE, particularly DC fast chargers, which require significant amounts of power in depot-style implementation plans. As necessary, Seattle City Light (SCL) assists EVSE providers in finding areas near the Shared Mobility Hubs that also have the electrical capacity required to deploy the desired EVSE configurations through the established Electrical Connection Application process. Through this process, SCL can also help identify potential site alternatives to overcome challenges in electrical grid connections.

Shared Mobility Service Providers – This project aims to include a variety of local shared mobility service providers, including providers of car share and ride-hail services. The role and responsibilities of each provider participating in the project will vary based on factors including the provider's business model and their commitment through the awarded grant (if any). Shared mobility service providers will be asked to provide input on a variety of project deliverables that may include the prioritized Shared Mobility Hub list, the EVSE Roadmap, and project evaluations. Providers should update their operating model and messaging (e.g. to gig drivers, fleet technicians, and/or dispatchers) to incorporate new EVSE locations and track the impact of this new infrastructure on operations as feasible. Project participants will work together to develop data sharing agreements to evaluate how new EVSE deployments are impacting EV adoption, trip-making activity, and climate impacts of shared mobility services. The Evaluation section (section 4.6) provides more information on key evaluation questions for shared mobility service providers.

Outreach Provider – The local clean cities coalition, Western Washington Clean Cities (WWCC), will provide targeted outreach and marketing support for regional project partners to use in promoting electric transportation to shared mobility services. Additionally, WWCC will organize and host one workshop for shared mobility service drivers to learn about the benefits of electric vehicles (EVs) and available resources for drivers to make the switch to EVs.

Office of Sustainability & Environment (City EV Lead) – SDOT worked closely with the Office of Sustainability & Environment (OSE) in developing its EVSE Roadmap to ensure it aligns with the citywide EVSE deployment strategy as outlined in the Drive Clean Seattle Implementation Plan. OSE also manages the citywide community engagement strategy on electrification and will lead the marketing and outreach strategy for the DOE grant project. OSE will work with SDOT and Western Washington Clean Cities Coalition to develop marketing materials and a targeted marketing campaign for electrification of shared mobility services.

Third-Party Data Storage Partner –The City of Seattle may work with a third-party data storage partner to ingest and process data from all project partners and provide high-level results to inform the project's evaluation and strategic deployment plans.

Other City Partners: Other departments may contribute to the project as necessary including the Seattle Department of Construction and Inspections (SDCI), the Office of Planning and Community Development (POCD), Department of Neighborhoods (DON), and Seattle Information Technology Department (Seattle IT).

TABLE 4. ROLES AND RESPONSIBILITIES[22]

	SDOT	EVSE Provider	SCL	Shared Mobility Service Providers	Outreach Provider	OSE
Program Development	● Lead	● Participant		● Participant	● Participant	● Participant
Community Outreach & Engagement	● Participant				● Lead	● Participant
Electrical Feasibility Analysis			● Lead			
Site Selection & Deployment	● Participant	● Lead		● Participant		
Program Evaluation	● Lead	● Participant		● Participant	● Participant	● Participant
EVSE Operation & Maintenance		● Lead				

● (blue) = Participant
● (black) = Lead

4.2 Community Engagement

The first steps for installing public EVSE in all neighborhoods in the city should be meaningful outreach, engagement, and education efforts to convey the benefits of EVs and to identify the primary barriers for EV adoption. The local clean cities coalition, Western Washington Clean Cities (WWCC), will provide targeted outreach and marketing support for this project. SDOT is also developing an EVSE Equity Toolkit to provide guidance to EVSE installers and encourage project partners to implement these strategies as feasible.

Additionally, learnings from the separate citywide outreach and engagement strategy on electrification led by OSE can further inform implementation strategies for this EVSE Roadmap. Outreach, engagement, and partnership development should take place in areas identified as "high displacement risk" to ensure communities' concerns around potential gentrification and displacement related to the deployment of EVSE are addressed. More detail on this process is described in the Equity and Displacement Mitigation section of the EVSE Roadmap.

4.3 Site Feasibility

The feasibility of a particular site is based upon a number of factors related to the electric grid, the spatial feasibility of the site, and the access available to the EVSE.

ELECTRICAL FEASIBILITY

After selecting preliminary sites at or near a prioritized Shared Mobility Hub, the site must be evaluated for electrical feasibility, including three-phase power for DC fast chargers. New EVSE may require installation of a new three-phase transformer bank on a 'free' electric pole, or there must be an existing three-phase transformer bank of the appropriate voltage for the EVSE nearby to serve the site. There are some pole framing configurations that also prohibit the installation of new transformers within the City of Seattle, including poles located at geographical street corners, primary termination poles, and switch poles.

The distance of the electric pole to the EVSE site may impact the costs for installation. For example, with a minimum of approximately $2,000 to $3,000 required to connect to a pole, every additional 50 feet of conduit and wiring necessary to reach a site adds approximately $1,000 to $2,000 to the cost. If the site requires

[22]This EVSE Roadmap strategy and delegation of responsibilities amongst project partners is subject to change throughout the project period and represents one of many potential implementation models for future electrification efforts the City may pursue.

extensive engineering, additional costs may apply. Installation of conduit and trenching are not included in this estimation. There are two methods to obtain the information necessary to develop a more accurate cost estimate for a particular site:

1. Submit an Electrical Connection Application for the site to SCL
2. Discuss with SCL options for gaining access to limited grid information at desired site(s)

SPATIAL AND ACCESS FEASIBILITY

Beyond identifying the feasibility for the electrical connections, spatial feasibility incorporates elements such as topography, barriers such as water and freeways, and access restrictions. Sites should be located where possible on level terrain to limit the difficulty of connecting a vehicle to a charger. Freeway and arterial access near the Shared Mobility Hub should be mapped to ensure that a connection to the hub from the charging site is possible without encountering barriers such as water crossings. In addition, sites that are not within the public right-of-way should allow for easy in and out access, preferably with no additional parking fee.

4.4 Car Share and Ride-hail Charging Location Siting Considerations

As referenced earlier in the model development section, the siting of EVSE at Shared Mobility Hubs for car share versus ride-hailing is based upon different operating conditions of the two respective providers. Leveraging stakeholder feedback and a literature review, **Table 5** highlights the background and considerations that may guide where EVSE is located at or near Shared Mobility Hubs. Specific site elements around a Shared Mobility Hub, such as the electrical connection feasibility and available on-street spaces, may determine where EV charging stations are located and therefore whether they may be deemed car share and/or ride-hail charging locations.

TABLE 5. CAR SHARE AND RIDE-HAIL EVSE SITING CONSIDERATIONS

Car Share EVSE Siting Proximity Considerations	
One to two blocks (330 to 660 feet)	• Park & Ride planning guidelines identify optimal distance for the furthest parking space to be placed between at most 300 to 600 feet away from the transit stop[23] • On-street space directly adjacent to a Shared Mobility Hub is prioritized for transit • EVSE should be sited near or at the designated car share parking spaces if possible[24] • Clear wayfinding and signage to direct users from a Shared Mobility Hub to a car share EVSE location
Ride-hail EVSE Siting Proximity Considerations	
Quarter- to half-mile	• Ride-hail driver focus group prioritizes charging locations within a close walk of amenities for use while vehicle is charging (shopping, restroom, etc.) • Ride-hail customers' and providers' optimal wait time is approximately three minutes • Ideal drive time of two to three minutes (approximately up to a half-mile during peak commute times) to provide optimal wait times for riders, and to not use on-street spaces directly adjacent to Shared Mobility Hubs for ride-hail vehicle charging

[23]Transit Cooperative Research Program (TCRP) Report 153 and TCRP Report 192. Ranges are based on transit service context such as mode (light rail, bus, commuter rail, etc.) and surrounding land use context (urban, suburban, rural, etc.)
[24]Locating near the designated car share parking would support the shared mobility providers fleet tech services by allowing vehicles to rotate from charging spaces to designated parking spaces with limited travel time required. Locating at the designated space could instead allow customers to plug in a vehicle at the end of their trip.

FIGURE 4: EXAMPLE RECOMMENDED EVSE ZONE PLACEMENT FOR A SHARED MOBILITY HUB[25]

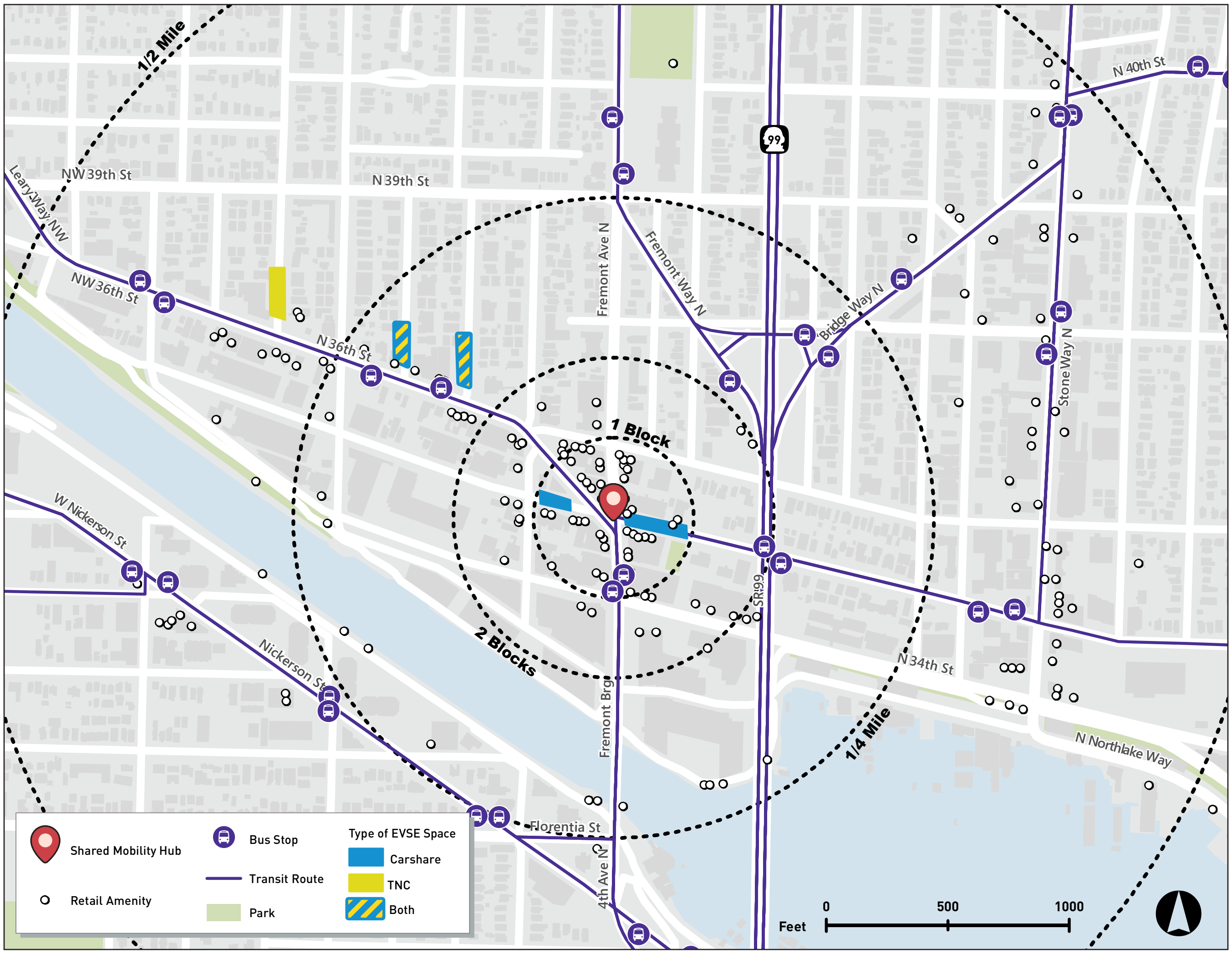


Figure 4 shows an example layout for where particular EVSE spaces may be located around a Shared Mobility Hub, in this case, the Fremont Avenue N/N 34th Street location. The close-in spaces (in blue) may be ideal for car share parking, with adjacent EVSE provided. This is ideal for a free-floating car share model with designated EV charging at reserved car share parking spaces where customers can plug in a vehicle at the end of their trip. However, car share providers with a fleet-tech services model, which is currently the only model operating in the City of Seattle, can still benefit from spaces further out (in the blue/yellow hatching within a quarter-mile distance of the hub), as they can move recently charged vehicles from those locations to adjacent parking near the Shared Mobility Hub in just a few minutes. The potential EVSE zone for ride-hail drivers (in yellow) is located between a quarter- and half-mile from the Shared Mobility Hub and has nearby retail amenities with easy access to the primary arterial of N 36th Street. This still provides an approximate three-minute drive-access time for a ride-hail driver to reach the Shared Mobility Hub. While locations across the Ship Canal may be within a half-mile of the Shared Mobility Hub, the drive time for access would likely exceed the optimal three to five minutes due to added congestion to cross the Fremont Bridge.

[25]EVSE is not restricted to being located within the public right-of-way

Spaces specifically designated for ride-hail and/or car share vehicles may be defined ahead of time but will largely depend on site feasibility and stakeholder feedback. For example, any sites that are within a two-block walk from the Shared Mobility Hub might be designated for car share vehicles only, and spaces that are between two blocks and a half-mile might be used by both providers and available for general public use.

4.5 Site Types and Timeline

Once feasible sites are identified near a prioritized Shared Mobility Hub, the EVSE provider is responsible for programmatic elements of implementation, installation, operation, maintenance, and all associated costs for EVSE deployments in alignment with the objectives of this EVSE Roadmap and the DOE grant objectives. The timeline and process for installation depends on the property type. Sites may be on public right-of-way, another type of city-owned property, or private property such as in a parking lot or garage. SDOT administers a standardized permitting process called the Electric Vehicle Charging in the Public Right-of-Way (EVCROW) Pilot Program for right-of-way-sites. Non-right-of-way locations require a site host agreement between the EVSE service provider and the property owner.[26] It is important to identify multiple potential sites in a given area because many potential sites will pose unforeseen challenges in site feasibility, host negotiations, or construction.

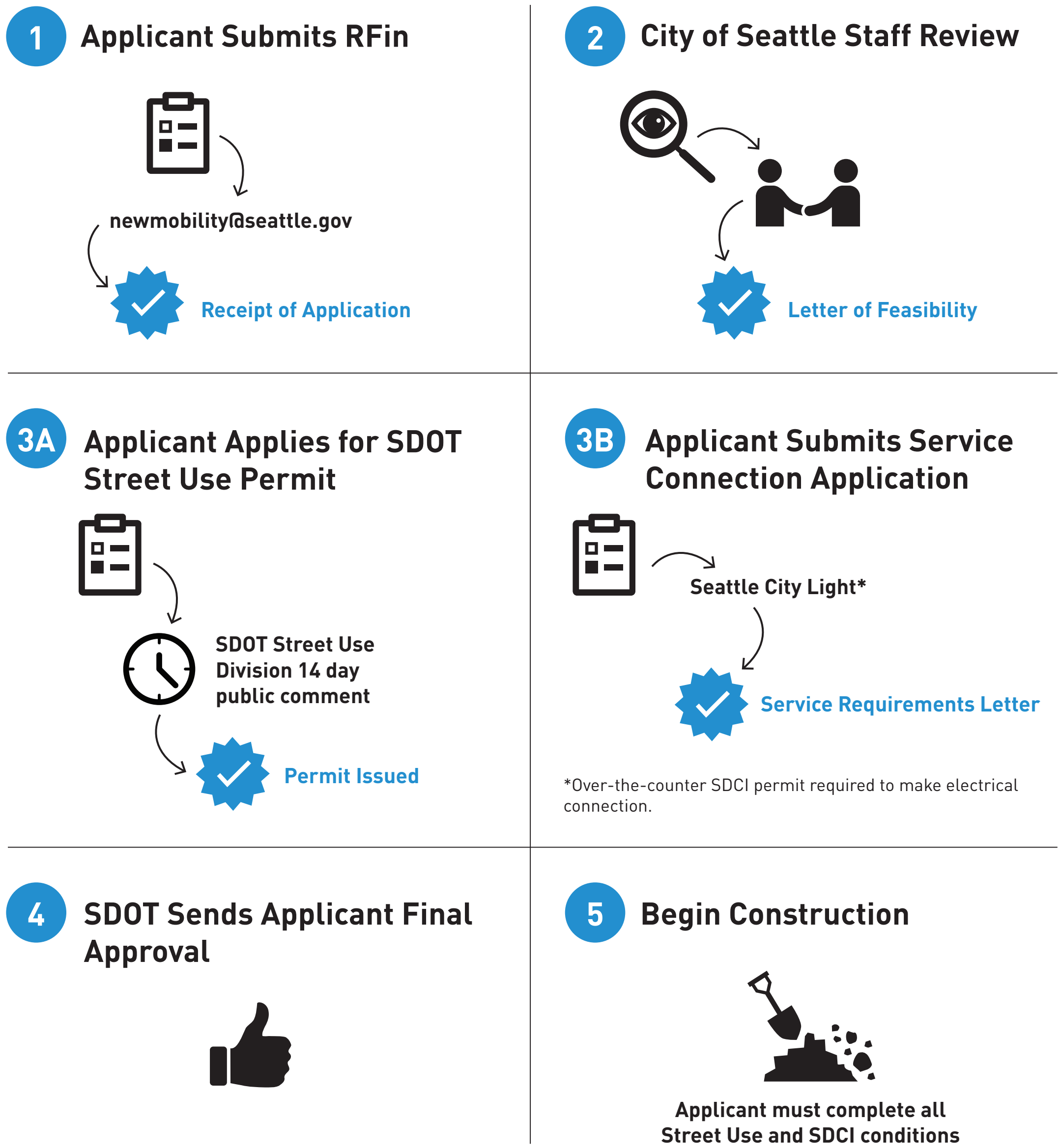
RIGHT-OF-WAY SITES

All right-of-way (ROW) charging locations will require several steps for permitting approval and installation that involve multiple city departments, including but not limited to SDOT, SCL, SDCI, and OSE. In addition to the steps outlined below and in the EVCROW pilot program requirements, site designers should work to incorporate elements the community expressed interest in as feasible, as determined through the community outreach and engagement process. Time requirements will vary by site with an approximate timeline for installations via the EVCROW pilot program shown in **Figure 5**.

Sites located in the ROW are subject to the EVCROW pilot program requirements and permitting process. Sites must be situated to meet clearance requirements (e.g., pedestrian clear zones, ground space, and accessibility requirements) and minimize impacts on mobility. Site designs should reduce the footprint of cabinets, meters, and similar infrastructure to support the EV charging station in the ROW. Additionally, curb spaces may be affected by new construction and capital projects. The EVCROW permit review process is designed to find and proactively address potential conflicts and competing uses of the ROW including upcoming capital projects, future bike plans, and rapid ride corridors.

[26] For public facilities, the property owner may be the city or another government entity.

FIGURE 5: EVCROW APPLICATION PERMITTING PROCESS AND TIMELINE



	MONTH 1	MONTH 2	MONTH 3	MONTH 4	MONTH 5
Step 1	48 hours				
Step 2	2 weeks				
Step 3A		4-6 weeks			
Step 3B			8-12 weeks		
Step 4				1 week	
Step 5					Construction

The EVCROW timeline is subject to change and is not guaranteed by SDOT or other departments participating in the permitting process.

Source: EVCROW Program, 2018

OTHER PUBLIC OR PRIVATE SITES[27]

Universities, hospitals, and hospitality and venue destinations are often ideal locations for EV charging infrastructure. It is often the case that these organizations are also interested in more convenient access to green transportation options for their constituents. Charging infrastructure located on private property will require a signed agreement between the EVSE provider and the property owner. This is a legal agreement adapted to each site and mutually agreed upon by both parties, not including SDOT. The EVSE provider is responsible for executing a site host agreement that ensures EVSE will be designed and operated in a manner that fulfills the DOE grant objectives, the goals of this EVSE Roadmap, and that data will be available to evaluate EVSE use for the purposes of the grant project. When such sites are identified, the following 10-step process outlines steps to secure the site with an estimated timeline provided. However, these sites can be difficult to approve due to the lengthy review and internal approval process.

TABLE 6. STEPS AND APPROXIMATE TIMELINE FOR NON-RIGHT-OF-WAY SITE ACQUISITION

	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6	Month 7
1. Initial site identification and tentative host approval.							
2. Conduct a site assessment.							
3. Site host stakeholder review.							
4. Review agreement draft.							
5. Negotiate terms of agreement.							
6. Order site engineering drawings and permits.							
7. Schedule construction.							
8. Conduct pre-construction, on-site safety meeting, and construct sites.							
9. Post-construction inspection and sign-off.							
10. Go-live meeting.							

[27]This section is provided as general guidance as SDOT is not involved in the host acquisition process for non-ROW sites.

Other elements to consider before a site is operational include the following:

- Revenue processing and fee structure: Most likely, chargers will require credit card payment or payment through a mobile application. The charging fees will need to include parking payment at right-of-way sites.
- Appropriate messaging: Information available at each site may include messaging regarding the fee structure, environmental benefits of electric vehicles, or other community information. Where feasible, messaging should be made available in the language of the community. Messaging may be wrapped on the equipment or provided through accompanying signage nearby the station. The EVSE provider and SDOT will work together to determine appropriate messaging at each site.
- Wayfinding signage: Appropriate wayfinding signage should be installed prior to EVSE operations. EVSE provider will work with SDOT to plan appropriate wayfinding signage and coordinate installations of signage with EVSE.
- Site monitoring: SDOT should work with local law enforcement to explain what an EV charging station is and its users' expected behavior, particularly in the context of right-of-way charging locations.

4.6 Evaluation

Evaluating the success of this program will involve establishing a clear set of performance metrics and ensuring consistent data monitoring and collection. Project partners will be responsible for providing data to SDOT or a designated third party in accordance with their data sharing agreements.[28] While measuring increased ownership of EVs requires a longer timeline to establish a trend, near-term evaluations will primarily focus on how new EVSE is being used and what factors are influencing demand. Data collected will inform updates to the Dynamic EVSE Siting Model to inform the final selection of Shared Mobility Hubs to electrify in Phase 2 of this project (October 2019-September 2020) and site selection at or near the hubs. This evaluation plan for the electrification of Shared Mobility Hubs will also be integrated into the broader Shared Mobility Hub Toolkit evaluation plan (forthcoming).

EVSE DEMAND

SDOT will collect data from the EVSE provider(s) via access to their Application Programming Interface (API) or monthly reports to understand how demand for EVSE installed through the grant varies between locations and among customer typologies (if available). Usage data from EVSE installed through the DOE grant project will be compared to usage data from EVSE installed through the broader EVCROW pilot to evaluate the demand for EVSE deployed to serve Shared Mobility Hubs compared to that of EVSE deployed generally across the city. Additionally, the EVSE demand evaluation will be used to estimate the reduction in greenhouse gas (GHG) emissions and electric vehicle-miles traveled (eVMT) as a result of the increase in charging infrastructure. Specific questions to be addressed by data collected from EVSE providers may include:

- Does providing well-located charging at Shared Mobility Hubs help to encourage EV use on car share and ride-hail platforms?
- How often was EVSE used by car share and ride-hail drivers?
- What are the usage patterns of EVSE at Shared Mobility Hubs and how might those differ from usage patterns of EVSE not installed at Shared Mobility Hubs (from general EVCROW pilot)?
- How does the usage of EVSE compare across different EVSE locations installed through this project?

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[28]All data sharing under this project must comply with City policy and relevant law.

CAR SHARE AND ACCESS-TO-TRANSIT IMPACTS

Through the car share permitting program, car share operators provide SDOT access to their API to track the vehicle locations in real-time. SDOT will use this data to evaluate if vehicles are starting and ending trips at Shared Mobility Hubs and using EVSE installed through this project as available. Additionally, car share providers could obtain the charging locations for each vehicle from fleet-technicians. SDOT can track EV and non-EV car share vehicles and identify differences in the usage of vehicles by fuel-type over time. Location data of car share EVs in real-time can be used to estimate eVMT and GHG emissions avoided. Specific questions to be addressed by car share partners include:

- Are car share services using the EVSE deployed through this project?
- Are car share trips starting or ending near the Shared Mobility Hubs?
- How many of the miles driven on the service are electric vehicle miles?
- What are the GHG savings associated with the electric vehicle miles driven?
- How does EV use compare to non-EV use on the same platform?
- Is there an increase in the number of EVs operating and electric miles driven in carsharing over the course of the project?

EV ADOPTION BY RIDE-HAIL DRIVERS

The City of Seattle is working to partner with ride-hail providers to assess the potential increase in EVs and eVMT as a result of the increase in EVSE through this project. In addition, opportunities to engage directly with drivers through surveys, workshops, or focus groups could provide valuable information to evaluate the project's success. If available, data collected from ride-hail providers would be used to answer the following questions:

- Are ride-hail drivers using the EVSE deployed through this project?
- Are ride-hail trips starting or ending near Shared Mobility Hubs?
- How many of the miles driven on the service were electric vehicle miles? How many person-miles (considering shared trips if available)?
- What are the GHG savings associated with the electric vehicle miles driven?
- How does EV use compare to non-EV use on the same platform?
- Is there an increase in the EVs operating and electric miles driven in ride-hail services over the course of the grant period?

5 EQUITY & DISPLACEMENT CONSIDERATIONS

Recognizing that past transportation investments and policies have resulted in some communities receiving disproportionate benefits (e.g., quality, frequency, and reliability of transit service) and other communities bearing disproportionate burdens (e.g., air pollution and exclusion from decision-making processes), SDOT aims to ensure that historically marginalized communities are empowered to participate in the design and implementation of EVSE deployments in their neighborhoods and investments provide benefit to the community. SDOT's overarching strategy to equitably deploy EVSE will be contained in its EVSE Equity Toolkit (in development), and grant partners will work to integrate these strategies into EVSE deployments as feasible.

Because EVSE deployments for the DOE grant project are not part of an SDOT program, but rather a partnership between the private and public sector, SDOT will provide guidance on the implementation of EVSE Equity Toolkit elements in collaboration with project partners and in alignment with the citywide outreach and engagement strategy. It is important to note that EVSE deployments through the grant project are geared toward shared mobility EV drivers, not general EV owners, when assessing potential equity and displacement impacts. The following are key elements from the EVSE Equity Toolkit that may be utilized in the context of this project.

Employ the Citywide EV Communication and Outreach Strategy
Work with other City of Seattle departments and partners to begin early conversations and outreach activities in areas of high displacement risk prior to selecting sites for electrification. Communication and outreach should begin with broader messaging around the benefits of transportation electrification and the Drive Clean Seattle program, and seek first to understand the general transportation needs of all community members. This may include a discussion on how other transportation-related investments could complement an EVSE installation to improve overall access and mobility.

Improve EV Access
Installing EV chargers in communities of color and communities with members of low-income alone may not benefit the people who live in those communities, especially those in high danger of being priced out of their neighborhoods due to new development and/or rising housing costs. Improved access to EVs can help ensure that EV chargers deliver benefits to low-income communities and communities of color. Collaboration with project partners, City partners, and outside organizations to couple vehicle access with EVSE deployments is important. This could be done through the implementation of a low-income community EV car share pilot.

Gather Input on Siting Considerations

Begin or continue the dialogue with community members and key stakeholders to understand local considerations for siting EVSE. The process may incorporate potential opportunities to engage with local businesses and provide an additional amenity (EV charging) at key centers within the community, and discussions of constraints related to curb space. Potential communities to engage in this conversation include community associations (e.g., University Heights, Somali Association, Ethiopian Community Center, Vietnamese Friendship Association, El Centro de la Raza, SeaMar Community Health Centers, among others), and neighborhood associations and libraries (e.g., South Park Community Center, NewHolly Campus, Columbia City neighborhood, Phinney neighborhood, Hiawatha Community Center, Rainier Community Center).

Consider and Pre-emptively Address Displacement Risks

Work with communities to understand how and where to deploy EVSE to serve their needs to reduce the potential risk for EVSE to exacerbate community displacement. Efforts should be made to not deploy EVSE in areas with high demand for on-street parking where EV ownership in the community is low. Engage with the community to discuss trade-offs in right-of-way allocation versus private garage access, mitigation of potential parking space loss, and alternative siting opportunities. Consider deploying EVSE in private lots nearby with excess parking and/or in conjunction with access to EVs, for example through a community EV car share program. Although it is difficult to measure the direct impact of EVSE on broader community displacement, SDOT could work with OPCD and other community partners to evaluate if EVSE deployments have impacted nearby businesses and residences with regards to the cost of rent, clientele, ownership, etc.

Establish Feedback Loops

Create a channel for community members to easily report issues with EV chargers in their neighborhood and track the concerns to influence programmatic improvements and future siting considerations. This can be done through community liaisons, focus groups, post-deployment surveys, or a "contact us" sticker on the EVSE and/or SDOT EV programs website. Additionally, develop an ongoing conversation with community members related to electrification efforts. This can be done by monitoring the current community perception of EVSE and EVs by engaging with community members routinely before and after the EVSE is operational. Work to understand how the community feels about potential EV ownership, how or if EVSE can serve as a catalyst to support other community-based investments, and what other concerns remain for EVSE siting, such as safety, right-of-way restrictions, and costs.

Address Safety Concerns with EVSE

Ensure that areas in which EVSE are installed have appropriate lighting and visibility and that parking restrictions will be enforced. Work to explain to local law enforcement what an EV charging station is and its users' expected behavior.

6 FUTURE CONSIDERATIONS

This EVSE Roadmap provides guidance for the deployment of EVSE to serve Shared Mobility Hubs in the City of Seattle over the two-year deployment phase for the DOE grant (October 2018-September 2020). Learnings from the evaluation of Phase 1 deployments should be integrated into future updates to this document. This document will also be integrated into Seattle's Shared Mobility Hub Toolkit and evaluation plan (forthcoming) to ensure considerations for EVSE siting are a priority in the development of Shared Mobility Hubs.

Future considerations for the EVSE Dynamic Siting Model might address the noted model limitations. As previously described, some limitations of the model required a qualitative and contextual interpretation of the results to ultimately finalize the priority hubs for EVSE deployment. Some elements that could be incorporated to address the limitations include:

- An input metric that highlights key transportation-related projects to align priorities around areas with upcoming construction and/or changing needs in travel demand (e.g., Viaduct removal increasing the demand for the Water Taxi).
- The ability to test EV charging location scenarios to understand impacts to the prioritization scoring in real time, such as a separate metric that allows a user to plot out potential future EVSE.
- A process to continuously update the Displacement Risk layer.
- A more complex EVSE metric that looks at density and distance between charging locations to plan out a more comprehensive EVSE network within the model as opposed to using a post-model process.
- Potential inclusion of more detailed site-specific data such as electric infrastructure, parking space availability, topography, and right-of-way information. The inclusion of this information would extend the ability of the model to not only prioritize areas at a high-level for EVSE, but to look at more block-level data to inform actual siting feasibility.

Many shared mobility drivers work in the City of Seattle but live outside the city. Other organizations could use this EVSE Roadmap as a template for their own planning, which will help support more EVs in shared mobility services. If future resources became available, the underlying objectives and framework of the current EVSE Roadmap could apply or be appropriately adjusted throughout the region to address context specific concerns as other cities look to increase the electrification of shared mobility services.

The Dynamic EVSE Siting Model could also be expanded regionally with a few adjustments to provide regional proxies for Seattle-specific data sources currently included. A coordinated regional strategy for EVSE deployment could improve the regional EV network and support more shared mobility EV drivers who frequently traverse city boundaries.

APPENDIX A: LITERATURE REVIEW

The following studies, sources, and plans were reviewed to inform the EVSE Roadmap.

- National Renewable Energy Laboratory Charging Electric Vehicles in Smart Cities: An EVI-Pro Analysis of Columbus, OH, 2018
  www.nrel.gov/docs/fy18osti/70367.pdf
- Analysis of Fast Charging Station Network for Electrified Ride-Hailing Services, 2018
  www.researchgate.net/publication/324255956_Analysis_of_Fast_Charging_Station_Network_for_Electrified_Ride-Hailing_Services
- BART Multimodal Access Design Guidelines, 2017
  www.bart.gov/sites/default/files/docs/BART%20Multimodal%20Access%20Design%20Guidelines.pdf
- Integrated Approaches to EV Charging Infrastructure and Transit System Planning, 2016
  www.nctr.usf.edu/wp-content/uploads/2018/04/020817-79060-02-C-UIL-Integrated-Approaches-to-EV-Charging-Infrastructure.pdf
- EV Shared-Use Mobility Program A Transportation Electrification Concept, 2017
  atlaspolicy.com/wp-content/uploads/2017/04/2017-04-06_Shared_Use_Mobility_Concept_Summary.pdf
- California Statewide Plug-In Electric Vehicle Infrastructure Assessment, 2014
  www.nrel.gov/docs/fy15osti/60729.pdf
- Regional Charging Infrastructure for Plug-In Electric Vehicles: A Case Study of Massachusetts, 2015
  www.nrel.gov/docs/fy17osti/67436.pdf
- An Analytical Planning Model to Estimate the Optimal Density of Charging Stations for Electric Vehicles, 2015
  journals.plos.org/plosone/article?id=10.1371/journal.pone.0141307
- Electric Vehicle Charging Station Location Problem: A Parking-Based Assignment Method For Seattle, 2013
  www.caee.utexas.edu/prof/kockelman/public_html/TRB13EVparking.pdf
- WMATA Station Site and Access Planning Manual, 2008
  www.wmata.com/initiatives/plans/upload/SSAPM.pdf
- City Of Portland Electric Vehicle Strategy, 2016
  www.portlandoregon.gov/bps/article/619275
- LA Metro First Last Mile Strategic Plan, 2016
  media.metro.net/docs/First_Last_Mile_Strategic_Plan.pdf
- Mohawk Valley Electric Vehicle Charging Station Plan, 2016
  www.ocgov.net/sites/default/files/hoctsmpo/MohawkValleyEVChargingStationPlan/Mohawk%20Valley%20EV%20Charging%20Station%20Plan%20FINAL.pdf
- Simulation of Ridesourcing Using Agent-Based Demand and Supply Regional Models: Potential Market Demand for First-Mile Transit Travel and Reduction in Vehicle Miles Traveled in the San Francisco Bay Area, 2017
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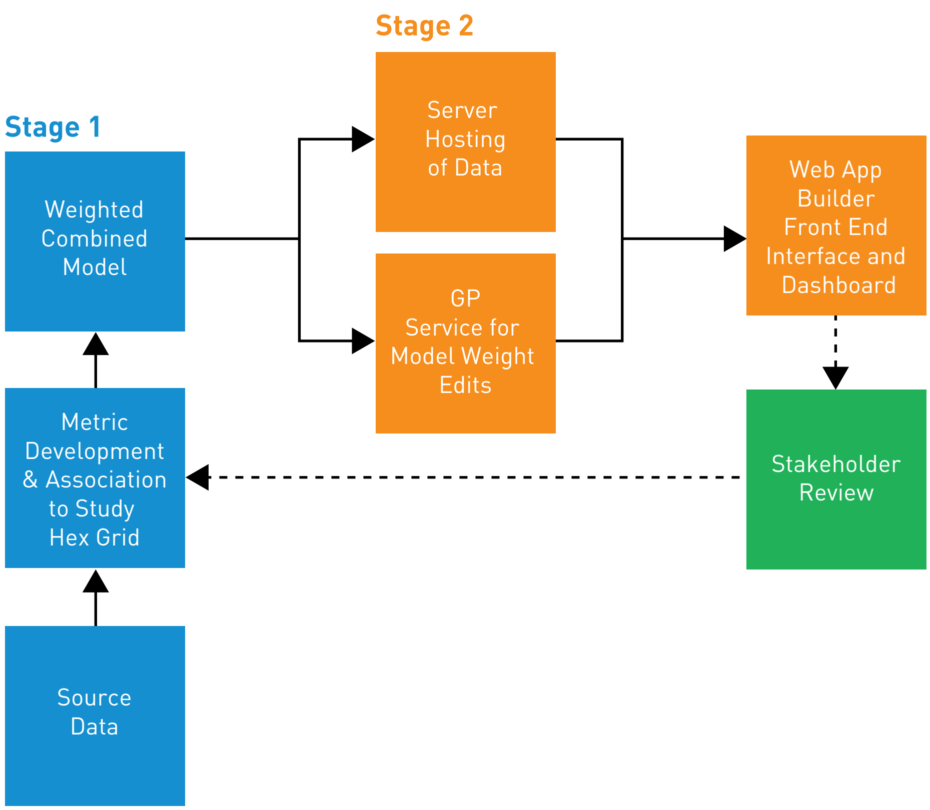
APPENDIX B: MODEL DEVELOPMENT PROCESS AND METRIC METHODOLOGY

The siting model design process is depicted in the figure below and the methodology behind each metric is described in this appendix.

FIGURE 1: SITING MODEL DEVELOPMENT DIAGRAM



Stage 1: Represents an analysis process of data collection, data processing, metric development, and initial model criteria weighting based on initial research and feedback from stakeholder review.

Stage 2: Represents a deployment of backend and frontend technologies to host analysis results, background data, and geoprocessing services to provide a tool and dashboard for users to interact with the data.

Stage 1 - Unit of Analysis for EVSE Prioritization

To provide a disaggregated outlook of suitable locations for EVSE, a 10-acre hex grid was developed for the City of Seattle. A 10-acre hex grid represents roughly a two-block distance across. This hex grid is the final study geography that was used to bring together all the inputs for final scoring in the EVSE Dynamic Siting Model.

Stage 1 - Metrics Development

With the identification of appropriate data sources, an iterative design process established appropriate methodologies to incorporate the data into the model and fit it within the hex grid unit of analysis. Integrating the metrics into the citywide hex grids required aggregating the data based on the individual data source. Approximately half of the data were based on the census block group level geographical unit, while the other half were more disaggregated spatial datafiles. When using more aggregate data such as block group or zip code data, the approach used was to spatially join the data with a higher aggregation level to the hex grids, but for more disaggregated data a common approach is a buffer analysis to identify the total number of elements within a certain distance around the hex grid. In order to develop a precise estimate of the total number of elements within the search distance, distance decay functions were applied to associate more weight to elements closer to the hex grid. This applied to the Parking Turnover, EV Charging, and Retail Amenities metrics. A modified decay function weighting was applied for the Highway Access Proximity metric to assign the highest weighting for points located between a quarter- and a half-mile from the hex grid. For example, for the retail amenities index, if ten amenities are located between 330 and 660 feet away from a hex grid, then they add eight to the total (or 80 percent of 10).

DISTANCE DECAY FUNCTIONS

	Weighting Applied for by Distance	
Distance from Hex a Grid (feet)	Decay Function	Modified Decay Function for Highway Access Proximity
0 – 330	100%	0%
330 – 660	80%	20%
660 - 1,320	40%	50%
1,320 - 2,640	20%	100%
2,640 - 5,280	0%	50%
5,280 - 10,560	0%	20%

Stage 1 - Weighted Combined Model

Including a number of disaggregate data sources requires an understanding of the relation between data, the potential for correlation, and the underlying basis of inclusion of each dataset. This process developed appropriate weights for each metric to align with the overall model objectives and to ensure multi-collinearity was addressed. Larger weights were assigned to metrics deemed important through literature review and stakeholder feedback. Metrics with high levels of correlation between other metrics were given a lower weight to ensure the model is not incorrectly biased toward a specific metric.

Stage 2 - Backend and Frontend Final Interface

The second stage of the model development established the backend data hosting and geoprocessing (GP) steps to provide a stable, usable front-end interface for viewing and interpreting the model results and to allow for adjustments to the baseline model framework. The geoprocessing service allows users to test prioritization strategies to understand how different metrics impact the model results. The frontend interface provides a means to share the relevant data and model results with stakeholders and internal city staff.

PRIORITIZATION AREA METRICS: SHARED MOBILITY

Car Share Demand	
Justification	The data used to determine Car Share Demand is a direct measurement of trip arrivals and departures. It indicates locations (blockfaces) where car share services are currently being used.
Methodology	1. Aggregate total arrivals and departures by block group and normalize by area and time to measure arrivals/departures per day per square mile 2. Spatially join block group level data to hex grid centroids 3. Calculate percentile score values to develop a final index
Considerations	The car share data indicates existing car share demand from one vendor. It does not differentiate between EV and non-EV car share usage.
Parking Turnover Index	
Justification	Parking costs (time and monetary) are good indicators of whether a trip via a ride-hail or car share service will be more convenient.
Methodology	1. Determine proximity to all on-street parking signs that indicate a passenger drop-off zone, timed parking, or priced parking 2. Determine proximity to all priced public garages 3. Merge the two files and apply the "Car Share Proximity Function" to the count within a half-mile of each hex grid 4. Calculate percentile score values to develop a final index
Considerations	This is a proxy metric with a basic representation attempting to capture locations that are likely to have high parking costs or turn over.
Ride-hail Demand	
Justification	The data used to represent ride-hail demand is a direct measurement of trip arrivals and departures. It indicates locations where ride-hailing services are currently being used.
Methodology	1. Aggregate total arrivals and departures by zip code and normalize by time to represent trips in terms of arrivals and departures per day 2. Use American Community Survey (2012-2016) to determine rates of non-Single Occupancy Vehicle (SOV) commute trips at the census block group level 3. Use rates of non-SOV commute trips to down sample data from the zip code to the block group level 4. Spatially join block group level trip totals to hex grid centroids 5. Calculate percentile score values to develop a final index
Considerations	The down sampling method used for the zip code level data depends on a proxy metric for ride-hail demand based on the rate of non-SOV trips. While at a zip code level the data is the same, the local distribution is altered to be consistent with other model inputs such as carsharing demand at the blockgroup level.

PRIORITIZATION AREA METRICS: TRANSIT ACCESS

Transit Access	
Justification	This metric aims to identify areas that have poor access to high quality transit services. It is assumed these areas could strongly benefit from more electric shared mobility options which could be used for first- and last-mile solutions to access transit.
Methodology	1. Run the documented GTFS processing tools that count the number of high frequency routes (10 minutes or less) on a weekday AM Period 2. Determine distance each hex grid is from all stops with high frequency transit 3. Spatially join the stops to the hex grid. Each hex within a half mile of a stop is associated with the stop with the highest number of high frequency routes stopping at it 4. Invert the percentile score (1 - score) values to develop a final index
Considerations	The Transit Access score is based on the transit stop with the highest number of frequent routes within a half mile of a hex grid and then inverted. It measures poor access to a network of high frequency transit routes.
Zero-Vehicle Households	
Justification	This proxy metric aims to measure areas with households with a higher propensity to benefit from increased access to electric shared mobility services.
Methodology	1. American Community Survey (2012-2016) Means of Transportation to Work to determine the percent of zero vehicle households. 2. Spatially join block group level data to hex grid centroids 3. Calculate percentile score values to develop a final index
Considerations	This metric is also a proxy for shared mobility demand but is distinct enough to be helpful in determining locations with fewer options for traditional modes of travel (transit and automobile travel).

PRIORITIZATION AREA METRICS: EQUITY

Low-income Households	
Justification	This metric helps to create a proxy for communities that have historically experienced disinvestment.
Methodology	1. Use EJScreen (2017) data from the United States Environmental Protection Agency (EPA) to determine percent of low-income households at the census block group level 2. Calculate percentile score values to develop a final index
Considerations	This variable addresses equity and environmental justice considerations related to long-term disinvestment and helps prioritizes these areas for future EV charging investments.*
Minority Households	
Justification	This metric helps to create a proxy for communities that have historically experienced disinvestment.
Methodology	1. Use EJScreen (2017) data from EPA to determine percent of minority households at the census block group level 2. Calculate percentile score values to develop a final index
Considerations	This variable addresses equity and environmental justice considerations related to long-term disinvestment and helps prioritizes these areas for future EV charging investments.*
Traffic Pollution Index	
Justification	This dataset is used as proxy metric for air pollution exposure from traffic.
Methodology	1. Use EJScreen (2017) data from EPA to determine the Average Annual Daily Traffic on major roads at the census block group level 2. Calculate percentile score values to develop a final index
Considerations	This variable provides a rough proxy of air pollution that might be due to vehicular emissions. It is intended to serve as a measure of pollution burden that could be gradually mitigated with the increased adoption of EVs.

*We recognize that historically disinvested communities are correlated with those both currently experiencing displacement and at risk of experiencing future displacement. To avoid exacerbating ongoing displacement, potential sites in areas with high displacement risk will be identified for a separate, more robust process as outlined in the EVSE Equity Toolkit (currently in development).

PRIORITIZATION AREA METRICS: EV NETWORK

Existing EV Chargers	
Justification	Identifying gaps in the EV charging network is a primary objective of the model, and this metric prioritizes areas with zero or lower amounts of charging infrastructure
Methodology	1. Determine number of DC fast chargers and L2 chargers within 1/2 miles of the hex grid 2. Weight each DC fast charger 12x that of an L2 charger (based on the charging time) 3. Apply Car Share Proximity function to the sum of chargers in range 4. Assign a score based generally on the following ratios (number of L2 chargers slightly changes the specific score): • 0 DCFC chargers – 1 • 1 DCFC charger - .75 • 2 DCFC chargers - .5 • 3 DCFC chargers - .25 • >4 DCFC chargers - 0
Considerations	This data is provided National Renewable Energy Laboratory (NREL) and is updated regularly.
Retail Amenity Access	
Justification	Ride-hail drivers from the focus groups prefer to charge in areas with nearby retail amenities.
Methodology	1. Select amenities relevant to shopping areas and stop overs (tags groups from shop & amenities): {food: [bar, cafe, bbq, fast_food, food_court, restaurant] , shop: [convenience, mall, supermarket, department store, general]} 2. Apply Car Share Proximity function to the count of amenities within range 3. Calculate percentile score values to develop a final index
Considerations	Amenity data is based on OpenStreetMap (OSM), a crowdsourced database where volunteered geographic information is contributed under an open database license.
Highway Access	
Justification	Ride-hail drivers from the focus groups prefer to use chargers with easy access to major freeways.
Methodology	1. Select OSM links with highway tag equal to "motorway_link" (on/off ramps) 2. Determine distance of each hex grid to the "motorway_link" 3. Apply ride-hail proximity function to a sum of interchanges in range 4. Percentile score values to develop a final index
Considerations	Highway network data is based OpenStreetMap, a crowdsourced database where volunteered geographic information is contributed under an open database license.

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