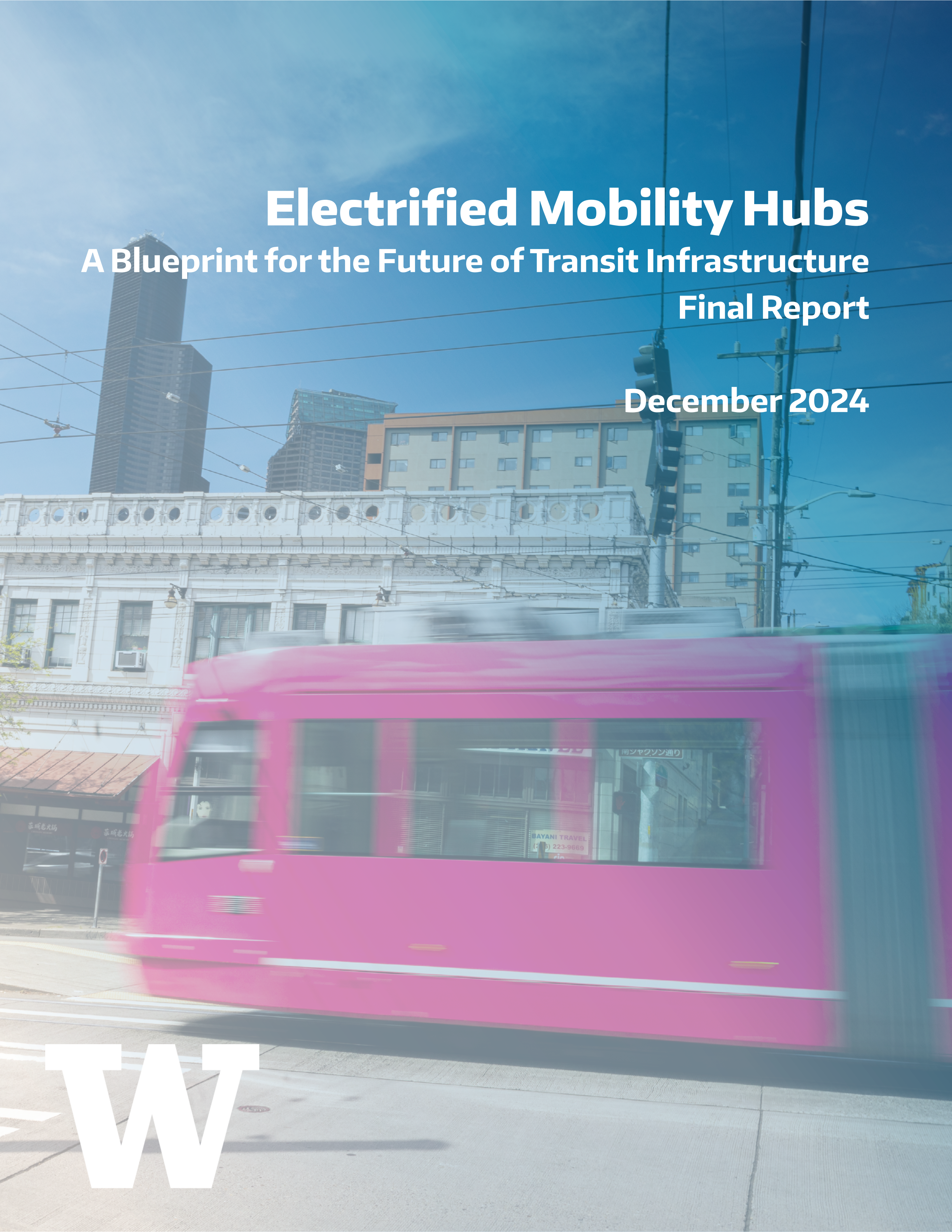
# Electrified Mobility Hubs

## A Blueprint for the Future of Transit Infrastructure

## Final Report

December 2024



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# Executive Summary

The transportation sector is undergoing a transformation. People are finding new ways to access the transportation system. Local and regional transit agencies and transportation departments are facing the diversification of travel through micro-mobility, market changes from the continuing integration of information technology with transport, post-pandemic shifts in commutes and travel behavior, and the imperative to join with the other sectors of the economy to curb greenhouse gas emissions.

This transformation is as much about infrastructure as it is service delivery, and perhaps no other form of transportation embodies the complexity of this change as much as the transit hub and its related architectures, built to facilitate parking, boarding, alighting, and the comfort of passengers. Today's transportation agencies are re-imagining these critical components of metropolitan transportation networks as electrified mobility hubs.

Mobility hubs are so named for the opportunity they create for users to access many forms of transportation. E-mobility hubs take the concept one step further, to exemplify the movement of the sector away from fossil fuels and toward the electrification of the full variety of vehicles and systems, taking advantage of opportunities to integrate solar and other onsite renewable energy and prepare for the possibility of hydrogen power.

The spaces that call for transformation are those that act today as crossroads—centers of vibrant communities and hubs of intermodal activity—and hold the promise of filling critical gaps in the transportation systems of tomorrow. They are the subject of earnest community interest and the product of deep collaboration between multiple public organizations, to meet new collective needs with a wave of capital investment and renewed focus on operations and maintenance.

This study offers a blueprint for transforming transit centers into electrified mobility hubs. It is the product of a sustained and structured collaboration between the key public stakeholders in the Central Puget Sound area transportation system—King County Metro, Sound Transit, Seattle City Light, and Seattle Department of Transportation—and academic researchers from the University of Washington Urban Infrastructure Lab, Department of Urban Design and Planning, and Department of Construction Management, coordinated by the university's own Mobility Innovation Center.

This research represents a new approach for the joint conceptual development of the features, functions, and operations of electrified mobility centers. Researchers combined a series of workshops over the course of a year, informed by principles of urban design, urban mobility data, field research, industry contacts, and literature reviews, in a graduated process of urban design.

Results deliver a conceptual framework for e-mobility hub design, key perspectives and recommendations for the Puget Sound and beyond, and an electrification cost model. Researchers and public agencies worked from an initial focal point in the case of Burien Transit Center, to a subset of five facilities in the greater transportation network, to a set of universally applicable urban design, cost, and electrical load considerations based on load demands and charging infrastructure additions. These products can help agencies and future partners plot a more comprehensive pathway for e-mobility hub development when applied prior to preliminary engineering and construction procurement.

## Key insights

### Mobility hub design is a team effort.

Early partner and stakeholder engagement, including transportation providers, city departments of transportation, and utilities, is needed to jointly and efficiently determine operational and user needs and their implications for capital investment in electrified mobility hubs.

### Agree to set standards together.

Develop consensus amongst transportation agencies for charging equipment and standards to ensure interoperability for transit and light-duty vehicles. Design standards can reduce the cost to maintain service through interoperability and the cost to provide resilience through redundancy.

### Everyone needs reliable electrification.

Electrification raises the value and utility of public assets. Protect publicly funded charging equipment to maintain availability and confidence with users and reduce costs for maintenance and repair. This may include using parking garages, cardkeys, and gates to control access to equipment.

### Make the system easy to use.

Information technology has the potential to reduce barriers and increase the convenience of electrification and micro-mobility, as well as transit. Seek opportunities to leverage existing technology for new applications, such as transit cards for electric vehicle charging and reservations.

### Design to provide value to the community.

Transit and transport facilities occupy valuable space in densifying urban environments. Act on opportunities to create a welcoming and safe public space for the community and address potential needs, such as affordable housing, within the existing facility footprint.

CHAPTER 1

# Introduction

This study offers a blueprint for transforming common transit system assets, such as park-and-rides and transit centers, into electrified mobility hubs. Transit agencies and transportation departments own and operate considerable physical assets within the densifying urban communities they serve. The spaces that call for change are those that act today as crossroads—hubs of intermodal activity—and hold the promise of filling critical gaps in the transportation systems of tomorrow.

As a concept, the mobility hub accommodates the diversification of travel through micro-mobility and the changes in transport markets that come from the deepening integration of information technology with transport, such as shared mobility. Electrified mobility hubs also incorporate the movement of the sector away from fossil fuels, toward more economical, environmentally-friendly, and efficient forms of transportation and energy supply. As such, they represent the joint effort of public and private energy providers working with the constellation of public organizations devoted to transit and transportation systems.

The scale of change to accommodate the combined innovations, market changes, and environmental imperatives is significant. The electrification of transit is systemwide. As a systemwide investment in long-lived capital assets, the upgrade of transit facilities to electrified, or e-mobility hubs brings with it an opportunity to reconceptualize the full set of properties and their value to the public. Public agencies, in collaboration over the provision of transit and transport services, desire safe and welcoming public spaces with amenities that meet the changing needs of the communities they serve. As an idea, the electrified mobility hub seems simple. As a concerted array of capital investments with complementary functions and operations and maintenance, it is complex.

This study offers a new approach and recommendations for the joint conceptual development of electrified mobility hubs. Starting from the focal point of one transit center in the Seattle area, researchers and public agencies worked together to create a framework for understanding the wide range of options available for mobility center design and electrification, and the implications for their implementation. Results include a conceptual exploration of urban design and electrification with cost estimates, applied to the Burien Transit Center; a field evaluation and reflection on the application of design principles and guidelines to a variety of sites and conditions in the transit system; considerations for policymaking across operations and maintenance as well as capital investment; and a conceptual cost estimating model for electrification that may be applied anywhere in the system.

**Participating Organizations**

King County METRO

SoundTransit

Seattle City Light

Seattle Department of Transportation

## Consider the humble park and ride

To contemplate the impact of these changes on transport infrastructure, consider the park-and-ride. Every aspect of the humble park-and-ride is experiencing change.

For decades the park-and-ride served commuters from low-density suburban and exurban communities with

**Table 1.1: Changing Uses and Demands for Park-and-rides**

| | Previous Use and Demand | Modern Use and Demand |
|---|---|---|
| Modal access | Light-duty vehicles (cars and small trucks, vans), carpool, transit vehicles, bikes | Light-duty vehicles (cars, small trucks, vans), micro-mobility (bikes, scooters), rideshare vehicles (Uber, Lyft) |
| Energy demand | Power for facilities, exterior lighting, restrooms, etc. | Electricity for transit vehicles, light-duty passenger vehicles, micro-mobility, and facilities |
| On-site amenities | Minimal light-duty vehicle parking and amenities such as restrooms and concessions | Charging with parking for personally-owned and light-duty vehicles and micro-mobility, access control and payment options for charging, waiting areas for shared mobility, and amenities such as restrooms and concessions |

access to urban centers via transit. Many were initially located on the fringe of urban areas, where transit was not cost-effective (Texas A&M Transportation Institute, n.d.; National Academies of Sciences, Engineering, and Medicine 2004, chap. 3). Facilities have varied in design and size, ranging from small surface lots to multi-story parking garages (National Academies of Sciences, Engineering, and Medicine 2017). Park-and-ride users have access to vehicles, but can be expected to park their vehicles at a facility for an extended portion of the day (National Academies of Sciences, Engineering, and Medicine 2004; 2017, 20). As time has worn on, urban growth has intensified and land use has changed around many of these assets. While still in use, many park-and-rides are not reflective of new mobility options, such as micro-mobility or shared mobility, which may be enjoyed by the communities that have been built up over time, gradually surrounding the park-and-ride.

Another dimension of the park-and-ride is the type of trip it is intended to support. Their purpose has been to offer suburban commuters transit access to city or metropolitan centers of employment. Since the COVID-19 pandemic, transit has dropped, both nationwide and in the King County Metro service area, and has yet to bounce back to pre-2020 levels (APTA, n.d.; King County 2024). The 2022 Seattle Commute Survey, which captured a robust sampling of people who travel into the city for work, indicated that nearly half of pre-pandemic transit riders switched to another mode of travel, and only 6% believed they would switch back (Ashour et al. 2023). The survey showed that respondents relied less on public transit for other trip types as well, such as trips for health care, leisure, recreation, and social visits. Data from the Puget Sound Regional Council (PSRC) also indicates a significant drop in park-and-ride use since 2020, with many spaces remaining available at facilities around the region (2024). Underutilized, a park-and-ride becomes an urban asset open to alternative visions for its use.

## Electrification of buses, bikes, and everything in between

Transit is undergoing a transformation with a shift to zero-emission vehicles and energy sources, which includes the buses and facilities that support the fleet. The largest public transportation operators in the US are shifting to zero-emission fleets, setting defined goals and targets for doing so. These include the Washington Metropolitan Area Transit Authority (WMATA) by 2042, Metropolitan Transit Authority in New York (MTA) by 2040, Los Angeles County Metropolitan Authority (LA Metro) by 2030, and the Chicago Transit Authority (CTA) by 2040 (Washington Metropolitan Area Transit Authority 2023; Metropolitan Transportation Authority 2023; LA Metro 2020; Chicago Transit Authority 2022).

Electrification to reach zero emissions is also a goal for the transit agencies in the greater Seattle area. King County Metro, which is the largest transit service provider in the Puget Sound Region—and among the top ten in ridership nationwide—has a goal to replace existing hybrid diesel-electric coaches with battery-electric buses, while increasing rollingstock of electric trolleybuses in service by 2035 (King County Metro 2022a). In addition to fleet procurement, the agency is building two new all-electric bus bases and will convert their existing seven bus bases that serve as the heart of their operations to provide battery-electric bus service and charging (Lee, Osburn, and Treece 2023; King County Metro 2022a). There are also plans for en route charging for buses that include existing transit facilities and facilities currently designated as park-and-rides, such as the Burien Transit Center (King County Metro 2022a).

Fleet electrification is not the only change in the system. Short trips bolstered by micro-mobility are growing in popularity and provide an opportunity to connect people with transit. "Micro-mobility" is a catch-all term that describes everything from skateboards to scooters to bicycles. These modes of transportation are not new, but in the past 15 years, US cities have experimented with sharing programs to provide better access and encourage more sustainable travel options. Electric-assisted bikes and electric-powered scooters jumped in popularity across the US in 2018, boosting the number of trips taken and ensuring the expansion of these shared mobility programs (National League of Cities 2019).

According to the National Association of City Transportation Officials (NACTO), shared bike and scooter trips in the US and Canada average 1.5 miles per ride (measured from 2010 to 2022, NACTO 2023). Shared micro-mobility is one relatively new tool available to transit agencies to address the first and last mile challenge, connecting people from their origins and their destinations to transit stations in order to board and alight transit for the bulk of their journey.

## Electric vehicle charging trends and challenges

In metropolitan areas, sales of electric vehicles are on the rise. Washington ranks fourth in the nation for total registered electric vehicles, with 166,800 in the state as of 2023, and with half of these registrations in King County (WSDOT 2024). What was once only a market for sedans and SUVs, is also now a market for light-duty electric trucks. In 2023, over one million light-duty electric vehicles were purchased in the US (Popovich 2024). Electric vehicles will continue to increase their share of the consumer market over time (Slowik and Isenstadt 2024).

Today's consumers of electric vehicles tend to have single family homes, relatively high income, and access to off-street parking, which allow for the capability to charge the vehicle at home (Ge et al. 2021). According to

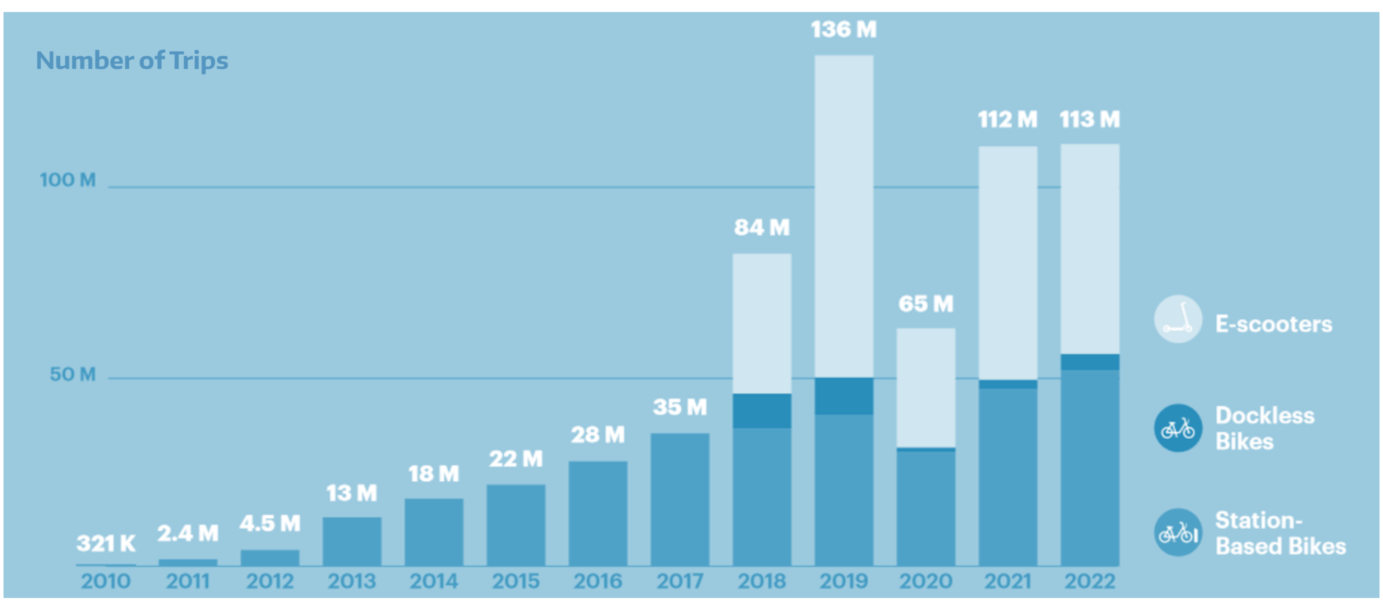


**Figure 1.1: Shared Micro-mobility Ridership in the U.S. (NACTO, 2023)**

a recent report on the future of electric vehicle charging from the US National Renewable Energy Laboratory, multi-family properties pose the greatest challenge to the further expansion of electric vehicles in the market; people who own single-family detached houses have better access to charging than renters or multifamily dwellers. Analyses across various metro areas elaborate on this situation. An analysis in the city of Dallas found localized disparity in electric vehicle ownership due to a lack of public charging equipment in environmental justice communities and multifamily dwellings (Dallas-Fort Worth Clean Cities 2022). Research in the Phoenix metro area found similar challenges, and further noted the high-cost of charging equipment installation (Cordova-Cruzatty et al. 2023).

In other words, local access to electric vehicle charging is not equally distributed. Public policy highlights barriers and provides guidance to improve access, especially for people in multifamily dwellings and households in traditionally marginalized communities (King County 2020; Song, Cline, and Lyshall 2018). Policy guidance from the King County 2020 Strategic Climate Action Plan highlights the role of government as an implementer and the public priority to both "Accelerate electric vehicle adoption that prioritizes environmental justice and equitable access to shared mobility solutions," and "support engagement and partnerships with utilities and organizations to develop regional pilots to incent the transition to electric vehicle ownership for all sectors, through development of infrastructure, education, and grants and incentives" (King County 2021).

## The questions driving this study

With these circumstances in mind, a coalition of public agencies—King County Metro, Sound Transit, Seattle City Light, and Seattle Department of Transportation—collaborated with the Mobility Innovation Center at the University of Washington, to bring together faculty from the Urban Infrastructure Lab, the Department of Urban Design and Planning, and the Department of Construction Management to consider the following questions:

- How do transit agencies convert existing public facilities, such as park-and-rides and transit centers, to accommodate electrification needs?
- How could these facilities be used as a community mobility resource, or hub, for transportation electrification?
- What would be the most cost-effective way for a public agency to develop an electrified mobility hub?

This report follows a one year study to produce guidance for public agencies, which they may enlist to take the next step in providing multimodal electrification capabilities for the traveling public.

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**Chapter 2** Methodology
**Chapter 3** Generalized Guidance for Electrified Mobility Hubs
**Chapter 4** Site Design for Electric Mobility Hubs
**Chapter 5** Developing a Cost Model for Electric Mobility Hubs
**Chapter 6** Conclusions

CHAPTER 2

# Methodology

The methods for this research were exploratory and applied—terms that are not often found together. The questions driving this research are not yet well-addressed in the literature, nor widely developed in policy documents. Though our methodology incorporated peer-reviewed and practice-oriented literature reviews, this effort would hardly launch the project.

Exploratory methods can be inductive, in search of patterns and involving the formation and application of taxonomies. To explore while engaging in applied research couples traditional academic research with a reasoned and methodical examination of the conditions and opportunities available in practice.

The many possible topics for consideration in the development of electrified mobility hubs are not equally valuable to public agencies. Through bi-monthly working meetings, we collectively drew our attention toward the novel elements or challenges faced by public agencies in this matter. The team conducted site visits, supported cross-agency engagement via regular meetings with agency stakeholders, and facilitated a series of workshops using principles of urban design to establish a systemic approach for collaboration.

Together, the research team and our public agency collaborators worked our way from the focused and detailed examination of conditions on one site, Burien Transit Center, through a series of discussions and field research to generalize findings to other sites, and concluded with the broadest possible frame of subject matter, which is systemwide and includes topics for shared policymaking.

## Review of the literature

Our review of the literature turned up 56 relevant articles from 23 journals published since 2019 on the topics of mobility hub design definition, best practices, and electric vehicle and bus charging, on the common research platforms Web of Science and Google Scholar. These were supplemented by a review of the literature of practice, such as policy and planning documents on the topic. One early and important aim of this research was to compare the guides currently in use by transportation agencies for the development of mobility hubs.

## Field reconnaissance

The project team conducted field reconnaissance through several site visits to the Burien Transit Center and, to place the findings from this research in context, supplemented with visits to five additional transit centers or park-and-rides. The team collected extensive documentation of the Burien Transit Center, which then provided a basis for detailed conversations with public agency partners. For example, what might have been a study focused entirely on capital investment and conceptual urban design, was broadened to encompass the ways in which operations and maintenance and design interact, often with one constraining the other. On that note, King County Metro maintenance employees provided a guided tour of the center, including the areas they felt were most impacted by safety and security concerns.

## Workshops: generalizing from the case of Burien Transit Center

The team used the basics of urban design practice to organize the research around a series of workshops. This series of in-person exploratory workshops with the partner agencies allowed us to address key research questions collectively, and gradually move from the detailed urban design considerations of one site to the general concerns for the system as a whole. Centering first on the current features and observations of

**Figure 2.1: Workshop Photo**

the Burien Transit Center provided an opportunity to focus our shared attention on the items most pressing for the public agencies. The workshops, which were held over a year, evolved through stages of research regarding design, operation, function, and agency factors concerning implementation.

## Electrification plan review

King County Metro has committed to achieving a zero-emission fleet by 2035 (King County Metro 2022a). As a part of their transition, King County Metro and Sound Transit had been planning, prior to and concurrently to this study, to develop en route and layover bus charging at Burien Transit Center. McKinstry had been selected as an Energy Service Company (ESCO) to perform design-build of charging infrastructure and devices. At the time of writing, the electrification plan for charging buses at Burien Transit Center consists of conductive pantograph bus chargers for King County Metro (King County Metro 2022a), and wireless inductive bus chargers for Sound Transit (Baguette 2024; Mass Transit 2024). Review of these plans and occasional coordination with contractors kept everyone apprised of ongoing decisions.

## A tool for generating conceptual cost estimates of electrification

The project team developed a cost model to support transportation agencies and electric utilities in their decision-making about transit facility electrification. In particular, the model is designed to assist agencies' go/no-go decisions during the early stages of planning and design by offering conceptual cost estimates based on layouts and design information. Cost model development involved (1) developing an MS Excel-based interactive model that accepts user input on design in order to generate a conceptual cost estimate of potential charging devices and infrastructure and (2) validating the usability and applicability of the developed model by applying the Burien Transit Center as a case study.

CHAPTER 3

# Generalized Guidance for Electrified Mobility Hubs

This chapter provides an overview of the deliberative process applied in this research to characterize the challenge of implementing electrified mobility hubs. The research was organized around a series of workshops with ancillary activities such as literature review, field reconnaissance, urban design, cost modeling, and plan review, to gain a general understanding of the challenge and create a conceptual framework for design and implementation.

The focus of this chapter is information and guidance that may be applied to any location under consideration for electrified mobility hub implementation. The chapter contains a literature review about mobility hubs and their electrification, followed by a review of the topics introduced in a series of four workshops.

## About mobility hubs and their electrification

Mobility hubs are nodes, typically along high-frequency fixed-route transit services, compatible with various mobility options. Mobility hubs are intended to offer a safe and convenient transportation environment by providing infrastructure supporting each person's travel needs. Their electrification extends the support of travel needs to include charging for electric buses, vehicles, and various forms of micro-mobility.

Mobility hubs are a relatively new concept, and despite the publication of strategies in cities such as Los Angeles and San Diego in California and Toronto, Canada, their full implementation is yet to be seen. This lack of practical knowledge on the siting and design of mobility hubs for existing fixed route facilities is a significant gap. The consensus among professionals and academics is that well-designed mobility hubs consider the hub's context and the transit network's larger hierarchical operations, leading to an understanding of the site features most likely to benefit the user. However, the finite nature of space at existing transit facilities presents challenges in determining which features are most crucial to the specific demands of a hub, leading to a series of design considerations and trade-offs, while electrification pulls utilities to the forefront of transit facility design and construction.

Transitions of existing transportation hubs into mobility hubs offer efficiencies in comparison to greenfield sites. Transit hubs, such as park-and-rides or transit centers, are often serviced by high-frequency transit. They are also located in areas of high demand, such as dense neighborhoods or corridors with mixed residential and commercial uses. Existing facilities do not incur the real estate costs associated with acquiring land. Most importantly, these facilities are already designed to be functional for transportation, making them a potentially efficient and cost-effective option for mobility hub implementation.

The growing body of mobility hub literature establishes benefits and general considerations for designing mobility hubs. They range from accommodating new modes of transportation to incentivizing mode changes from the automobile.

### About mobility hubs

The original concept of a mobility hub was as a shared mobility connection point, used to alleviate the need for parking within cities. Researchers suggest that mobility hubs play a critical role in the regional transportation system and a significant place-making role (Enbel-Yan and Leonard 2012). Ideally, a mobility hub would be an exciting and desirable place that encourages a diversity of uses and activities, including eating, shopping, and pick-up points that help create an activated and dynamic space (Enbel-Yan and Leonard 2012; Saravanan 2022).

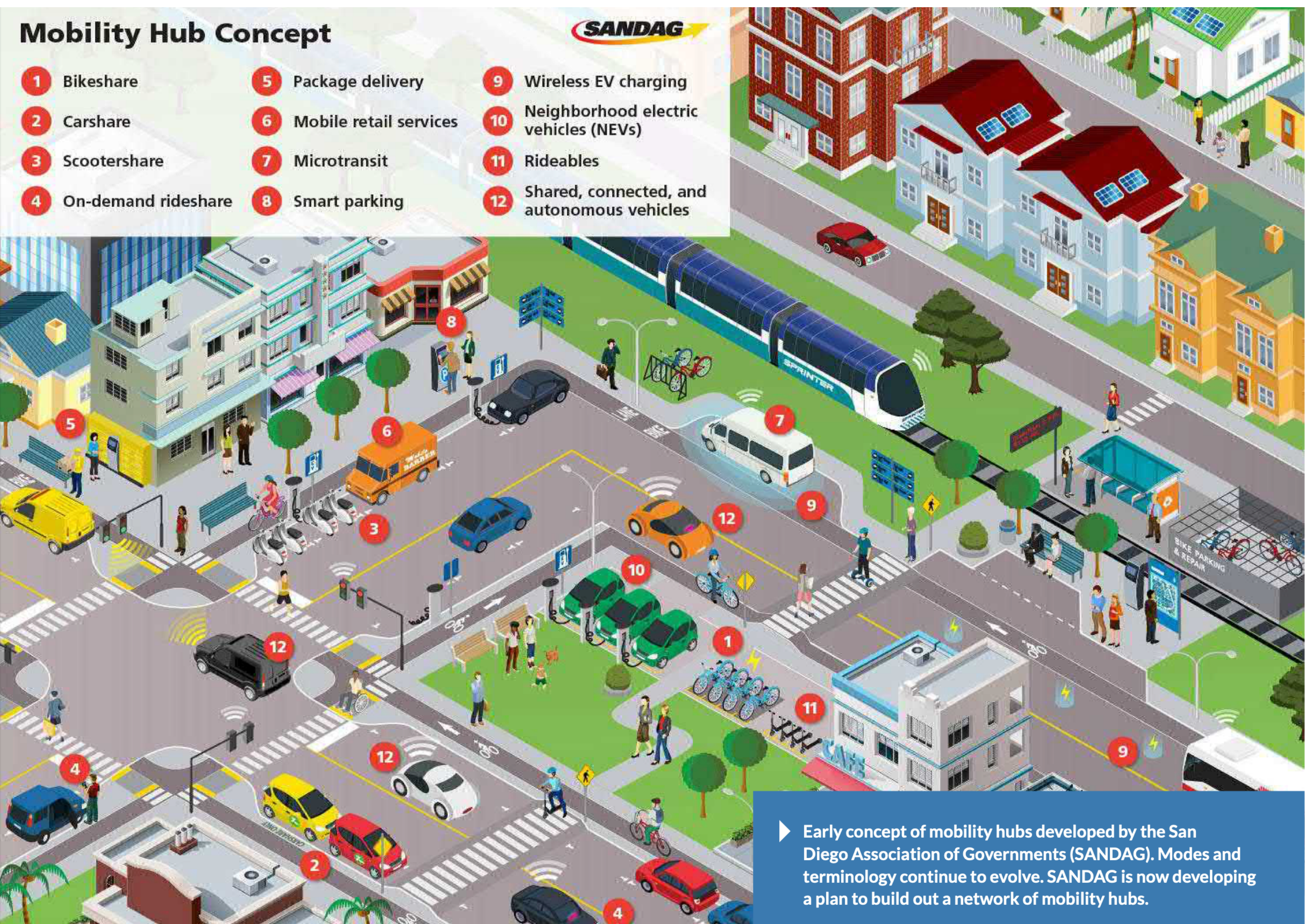
The choice of location appropriate for mobility hub implementation depends on each transportation agency's specific goals. However, the above traits suggest the environmental contexts most suitable for mobility hub application. Mobility hubs should:

1. **Surround major transit stations**—The presence of one or more major transit stations is enhanced by residential and employment services accessible by uptake services at the hub.
2. **Provide sustainable transportation options**—Services and destinations are easily accessible within a five-minute walk, ride, or drive distance. Mobility hubs encourage active and shared transportation methods such as micro-mobility, bike-share, car-share, and other transit services like paratransit.
3. **Access areas of high residential and employment density**—Dense urban environments with high levels of activity are integral to achieving agency goals. Urban environments provide origins, designations, and ridership.

Mobility hubs are envisioned as positive additions to and centers of community life. This entails developing a range of amenities, services, and activities at each hub, with the largest hubs having 24/7 activities, as evidenced by on-site housing, day and night-time parking, and transit services.

Figure 3.1, from guidelines published by the San Diego Association of Governments (SANDAG) (San Diego Association of Governments 2017), visually depicts mo-

**Figure 3.1: Mobility Hub Concept (Shared-Use Mobility Center, 2019, pg. 4)**




Early concept of mobility hubs developed by the San Diego Association of Governments (SANDAG). Modes and terminology continue to evolve. SANDAG is now developing a plan to build out a network of mobility hubs.

bility-related activities serving such a hub. It should be noted that these activities, amenities, and services are oriented to both transit users and local residents.

Accessibility to high-frequency transit services such as light rail and bus rapid transit creates a transparent transportation hierarchy connecting neighborhood residents to a regional network of destinations. The Shared-Use Mobility Center (SUMC), for example, suggests a design strategy considering specific high-frequency transit types (Shared-Use Mobility Center 2019).

## On the effectiveness of mobility hubs

The mobility hub concept was initially conceived at the turn of the century in Germany to overcome growing parking issues. In these first iterations, mobility hubs primarily served as shared-mobility connection points. The concept has evolved over time, however, expanding in purpose and challenging researchers to test these conceptions.

Evidence of the effects of mobility hubs on vehicle miles is mixed. Mixed results can be expected when the aim of shifting modes of travel grows in its complexity, ultimately transforming what has been a station for transferring drivers and passengers into a destination for travel. Research, for example, testing the applicability of mobility hubs in Dutch residential neighborhoods observed decreases in overall car and bus trips, and increases in vehicle miles traveled (van Rooij, 2020). Trip reduction is widely accepted as a desirable outcome. The reduced bus trips were considered a symptom of mode shifts favoring active transportation in a multimodal approach. Counterintuitively, increases in vehicle miles traveled suggested that mobility centers may attract people from greater distances to urban centers.

Some researchers suggest that the placement of mobility hubs in underserved neighborhoods can help address issues of transportation equity. The implication is that communities less served by public transportation may stand to benefit the most from the rollout of mobility hubs in their neighborhoods (Ye et al., 2024). Supporting this is the idea that neighborhood locations could be designed to serve a larger catchment area with local amenities and services.

## Transportation functions of mobility hubs

The main purpose of a mobility hub is to function as a node in a transportation network, connecting origins with destinations and supporting seamless mode shifts. Access to the network is facilitated by rapid transit services, and by a wide range of modal and micro-mobility options for traveling to and from the hub. Access also implies safe and secure spaces for parking and pick up and drop off. All of these services are undergoing some degree of change in assets and services as transportation is electrified.

Publicly-operated fixed-route rapid transit services are foundational to mobility hub development. Several leading transportation agencies have specified the importance of integrating mobility hubs around core public transit systems. All forms are applicable, whether commuter or local rail or bus service, and express or full bus service.

These systems are being upgraded to include electrification. Implementation of bus charging infrastructure can be space-intensive. When en-route charging services are required, stations with layover zones are examples of locations relatively easy to reorient to provide charging during operator break times.

The concept of mobility hubs also recognizes the outsized role that parking facilities can play, the rising market prevalence of shared mobility services and micro-mobility demand, and the need to provide safe and welcoming facilities to support bike and pedestrian mobility. For example, park-and-ride facilities can be changed in their configuration to suit changing demands (Paslawski and Rudnicki 2021). Car and van pools have long been complimentary to basic park-and-ride functions. Micro-mobility, in the form of bikes and scooters, and shared mobility with Transportation Network Companies (TNCs), represent departures from the historical functionality of park-and-rides, yet are staples of mobility hubs.

In the transition of facilities to mobility hubs, the need to expand the functionality of park-and-rides and transit centers can change the perceived value of parking garages. Consideration of a new variety of travel options can give way to flexibility in the considered use of space (see examples in Figure 3.2, 3.3).

The electrification of parking is important to the transition of facilities to mobility hubs. Parking facilities can provide increased benefits to communities through the installation and management of car charging infrastructure. Strategic parking provisions, when implemented, can improve environmental and social conditions in dense urban areas through the rollout of electric vehicles and car-share infrastructure. A lack of reliably available vehicle charging stations artificially suppresses the desire to switch from fossil fuel to electric vehicle ownership.

In other words, publicly available charging infrastructure conveys public benefits. Consider that transit centers and park-and-ride facilities have historically been designed to provide parking for people commuting to city centers. If a driver leaves a vehicle parked for some time during the day, a public agency could serve their needs with infrastructure that costs less to provide. Level 2 chargers cost significantly less to build than so-called fast chargers. The agency can pass on those savings to the community with a comparatively lower cost for the electricity. These parking facilities typically empty out as the day comes to a close. If Level 2 charging were available, the local community in the vicinity of the facility could obtain the benefit of charging vehicles overnight in the same facilities. Electric vehicle charger access and visibility reduces the mental barriers associated with electric vehicle ownership, and can change public per-

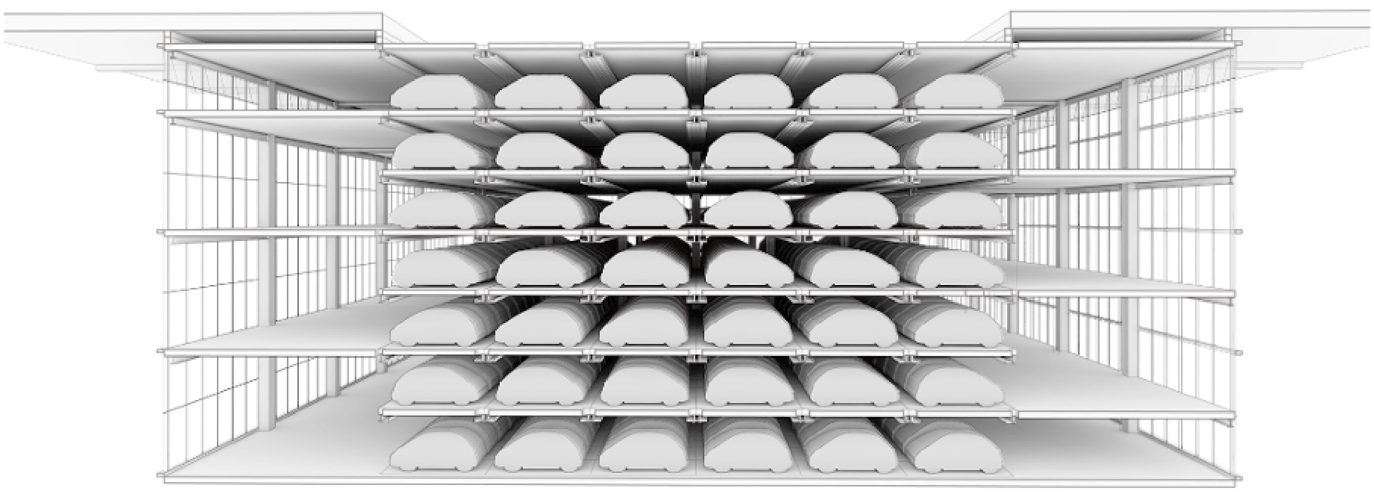


**Figure 3.2: Parking Garage Reuse Concept (Chen, 2018, fig. 40, pg. 71)**

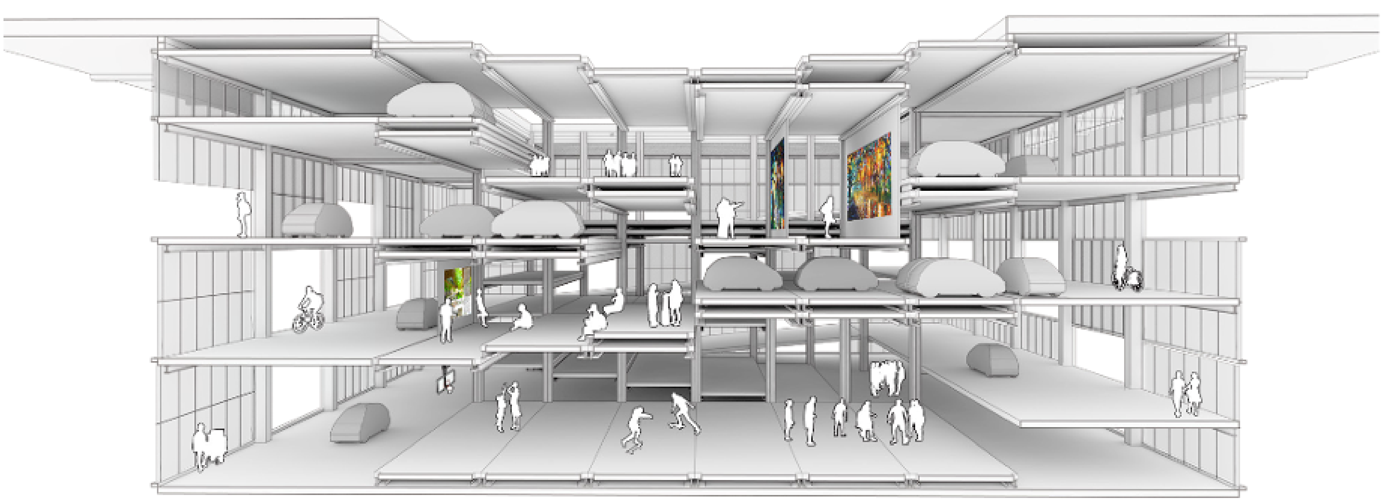


**Figure 3.3: Multi-purpose Garage Fitting People and Vehicle Storage (Chen, 2018, fig. 39, pg. 71)**

ceptions of limited availability and lack of reliable access to the infrastructure (Hou et al., 2024; Ma et al., 2024; Shah, 2024). The ownership of significant amounts of publicly available parking within densely populated and urbanizing areas places public transit and transportation agencies in a key position to incentivize the transition to clean, carbon free electric forms of transportation, by electrifying these parking assets. Operating facilities overnight would also increase community use and therefore the overall efficiency and utility of these important publicly owned assets.

The rise of shared mobility and gradual introduction of autonomous vehicles compound the need for curb space, separately from parking. In the last decade, the rise of ride-hailing TNCs, such as Uber and Lyft, has signaled this shift, which promises to grow with the advent of autonomous vehicles. The shared demand for curb space between TNCs, pick-up and drop-off areas, and future autonomous vehicle accessibility, call for the strategic assessment of curb space. Similar to parking provisions, features oriented to automobiles may come at the expense of micro-mobility, walkability, accessibility, and the pedestrian experience. Thus, designing for these uses must carefully balance pedestrian and active rolling transport (bicycling, scootering, and using a wheelchair) with auto access needs.

Micro-transit and paratransit are increasingly valuable features of mobility hubs. Micro-transit functions as a shuttle service connecting transport services and amenities near mobility hubs. These smaller vehicles have a capacity of five to twelve riders and offer flexible on-demand services. Generally, such services require less space, given their dimensions and route frequency. Features that would benefit this mobility type include dedicated or shared space for drop-off and pick-up. These vehicles may also run on electricity or alternative fuels, thus requiring curb or parking space for layover charging. Again, this depends on route frequency, right-of-way configuration, and other environmental limitations.

Bike facilities are integral to incentivizing active transportation by improving attitudes toward mode choice. Protected access and secure parking facilities may help change behavior towards biking (Dill, Mohr, and Ma 2014). Features that can improve bike accessibility include bike parking (long- and short-term) as well as options for on-demand or membership-based services. Providing clear access points and dedicated lanes or raised pathways can also improve rider experience by prioritizing user safety. Other facilities that can improve bike implementation include bike repair stations, electric charging stations, and secure storage (Aono 2019).

### Sizing mobility hubs according to location

The sizes (scales) and service levels of mobility hubs will differ according to their context. The Los Angeles Mobility Hub Reader Guide splits mobility hubs into three tiers to reflect transit needs and the existing built environment: Neighborhood, Central, and Regional. Figure 3.4 demonstrates this idea.  At the smallest scale of the neighborhood, many mobility hub amenities are optional or recommended rather than vital. While at the central or regional scale, a wide range of amenities and larger sized facilities are considered vital to support the larger numbers of users.

***The following sections describe the activities of this study, centering on four workshops conducted with transit, transportation, and electric utility partners.***

## Timeline and organization of four workshops

Together, the project team and agency stakeholders engaged in a year-long process to explore what electrified mobility hubs could be, and how they may come to be in King County (Figure 3.5). The agencies and research team selected one site to provide a focal center for discussion of capital and operational constraints and opportunities, in the City of Burien.

Primary information-gathering activities for this study included site visits to the Burien Transit Center, bi-monthly project management meetings with public agencies and, most importantly, a series of in-person workshops centered on key questions. While the project focused on King County facilities, the team was directed to the Burien Transit Center to allow discussions to reinforce general concepts with local details and to gain a shared understanding of existing conditions and pos-

| Mobility Hub Amenities | Bicycle Connections | | | Vehicle Connections | | | Bus Infrastructure | | Information-Signange | | | Support Services | | | | Active Uses | | Pedestrian Connections | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | 2.1. Bike Share | 2.2. Bike Parking | 2.3. Bicycling Facilities | 3.1. Ride Share/Pick up-Drop off | 3.2. Car Share | 3.3. EV Charging Stations | 4.1. Bus Layover Zone | 4.2. Bus Shelters | 5.1. Wayfinding | 5.2. Real-time Information | 5.3. Wi-Fi / Smartphone Connectivity | 6.1. Ambassadors | 6.2. Waiting Area | 6.3. Safety and Security | 6.4. Sustainable Approach | 7.1. Retail | 7.2. Public Space | 8.1. To the Mobility Hub | 8.2. At the Mobility Hub |
| (N) Neighborhood | ● | ● | ■ | ■ | ○ | ○ | ■ | ○ | ● | ○ | ○ | ■ | ○ | ○ | ○ | ■ | ■ | ○ | ○ |
| (C) Central | ● | ● | ○ | ● | ● | ● | ○ | ● | ● | ● | ● | ○ | ○ | ● | ● | ○ | ● | ● | ● |
| (R) Regional | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ● | ○ | ● | ● | ● | ● | ● | ● |

Legend: Vital: ● Recommended: ○ Optional: ■

**Figure 3.4: Mobility Hub Typologies (LADOT, 2016, pg. 7)**

sible design futures. See Chapter 4 for more information about the Burien Transit Center.

Our approach to designing mobility hub development and electrification began with an understanding of the functions and operations of existing assets, and expanded into consideration of design guidance for mobility hubs and electrification needs from there.

## Step 1: Physical, functional, and operational demands

Agency efforts to create and operate electrified mobility hubs consider many factors. In the first step, the project team and agency partners co-developed a "wish list": an unconstrained, blue sky list of physical, functional, and operational features under consideration for electrified mobility hubs. The wish list was curated from

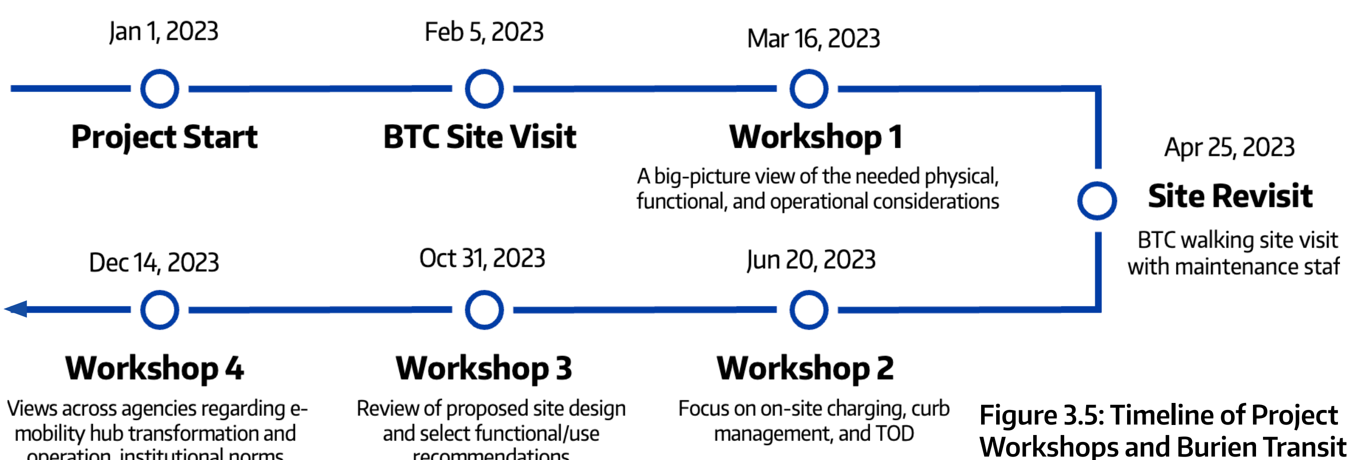



**Figure 3.5: Timeline of Project Workshops and Burien Transit Center (BTC) Site Visits**

peer-reviewed literature, key plans and policy documents from an array of public agencies, and agency partner input.  This was the subject of Workshop 1.

## A wish list on a timescale

In Workshop 1, participants created a big-picture view of considerations to address in order to establish a successful electrified mobility hub. In the workshop. Small cross-agency groups worked with the project team to review and edit proposed wish lists of features, functions, and operations. They were also asked to identify existing conditions that would need to be addressed in the transition to mobility hub services. Each participant then prioritized considerations and worked toward a consensus for their group regarding whether the

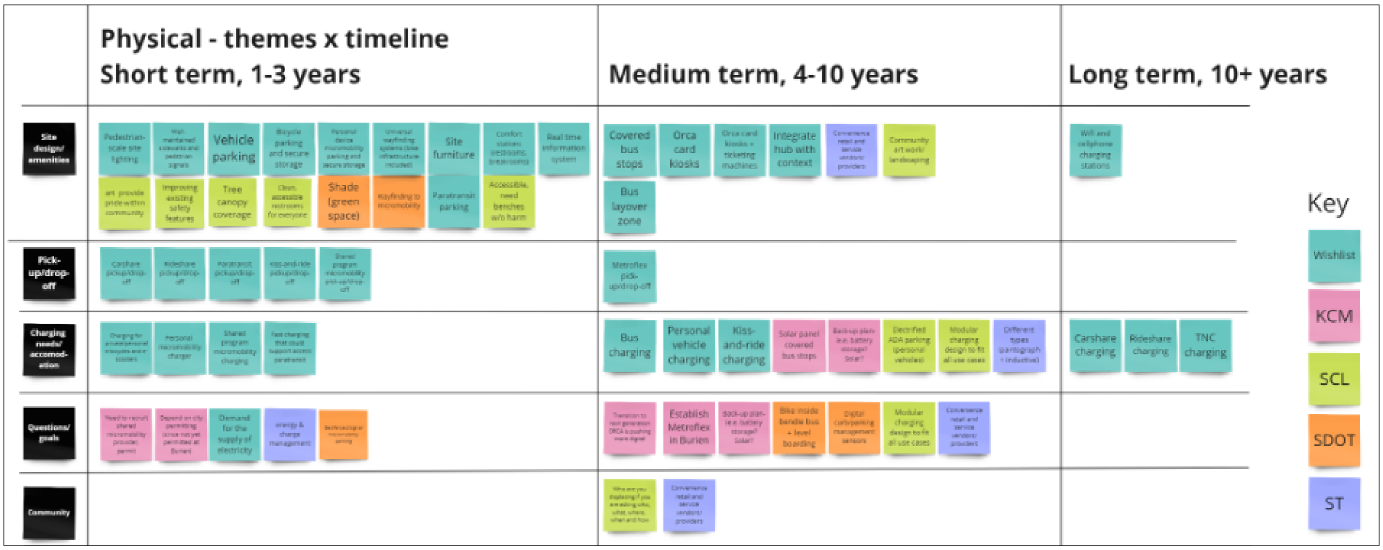



**Figure 3.6: Physical Wish List Items**

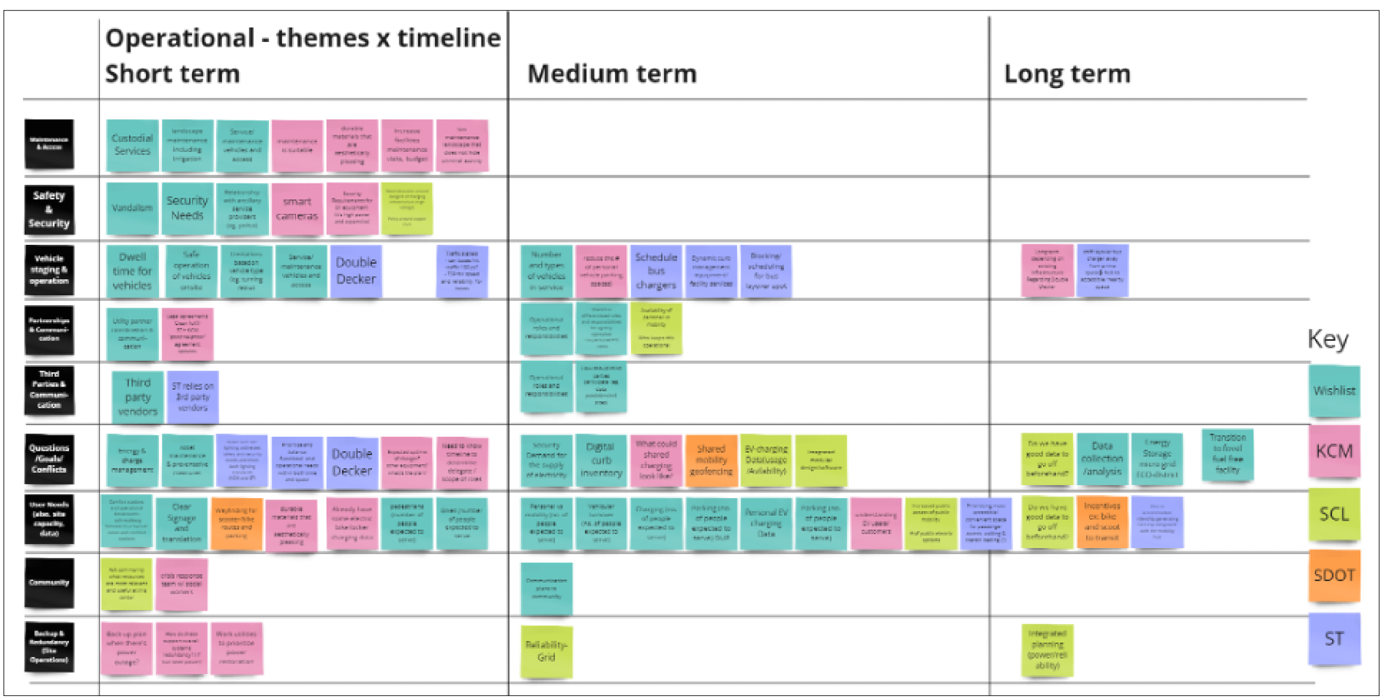



**Figure 3.7: Operational Wish List Items**

features were essential, nice to have, or less important. Each group also identified key adjacencies and incompatible features and placed needs and desires across short-, medium-, and long-term investment timeframes.

The three categories of input and prioritization were for physical features (Figure 3.6), operations (Figure 3.7), and functions (Figure 3.8). In each case, the research team provided lists of constraints and opportunities derived from the literature and field reconnaissance. Participants from public agencies and community groups invited by the collaborating public agencies were asked to respond to those lists and—using their own practical knowledge, awareness of conditions, and experience—to further contemplate what would be needed and/or desired in this transformation to electrified mobility hubs. The research team then coded and organized the collection of input into categories, as shown in these figures. The outcome was an expanded wish list of physical form (Appendix B), functionality, and operational characteristics for electrified mobility hubs, grounded by the experience of practitioners.

## Feature guidance comparison

The project team compared transit center design guidelines prepared by King County Metro (King County


**Figure 3.8: Functional Wish List Items**

Metro 2022b), the local transit facility operator, against mobility hub design guidelines published by the San Diego Association of Governments (SANDAG) (San Diego Association of Governments 2017). The team found that SANDAG's document represented, among those publicly available, the most comprehensive catalog of potential mobility hub features.

Figure 3.9 assesses the compatibility of the two sets of design guidelines. It demonstrates a wide gap between King County Metro's design guidelines for transit hubs (toolkit) and SANDAG's Mobility Hub Features Catalog (catalog). The rows and columns in the table correspond to themes found in each of the two sets of guidelines. Each cell in the body of the table has been given a cell number (cells are numbered in bold and underlined, 1 through 20). Below each cell number are three values, ordered from left to right, which indicate:

1. the total possible features (amenities and services) identified in both documents;
2. the matches in terms of either design or function (partial matches) when comparing the two documents; and,
3. the complete feature matches in both design and function between the two documents.

| | | SANDAG Mobility Hub Features Catalogue Themes | | | | |
|---|---|---|---|---|---|---|
| | | Transit Amenities | Pedestrian Amenities | Bicycle Amenities | Motorized Services and Amenities | Support Services |
| King County Transit Hub and Element Typology Themes | Environmental | **1**<br>230 / 44 / 3 | **2**<br>253 / 51 / 2 | **3**<br>345 / 25 / 0 | **4**<br>322 / 20 / 0 | **5**<br>115 / 9 / 0 |
| | Convenience | **6**<br>130 / 3 / 0 | **7**<br>143 / 2 / 0 | **8**<br>195 / 13 / 5 | **9**<br>182 / 11 / 1 | **10**<br>65 /3 / 0 |
| | Information | **11**<br>100 / 14 / 1 | **12**<br>110 / 0 / 0 | **13**<br>150 / 1 / 0 | **14**<br>140 / 2 / 1 | **15**<br>50 /6 / 0 |
| | Comfort | **16**<br>100 / 10 / 2 | **17**<br>110 / 7 / 1 | **18**<br>150 / 1 / 0 | **19**<br>140 / 1 / 1 | **20**<br>50 / 4 / 1 |

**Figure 3.9: Wide Gaps Between King County Metro Design Guidelines and SANDAG's Mobility Hub Features Catalog**
*In each of the 20 numbered cells, the values shown (from left to right) compare the total number of design features to choose from in both guidelines to the number of features with partial match and the number of features with a complete match. (Machala, 2024, pg. 41)*

Note how little these guides have in common; they suggest how novel and expansive mobility hubs can be in comparison to existing nodal assets in transit or transportation systems. Of the 3,080 features contemplated in these two guidelines, only 18 bear a complete match for design and intended function. This simple exercise explains how thoroughly different electrified mobility hubs are from the current design and functionality of transit centers.

To illustrate, SANDAG offers a category of pedestrian amenities and King County has a section devoted to environmental elements. Cell 2 is at the intersection of these two categories. It shows that there are 253 separate features or elements contemplated in these two guidelines for pedestrian and environment, and 51 of those are at least partially compatible (in possible agreement in terms of design or functional intent), but only two amenities are clearly held in common in both guidelines. Figure 3.9 is a summary table; the full matrices are provided in Appendix A, where you can see what those 253 features are and note compatibility.

The gaps and areas of overlap between these guidelines allowed the team and public agencies to engage in active discussions about desirable design and operational characteristics. The ideas of King County Metro and Sound Transit in the wish list from Workshop 1 were placed against the backdrop of possibilities contemplated by SANDAG for mobility hubs. The collection of possibilities contemplated in SANDAG's guidance was also reviewed in light of the trial and error experiences of local operations.

With a basic understanding of physical, functional, and operational mobility hub features defined, and the baseline of current design guidance for King County Metro and Sound Transit, the project team moved to consideration of on-site charging, curb management, and transit-oriented development.

## Step 2: On-site charging, curb management, and transit-oriented development

In Workshop 2, the project team worked with cross-agency small groups to discuss existing conditions, assumptions, and desires regarding on-site charging, curb management for private and shared vehicles and devices, and a King County Metro mandate for transit-oriented development at mobility hubs. These topics were prioritized from the findings of Workshop 1 because they would have to be addressed early in any process of urban design for a mobility hub, they represent potentially substantial commitments in terms of scope and capital cost, and they pose novel challenges to the public agencies that would have to be resolved to move forward with mobility hub design.

Common themes and site design and function implications are summarized here.

## Onsite charging

Regarding on-site charging, the following questions were discussed.

- What services or elements on site are important to provide with managed charging?
    - What are the top priorities?
- What platforms and/or applications could be used?
- What does future demand look like?
- What should we use as our assumptions?

Two primary themes emerged regarding charging priorities and charging types and uses. Charging priorities for participants were organized into:

1. Buses, Access Paratransit, and other fleet vehicles
2. Carpool, personal vehicles, and
3. Private micro-mobility devices.

These charging priorities need to be integrated into an overall charging strategy that accounts for electrical supply, demand, and pricing changes throughout the day and night. Level 2 chargers were considered appropriate to charge vehicles in medium- to long-term parking (2 to 8 or more hours onsite). Level 3 chargers are more expensive but charge faster and are best provided in short-term, easily accessible parking spots. Note that onsite charging for shared micro-mobility devices was not considered a priority for participating agencies.

Charging infrastructure adds significant value to parking properties. The project team and agency partners considered placing the highest-capacity charging below grade, in various parts of parking garages, or anywhere where access could be controlled and/or more electrical infrastructure might be present. However, in terms of convenient site design and function, providing Level 3 charging in surface parking lots is best. Relatedly, some of these chargers must be located to support accessible parking spaces, including van-accessible spaces. Also, a certain number of Level 3 charging spots could be reserved for agency vehicles with the repurposing of spaces and appropriate signage adjusted over time as demand increases.

The provision and distribution of chargers should be sufficient to lead and keep abreast of demand, while agencies should be pre-planning future waves of charging investment once demand thresholds are met. This is not a simple task. The charging market is not entirely known, and the economics of personal charging is changing as vehicle prices change, a secondary market for used EVs opens up, and public agency awareness of the public need for reliable access to EV charging grows.

Equity and justice considerations are also involved. As noted, people with single-family homes and a dedicated driveway or parking space currently have an advantage in charging. Those who live in multi-family housing have more limited access to charging infrastructure. For local residents with charging needs, charging their personal vehicles at an electrified mobility hub would improve equitable access. Incentive programs for charging at mobility hubs could employ a fixed or tiered pricing system. Climate justice funds could support these types of programs.

Another equity consideration focuses on where facilities are located. Do all communities have equitable access to future electrified mobility hub sites? Where should agencies expand or add new facilities? Though beyond the scope of this study, the siting of neighborhood, district, and regional mobility hubs is a key consideration of equitable service provision.

## Charging management systems and their integration

Real-time technology should be used in charging management to balance the use and availability of charging stations throughout the mobility hub. This includes making and managing reservations, changing peak and non-peak pricing rates, assessing missed reservation fees, and helping manage electrical demand based on vehicle dwell times.

The project team strongly recommends managing all charging needs through a common app. The team is aware of open source software that is serving as the basic code for many managed charging applications. Also, it is possible to operate an app for managed charging on top of a variety of charging hardware (various types of chargers and their associated controllers). For users, the ability to review charger availability, schedule in advance, and observe the progress of charging over time, contributes to the overall public understanding of the reliability of publicly available charging infrastructure. For people who do not already have access to private charging—in one's own private parking area—publicly available and reliable charging could be the difference between choosing a fossil fuel powered or electric vehicle.

Many forms of chargers have been designed in ways that are highly vulnerable to accidents and vandalism. Computerized components on a pole are easily broken through parking accidents, and cables may be cut by vandals and those who try to sell the metal contents on a secondary market. A key security feature of charging stations placed in electrified mobility hubs will be to place the smart systems of the chargers, like load management and other computerized components, inside electrical panels rather than on the top of post and cable systems or inside of wall-mounted cable systems. This is a physical approach to minimize vandalism and reduce costs. Electrical panels must be carefully sited, and power distribution plans must be carefully made to support this premise. The physical approach should be accompanied by a well-matched investment in operations and maintenance. Though it may be common for public agencies to outsource charging system ownership, operation, and maintenance to private vendors, there are no guarantees that private vendors will price services or execute contracts in the public interest or maintain these assets as envisioned. In the meantime, these parking areas are recognized as publicly owned spaces, with the public perception of the agencies inevitably tied to the reliability and security of vehicle charging assets.

The electric vehicle charging industry has increasingly moved toward standards that enforce principles of interoperability and forward compatibility. Interoperability allows all manner of vehicles to benefit from access to all manner of vehicle charging stations, which may be facilitated by standardized designs of connectors. Forward compatibility involves the organization of agency policies and strategies to remove hurdles to the holistic expansion of electrification. One way to do this is to make publicly available applications and to use open source code as the basis for those apps. Another aspect of this approach is to extend these principles beyond vehicles, to include the various other forms of transportation.

Managed charging services can be extended to micro-mobility, involving dedicated spaces, facilities, and services. Vehicle storage and charging space should be developed for all modes of transport supported by the e-mobility hub, including personal micro-mobility devices. A bike house can house devices such as bicycles, e-bikes, cargo bikes, and scooters, where charging and repair supplies can also be provided. Providing a co-located space for planned and emergency charging and supply vending would provide a significant support location for riders.

## Integration with the ORCA card system

The ORCA (One Regional Card for All) payment system application in the Puget Sound area is an example of a platform that could be further developed to obtain the benefits of interoperability and forward compatibility in vehicle charging, smart systems, and the overall management of facilities. ORCA cards can fulfill several roles on site, including verifying that users are transit users if needed. We stress the importance of creating an integrated system, from the agencies to the users.

The charging rate system at e-mobility hubs could use existing ORCA card user categories to help with price setting, revenue collection, and the sharing of costs associated with the charging system. A pricing system could, for example, offer its highest rate for the general public, a lower rate for transit riders, and the lowest rate for ORCA Lift holders. The lowest rate might also be extended to local residents who qualify for other low-income programs in addition to ORCA Lift. ORCA cards can be used to verify that users are transit riders. Rates charged during off-peak hours for the local electric utility, Seattle City Light, could positively affect pricing for local residents, encouraging overnight parking and charging for residents who otherwise do not have reliable access to chargers.

In raising the value of property, the installation of charging infrastructure provides public agencies with a motivation to control ingress and egress to parking facilities. The ORCA card could become the primary means for people entering a mobility hub to manage parking entry and exit, use bicycle lockers and services, and pay for transit rides, parking, and charging.

Such smart systems increase the availability and potential uses of data for facility owners, operators, and users alike. In addition to apps for users, agencies can provide real-time data at key points in the hub, including main pedestrian zones/nodes near ticketing, other amenities, and bus stops. Though the design of smart systems was beyond the scope of this study, the team and partners discussed data collection, analysis, and governance. A key point to arise from this discussion was that public agencies should collect their own data and minimize reliance on vendors. Vendors can provide valuable support in the set up of data collection hardware and architecture, the curation of business intelligence reports for management, and the design of user interfaces for online access and app-based connections to the system. Public agency ownership and capability to manage and operate these systems is critical, however, to minimize the transaction cost of data use and governance. These information and payment systems should be used to manage user and vendor experiences onsite in ways that actively support communities.

## Curb management and charging

Questions considered for the strategic assessment of curb space included:

- What are the anticipated needs for curb space across modes?
- How should curb management differ for parking lots and sidewalks?
- What does future demand look like?

There are governance considerations for curb management. Spatial considerations for curb management spill over the edges of mobility hubs. While the team and partners discussed curb management and charging opportunities in the surrounding streets, we recognized that the local county or municipality is responsible for those spaces.

Discussion of curb management in e-mobility hub design led to an implicit sorting of uses for parking garages, surface parking lots, and on-street curbside space. Surface lots appeared poised for relatively fast and prioritized services, such as kiss-and-ride, micro-mobility, and paratransit services with fast charging systems. These areas also enjoy open sight lines and the possibility of social amenities. Longer stays, slower charging, light duty vehicle and sedan fleet charging, and enhanced security systems were ascribed to parking garages. TNC-owned charging systems were among those more likely to remain in on-street locations.

Over the long-term, curb management and electrification have economic and social implications.  E-mobility hubs can be designed with the intention to catalyze electrification, economic growth, and social justice. Broader electrification strategies for neighborhoods or urban centers could begin at mobility hubs and radiate out. If strong design and charging corridors are created, they could become car-free to further support the transition to cleaner energy and safer streets.

## Transit-Oriented Development

Given King County Metro's mandate to engage in transit-oriented development (TOD) at select transit centers, the project team and agency partners discussed a series of TOD-related questions.

**If housing is placed onsite, what are the implications for:**

- Parking and charging for residents and non-residents?
- The site's liveliness and sense of safety?
- Bicycle and other micro-mobility lockers and charging for residents?

Developing TOD at electrified mobility hubs requires a long-term vision that accommodates the growth of TOD within the context of the neighborhood and aspires to the gradual reduction of single-occupancy vehicle parking. Surface parking lots are expected to give way to other development interests that add value to urban communities over time, including TOD, while the value and collection of services within adjacent parking garages may rise to accommodate residents and vehicle charging, as well as mode changes for travelers. TOD is centered on developing living units and supporting services and amenities near transit stations.

Currently, King County Metro expects TOD to provide residents with assigned parking spaces at mobility hubs. TOD residents could be incentivized with bicycle storage, repair spaces, and possible bicycle and/or car charging stations to support increasing independence from fossil fuel-powered automobiles. With more residents living at mobility hubs, the sense of liveliness and safety could likely increase in a way that supports the transition of transit centers to the community spaces mobility hubs are intended to be.

## Step 3: Belonging and safety, site furnishings, and the pedestrian realm

Step 3 involved the review of select functional and use recommendations together, addressing the challenge of competing demands for limited space. In Workshop 3, small cross-agency groups used a conceptual site design for the Burien Transit Center (see Chapter 4) to review and comment on (1) curb management, circulation, and charging placement and (2) sense of belonging, safety, site furnishings, and the pedestrian realm. Together, these features allowed the team and public agencies to provide deeper consideration to problems with operations, maintenance, and safety that appear to be intractable, yet are meaningful for the transformation of this and other sites into electrified mobility hubs. This marks a significant step from blue sky discussions of what is desired and prioritized, into perceived or actual constraints and problems to be addressed.

### Design features for safety and to reduce conflict

In the discussion of the relationship between the built environment and safety, many features were highlighted and creatively brought to the forefront of urban design.

Features of the built environment, such as traffic calming devices, signage, and bollards, should be used liberally throughout the site, especially in potential conflict zones for pedestrians, bicycles, and vehicles. Site lighting should be environmentally friendly and work for TOD residents and general mobility hub users. Special attention should be paid to comfortable and well-lit non-motorized circulation routes on and off of the site.

Participants commented on the benefits of ensuring that food trucks and other culturally-appropriate amenities are incorporated into mobility hub layouts. Waste and recycling needs could be planned and coordinated with operations and maintenance services. Food trucks should also use power pedestals rather than generators, as they will detract from pedestrian comfort regarding heat, noise, and pollution.

The transition to electronic bicycles and other forms of micro-mobility raises the need for improvements to security for the storage and charging of this equipment. Bike houses, rather than lockers, should be roomy and secure, and support the charging of individual devices. Systems should be installed to allow secure charging of removable batteries via a fire-proof bike battery charging kiosk or locker.

A sense of belonging can accompany the installment of features that provide safety. Consider providing more benefits to people who are not driving. Operations can involve programming tailored to the needs of the community, for example, bringing in a bike mechanic one day a week or month to support rolling users. Streetscapes and site design can delineate where pedestrians and cyclists should cross or access the site and reduce passenger vehicle speeds as they enter and exit the mobility hub. Particular attention is required for efficient bus ingress and egress and clear separation between modes.

A sense of belonging takes effort to gain, and can be easily lost. For example, the vandalism of electric vehicle chargers is more common than people may realize, and the tendency of public agencies to ask private firms to shoulder that risk has the unintended consequence of creating an unfulfilled promise of access to charging for communities. Vandalism can quickly overwhelm the financial and physical resources of the firms in the business of installing and operating charging stations.

As noted, there are a variety of ways in which public agencies can provide improved protection for assets such as charging stations, and for the public's own private property. Parking garages and surface lots can be gate controlled, managed through ORCA card access. ORCA card access can further become a basis for incentive programs for garage use. People using their ORCA card for transit use could be offered incentives in the form of several hours of free or discounted parking and charging. When well-designed and consistently implemented, the perception of a gate in the public imagination moves from a feature installed by a public agency to limit valuable access, to a feature managed by a public agency to protect everyone's valuable assets.

### Responding to uncertainty in the evolution of technology

Future changes could render our assumptions moot. That said, of all the trends reviewed in this research, the need to electrify transportation assets in order to address climate change stood out for its likelihood to persist and grow in the coming decades. This is coupled with the need to prepare for natural hazards to increase in magnitude and spatial extent due to climate change. One way to improve flexibility is to create a robust electrical infrastructure underground, considering the potential demand for future charging and the need to respond to emergencies with resilience.

The substantial effort required to provide electrification for bus charging and personal vehicle charging also creates opportunities for mobility centers to serve as sources of energy in the wake of a disaster. Any effort to make these electrical services interoperable to a variety of vehicle types and battery systems will provide the dual functionality of support for emergency, evacuation, and recovery services.

It is also important to keep in mind that redundancy is a significant source of resilience for infrastructure goods and services. If bus bases and parking garage charging facilities can be designed to provide redundancy for critical energy services, this would be an important co-benefit of mobility hub design. It would merge the concept of the mobility hub with the resilience hub.

The team notes that solar energy generation is financially viable in the greater Seattle region, and has been so since 2019. This is new information for public agencies responsible for transit centers and park-and-rides, and can be viewed as a financially meaningful part of the transformation of these facilities into resilient, e-mobility hubs.

## Step 4: Mobility hub transformation and operation

Workshop 4 broadened the scope of discussion to the overall transformation and operation of electrified mobility hubs. Previous Workshops housed blue sky discussions or based discussions on observed details within a collection of themes or categories. In this fourth and final step, we collectively zoomed out to consider inter-organizational differences between the agencies, and areas of potential conflict between organizations and organizational policies, roles, and responsibilities.

The project team asked a series of questions based on themes and "tensions" identified throughout the year. We also asked agency partners about (1) how, individually, their organizations think about these themes and (2) How, as a collection of organizations, they believe they should think about them. The topics included operation and maintenance roles, operation and maintenance of charging infrastructure, parking reservations, building "smart" versus building to last, and micro-mobility charging.

## In-house versus third-party operation and management

Transit agencies address operations and maintenance issues across a full spectrum of contractual relationships, from in-house to third-party. Currently, as the operating transit agency, King County Metro handles operations and maintenance in-house. Sound Transit frequently works with third-party operations and maintenance vendors. King County Metro is a third party for Sound Transit, working together as partners. Moving forward, King County Metro is open to in-house and third-party contractors. In this county, many such activities are unionized and therefore conducted in-house.

Observations in the field and discussions over the course of the year made it clear to everyone involved that maintenance issues that are not resolved in the design phase of site development have the long-term effect of impacting the functionality and accessibility of facilities. The team observed, in site visits to the Burien Transit Center, for example, that unsafe behaviors or conditions on the top deck of the parking structure resulted in maintenance crews placing a jersey barrier that blocked access to the full top floor of parking. Public restrooms and facilities intended for comfort such as market stalls or vending machines were closed and inaccessible, likely due to the difficulty of servicing such facilities. Video surveillance appeared limited in its use, and could have benefited from investments in lighting and design to signify active use. The key to preventing these difficult outcomes is to incorporate maintenance into design, working by consensus to meet the challenge of reaching new levels of service and accessibility.

No singular operations and maintenance pathway is required to build and operate electrified mobility hubs. The best pathway would be based on the required onsite installation needs and how those elements and systems will be used. For example, for larger or more technical projects that will go out to bid, it is important to consider how charging infrastructure would be developed, owned, priced, and managed, and whether any new teams would need to be stood up at King County Metro to provide support and expertise.

## Operations and management for charging infrastructure

Charging infrastructure for personal vehicles and devices represents a significant opportunity for public agencies to transform a liability into an asset.

We see an advantage to moving from third-party contracts for charging, which have provided limited oversight and repair, especially after vandalism, to charging as a service. Agencies should avoid creating the conditions by which a contractor is responsible for addressing vandalized charging infrastructure on agency-managed property. While moving the repair of vandalized charging infrastructure away from contractors could be useful, the project team understands that in-house operations and maintenance also bring risk, new resource expenditures, and new areas of exploration and expertise to agency partners. Whether due to formal policy or informal norms, public agencies are just beginning to contemplate the opportunity that comes from charging as a service. A shift in perception and action, which currently happens to be supported by government grants and incentives such as the Inflation Reduction Act, could move electrification from the cost to the revenue earning site of budget ledgers. This shift will likely change with increased provision of charging infrastructure, adoption, uptake, and future funding cycles.

Public agencies may currently be under the impression that they compete with homeowners to provide charging services. The public is, however, divided into those with and without their own homes, their own private parking spaces, and their own funds to install and access charging equipment. There is a significant portion of the population in urban areas that do not share this accessibility. Electrified mobility hubs could provide a vital opportunity for those without a driveway or single-family home to charge their vehicles while commuting.

If wrapped into a more comprehensive set of smart infrastructure investments to manage ingress, egress, security, and the provision of a wider array of public amenities, public charging as a service at e-mobility hubs would support public agencies in their ability to carry out existing policy goals for these spaces, and develop new policy goals that encourage belonging and a stronger sense of community ownership. Currently, though there is evidence of demand for overnight use and a concomitant demand for security, transit center parking garages operate on an "honor system." Sound Transit has a 24-hour parking limit policy; King County Metro has a 72-hour limit. The efficient and effective use of charging infrastructure would include overnight charging and parking for nearby residents. Upgrading these valuable public spaces with a smart and well-supported 24/7 presence would become transformative for perceived and actual material value these spaces bring to local residents. Instead of being spaces that people pass-through, they would become spaces people depend on for local use.

## Changing how we think about who we serve with parking, and why

With the proposed increase of TOD, vitality at mobility hubs, and agency decarbonization goals, a new mandate for parking management at transit centers is possible. At this time, King County Metro has more parking supply than demand. King County Metro and Sound Transit are discussing daily charging fees for parking separate from charging. And decarbonization goals affect everything these organizations are doing to improve their capital assets. A window for policy change is opening.

The "blue sky" policy for local users would include safe overnight parking and charging and the opportunity to book off-peak charging. The constraints that prevent this vision from becoming a reality are two-fold. The first is widespread vandalism of chargers and other properties at transit and park-and-ride facilities—which has been discussed above in terms of the ownership and safety features of public agency properties (Workshop 3). The other constraint is a current interpretation of local code that suggests that public agencies must dedicate parking at their facilities and services only to people who use transit. There are people who would benefit from access to publicly available parking with charging and choose to ride transit (and likely park during the day), and people who would simply be in need of a reliable and safe place to park and charge an electric vehicle overnight. Only the first of these two groups is being served by this interpretation of local code. A broader interpretation would perhaps recognize and resolve the conflict inherent in this interpretation of code and the policies and regulations that exist to support the need to meet state and local mandates to eliminate and sequester greenhouse gas emissions across all sectors of activity, including transportation.

The era that defined the development of transit centers and park-and-rides embodied a goal of reducing vehicle miles traveled and single occupancy vehicle use, especially for commutes into and out of downtown areas. The design of these facilities, still in use today, also happened to fit early narratives of the collective goals people have around the world to reduce greenhouse gas emissions: public agencies promoting the use of transit achieve co-benefits if they manage to reduce vehicle miles traveled in fossil fuel powered vehicles. Electrifying bus fleets and expanding other electrified transit options, such as trolley and streetcar services, furthered this narrative as well.

Today, however, climate science makes it clear that the reduction of greenhouse gas emissions made possible from mode shifts to transit is no longer an adequate target, and that the timeframe to act is now. The transportation sector is, among urban infrastructure systems, the greatest source of greenhouse gas emissions in the US. The built environment of the US cannot be expected to transform so completely as to make people feel comfortable leaving their vehicles behind, and we do not have much time to transition to a clean energy economy. As beneficial as it may be to promote transit use, a great number of people in the US will continue to own and operate vehicles. For this substantial portion of the population, electrification is the way to eliminate vehicular emissions. Public transportation agencies have a significant role to play in this clean energy transition, scheduled to take place in the greater Seattle area over the next ten years. The question for public transit agencies is, can we incentivize certain groups and locations in the push to decarbonize?

The parking assets of transit and transportation agencies, spread as they are across urban transportation networks, represent key opportunities to cut a path for both climate justice and greenhouse gas emission target achievement in the transportation sector. The solution is simple and economically meaningful, because it involves electrifying everything, and supporting the widest possible public need for local and cost-effective transportation charging services on a 24/7 basis. This vision is foundational to the concept of e-mobility hubs.

### "Smartness" or built-to-last

There is tension between known and aging technology and its operation and maintenance, and smarter or more complex mechanical and information technology. With higher levels of technology, misuse, and less adaptable use could result.

Consider the fact that charging management is essential for implementing electrified mobility hubs. Implementing a charging reservation system will be a key step. Barriers to use must be kept as low as reasonably possible, and penalties for lateness or absence should be considered. King County Metro and Sound Transit are currently exploring paid parking systems for their facilities, and this system would have some similarities.

The biggest concern is what implementation would look like. Consider charging as a service, offered directly by the public agency, to be no different from today's use of the ORCA card to access public transit. It would be beneficial to co-locate ORCA card kiosks with the onsite charging reservation systems. ORCA and credit card readers will be necessary, because not everyone can or will pay using a smartphone. The system should also provide for people who are not part of the managed charging ecosystem, though they should be encouraged to join. If people are late, the charging system should embrace a small pool of same-day spots and a time-out system.

### Micro-mobility and charging

Micro-mobility is growing so ubiquitous that the project team wanted to return to the topic of how to support and differentiate personal versus shared micro-mobility devices (SMMD) at mobility hubs. One of the best locations for shared micro-mobility services is near transit hubs. Sound Transit is working on a micro-mobility policy for transit facilities. Sound Transit, in collaboration with the Seattle Department of Transportation (SDOT) and King County Metro (KCM), has launched two pilot projects. These projects include designated parking areas for shared bikes and scooters at select Link light rail stations and incentives for using micro-mobility services to connect to transit (Sound Transit, 2022). E-mobility hubs could be natural extensions for these pilot programs.

People are making increasing use of SMMD to access transit systems, creating a demand for safe and secure spaces for parking and re-use. The disarray of SMMD equipment in urban areas, blocking sidewalks, driveways, and streets, is a matter of concern for mobility hubs. Personal and SMMD device parking will likely be a popular amenity at mobility hubs, and should be planned to provide convenient mode switches, safe storage, and keep the pedestrian realm clear and accessible for everyone using the mobility hub. In this context, geofencing is an important tool for governing shared mobility and micro-mobility systems. Transit centers may need to be geofenced to keep SMMDs to particular areas of the facility.

Personal micro-mobility device charging has some traction among public agencies because it can help empower personal mobility rather than provide resources for a for-profit entity. Discussions pointed to the preference to allow personal devices to be brought onto electrified mobility hub sites. However, such equipment should be kept in or near a bicycle house to help prevent vandalism and keep the pedestrian realm free from impediments.

## Closing points

This chapter introduced the process and results of this study that are broadly applicable in the transformation of transit and transportation assets into electrified mobility hubs. These were the essential issues our team found worthy of attention in the planning and design of electrified mobility hubs with public agencies.

In closing, consider that the details raised in the discussions during this year-long study could be described in terms that are broader, representing a larger framework for understanding the motivation behind e-mobility hub development. The topics in this chapter could be said to fit anywhere within a set of conversations on:

**Technological ambiguity**

- Agencies are concerned, for example, that the charging technology being used will not be mainstream and that adapting to other technologies will incur extra costs.

**Asset specificity**

- Concerning whether technology makes some facilities obsolete, how can better design inspire beneficial usage for those in the future?
- Public agency assets exist within communities that have been growing around them, with new and different needs. How to adapt to serve them?

**Business model**

- Own or contract out? In either circumstance, how can reliable operation be assured?
- Is electrification a cost center or source of revenue? How does the business model serve, with safety and convenience, the full array of community members?

**Service ambiguity**

- Who is the public? Who defines the public? In an era of new mobility, TOD, and climate change, who do transit agencies serve?
- Can the mandate broaden from transit users to include local residents? In this context, how does social equity become part of the vision of transit agency facilities and services?

The transformation of transit centers, park-and-rides, and similar public facilities into electrified mobility hubs is a grand effort to reshape the roles and responsibilities between transportation agencies and the communities they serve, and to do so through a major program of capital investment. Public agencies all across the US are grappling with what it means to decarbonize their assets and operations, including the University of Washington, with its Seattle campus nestled within city limits. All of the public agencies operating in the greater Seattle metropolitan area are facing these challenges, operating under regulatory mandates as well as self-imposed targets to make a difference, to lessen the impacts, burdens, and inequities of climate change.

The transportation assets discussed in this study can be part of the solution. In the next chapters, we take a closer look at the transformation of the Burien Transit Center into a mobility hub, and a cost model for its electrification.

# CHAPTER 4

# Site Design for Electric Mobility Hubs

This study brought together a multidisciplinary team of academic researchers with several public agencies concerned with the electrification and upgrading of transit centers and similar facilities. The research was exploratory, and in order to be effective as applied research, we selected a site of shared interest to discuss transformation into an electrified mobility hub. The purpose of the team's conceptual urban design for this site is to demonstrate the application of design elements informed by research, best practices, and a literature review from a general planning perspective. Additionally, we provide an analytical discussion that examines both the benefits and potential challenges of the proposed options. This is accompanied by a cost estimate specific to electrification, which is detailed in Chapter 5.

## Site location

Burien Transit Center, located at 209 SW 148th Street, in Burien, Washington, is served by both King County Metro and Sound Transit. Burien is a suburban city just south of Seattle on Puget Sound. It is advertised as a place that offers big-city accessibility without the big-city price tag.

The transit center is surrounded by a variety of land uses typical of urban city centers, including grocery stores, restaurants, banking, postal service, sheriff's offices, drug stores, multifamily housing, and parks. The site is one block from Burien city hall.

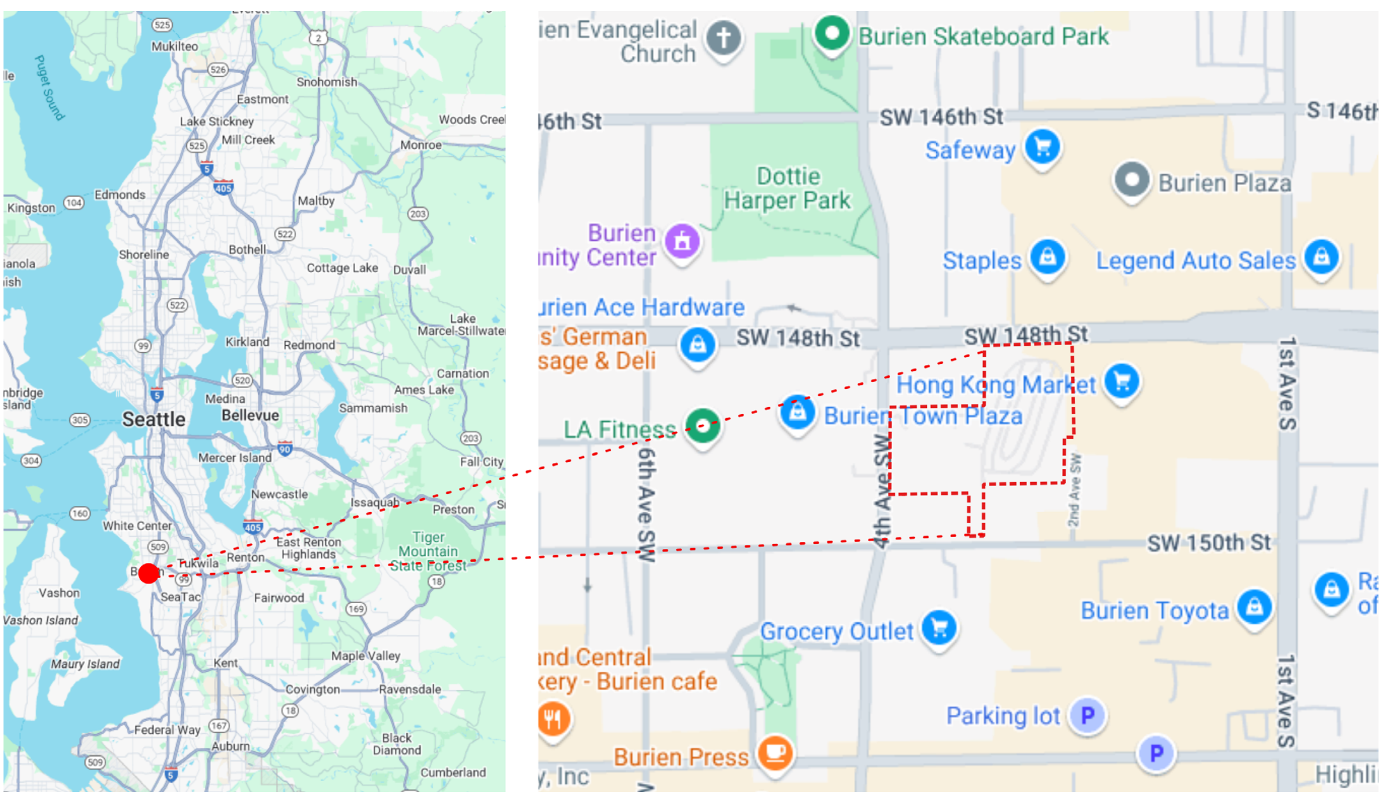



**Figure 4.1: Site Location in the Puget Sound Region**

## Initial thoughts, possible issues

Early conversations with public agency collaborators brought forward a wide variety of questions and possible issues in connection with the prospect of transforming Burien Transit Center into an electrified mobility hub:

- Technological ambiguity: Apprehension about the future viability of charging technology and whether it will align with mainstream adoption. This uncertainty could lead to additional costs when adapting to other emerging technologies.
- Asset specificity: Concerns arise about potential technological advancements that may render existing facilities obsolete. This prompts questions about repurposing or enhancing these facilities for more effective future usage.
- Business model: Determining whether to maintain ownership or contract out certain aspects of the e-mobility hub remains a critical decision. This consideration involves exploring the tradeoffs of both options to ensure optimal operations.
- Revenue division: The delineation of revenue, for example, from exercising charging as a service, and how it will be shared among stakeholders is a crucial aspect that requires clarity and agreement among involved parties. Adding charging increases the value of these assets to the agency and the public, suggesting a need for well-defined and enforceable systems of ingress, egress, reliable use, and security.
- Service ambiguity: Identifying the target audience or defining the public in the context of the e-mobility hub remains a critical question, directly tied to concepts of social equity and climate justice. This is very pertinent to the particular question of whether electric vehicle charging should serve local residents with overnight charging as well as non-transit users with daytime charging.
- Operation and maintenance responsibilities: Clear roles and responsibilities by public agencies and their procured service providers are needed to effectively operate and maintain an e-mobility hub. This will help keep equipment in good working order, ensure repairs are as timely as possible, and promote confidence by users.

## Observations of the site, problems on the ground

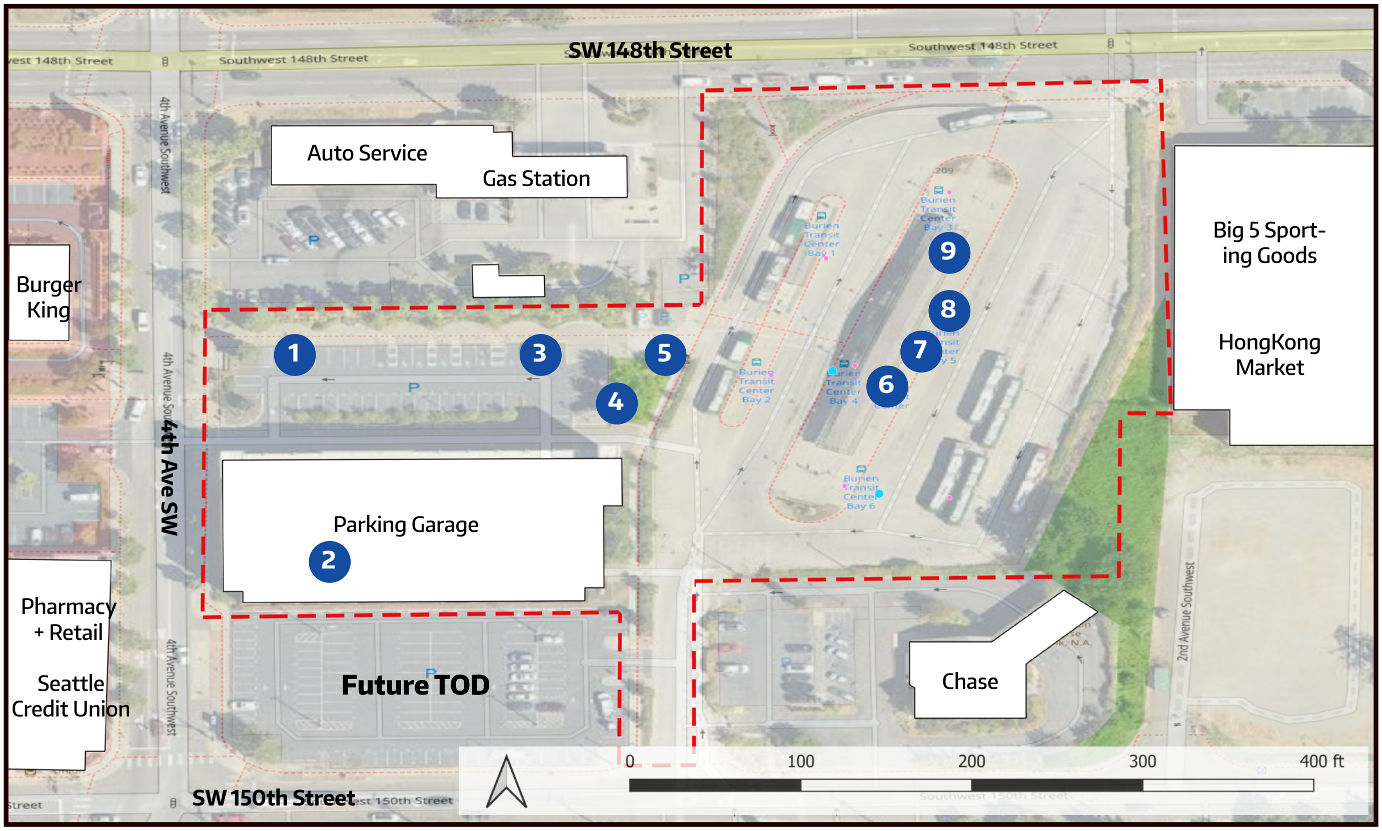
Field visits to the site, at times accompanied by maintenance and operation crews for the Burien Transit Center, resulted in a list of observations and current issues for the site (Figure 4.2).

Prior to the COVID-19 pandemic, the site was reportedly full or nearly full on a regular basis. A 500-space parking garage had opened in 2011 to serve growing demand for transit services at the site, including 10 electric vehicle chargers. The site has undergone dramatic changes over the past five years. Crew members noted an increase during the pandemic in non-destination ridership and homelessness. It is possible that free transit service during the pandemic led to non-passengers spending significant amounts of time at transit facilities. In today's post-pandemic environment, we found the garage empty, except for unauthorized use by recreational vehicles.

During field visits there were multiple signs of unauthorized activities, unintended uses of facilities, vandalism, and makeshift efforts to maintain safety and curb damaging behavior. Signs of loitering and drug use were prevalent. Facilities had been used in unintended ways, such as garbage cans being used as screens for unauthorized activities and toilets, bus shelters and garages being used for overnight stays, and bike boxes being used for overnight stays and personal storage beyond bicycles. In the parking garage, there were recreational vehicles parked for prolonged periods of time, tent camping, and signs of drag racing. The uppermost floor was barricaded to prevent auto access, presumed to be in response to racing. All but one of the 10 ChargePoint electric vehicle chargers were inoperable—the cables had been severed and removed. Maintenance crew members indicated that the wires of some electrical access outlets were pulled out to meet personal needs. Glass and solar panels were often shattered. Such circumstances held off the installation of digital tablets to bus signage.

The site had been provisioned by King County Metro with a private contractor to conduct random security sweeps. As private security they could only report, and

## Figure 4.2: Site Analysis




### 1 Amenity concern

Concrete seating in the main pedestrian space is a magnet for the unhoused, but can't be removed as part of the stowrm-water collection system


### 2 Parking garages

Garage gets pretty empty after COVID.
9 out of 10 chargers were not working due to vandalism.
Attracted unauthorized activities.
KCM barricading sections and floors to prevent drag racing, RV and tent camp-ing, etc.

### 3 Amenity changes

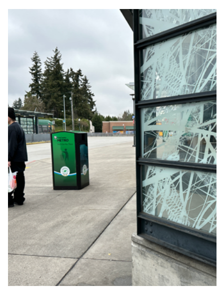
Bike racks removed. Bike lockers turned N-S to create better site lines.

### 4 Site maintenance

Foliage hinders sight lines and associat-ed awareness of security.

### 5 Site maintenance

Pressure washing the permeable con-crete to eliminate moss growth

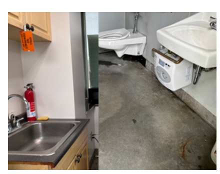


### 6 Amenity changes

Garbage cans removed in some cases, moved away from walls in other, used as screens for unauthorized activities, toilets and areas designed for vending are closed.

**Vandalism**

Folks use outlets, pull wires and create outlets, and otherwise transform site electrical access to meet individual needs



### 7 Staff facilities

Locked bathrooms; a lounge with seats, vending machines, and a microwave Burien, Bellevue and Aurora Village have lounges.

### 8 Amenity changes

Moved benches under the primary over-head structure from the inside to the outside to avoid overnight stay

### 9 Securitas activity

There is relatively little security on site: Securitas, a private contractor, provides random sweeps. They can only report problems and do not intervene directly. The sheriff's department visits the site when possible/called.

not intervene, if there was an incident. We observed security at neighboring properties, such as the site of a bank and a gas station within eyesight of the transit center. The parking garage contained a limited set of camera systems to record activities onsite and deter crime, though they appeared to be underutilized. Safety for crew members, onsite lines to emergency service providers, collaboration with the city of Burien and appropriate social support authorities to address prevalent drug use, homelessness, and vandalism at the transit center are heightened concerns.

## Electrification plan review

Development of bus charging stations onsite was ongoing at the time of this study. The team reviewed available plans and discussed decisions about technology with King County Metro and Sound Transit. King County Metro and Sound Transit had independently selected different technologies for electric buses and bus charging.

The divergence in technology choices (pantograph and wireless charging for buses) between two transit agencies poses both challenges and opportunities. As an experimental phase in fleet electrification, this application of divergent charging technologies presents an opportunity to comparatively examine two fundamentally different forms of capital investment and their operations and maintenance characteristics side-by-side. In an era of uncertainty, such an approach could prove beneficial if, eventually, the more reliable and cost-effective of the two were eventually adopted for a more widespread collection of assets and service areas. This forward-thinking approach aligns with the transit authority's commitment to be open to new ideas and continuously experiment to drive improvements.

This integration of different charging infrastructures brings potential challenges. An optimal choice for charging technology would provide interoperability and redundancy. Interoperability would allow the transit agencies to share charging facilities, potentially saving space and providing more effective use of the assets that are installed. Redundancy is possible with two different charging systems, but only if they are interoperable for the fleets of the agencies, and redundancy has long been recognized as a source of resilience in system design and operations.

Economically, the development of divergent charging infrastructures comes with transaction costs for the transit agencies. These costs include installation, maintenance, training, and potential complexities in managing disparate systems. The potential lack of interoperability between these systems may lead to operational inefficiencies and increased resource allocation. Operating and maintaining multiple charging systems may pose logistical complexities and financial burdens for the transit agencies. Moreover, integrating diverse charging infrastructures might complicate efforts to establish universal protocols and guidelines within the domain of bus charging infrastructure.

## Initial electrical capacity considerations

The imperative to electrify transit and transportation services brings with it the challenge of building now at a scale to accommodate future growth and the evolution of rapidly changing technologies. Given the uncertainty surrounding electric vehicle charging challenges, such as demand for future charging, charging technologies, and business models, a few critical decisions to make for the site are the level of electrical grid capacity to upgrade to, and the cost or feasibility of doing so in order to adapt to forecasted needs. These upgrades aim to ensure infrastructure adaptability while exploring feasible options for better service provision.

Transportation electrification involves multiple types of electric vehicle (EV) chargers, each with different power requirements:

- For the fleet, depot plug-in charging can deliver between 40 and 125 kW of power, with charging times ranging from one to eight hours. This type of charging generally involves lower initial costs, lower electricity expenses, and minimizes operational disruptions if a charger fails, as long as chargers are available at the depot. On the other hand, on-route fast charging provides higher power levels (125 to 500 kW) and significantly shorter charging times, typically between 5 to 20 minutes per session. This method allows buses to operate on longer routes, requires smaller batteries on board, and reduces the total number of chargers needed to support a fleet compared to depot charging (Federal Transit Administration, 2023).

- EV car chargers vary widely in power needs, from Level 1 chargers (120V, 1.3-2.4 kW) suitable for overnight charging at home, to Level 2 chargers (240V, 7.2-19.2 kW), to DC fast chargers (50-350 kW). DC fast chargers, especially at the upper end (e.g., 150 kW or 350 kW), can charge most cars to 80% within 30 minutes but have about one-third the power requirement of a bus charger (SDGE, 2020).
- Charging infrastructure for electric bikes and scooters typically requires much lower power, around 250-1000 W (0.25- 1 kW). These chargers are less demanding on the grid and are generally not a significant factor in grid upgrade requirements.

Sites requiring multiple opportunity chargers (e.g., several 450 kW chargers) would require significant utility upgrades, such as additional transformers or even an upgrade to a substation. This could take years due to planning, permitting, and construction timelines. In contrast, sites with no bus chargers and only Level 2 EV car chargers would typically require much less extensive utility upgrades, often involving simpler grid connections and less planning.

To address these considerations, it's essential to engage with the utility provider early and frequently. Understanding the process of adjusting grid capacity is crucial, especially when planning capacity upgrades for charging infrastructure. By doing so, transit agencies can better evaluate the costs and practicalities of service upgrades, ensuring that the site's electrical infrastructure can meet future demands effectively.

## Initial mobility hub design considerations

Moreover, discussions about e-mobility enhancements based on the Burien Transit Center site involved planning for multiple transportation modes. Several capital investments were discussed:

- Bike houses near the bus waiting area that accommodate personal e-bikes and e-scooter charging promote multiple modes of transportation.
- Integrating fast charging options in surface parking areas, perhaps for paratransit and/or transportation network companies (TNCs), further demonstrates a commitment to expanding charging accessibility.
- Beyond infrastructure, place-making strategies encompass mixed-use ground spaces, including residential and commercial activities, which are used to revitalize the area.
- Traffic calming solutions, way-finding strategies, and the incorporation of engaging elements for pedestrians signify a holistic approach toward creating a vibrant and user-friendly transit hub.

As part of an ongoing process, public agencies should be comfortable actively addressing maintenance concerns, leveraging face-to-face interactions and work orders to attend to complaints and meet ridership needs. A rigorous follow-up process incorporating ridership surveys should be established to allow for continual refinement and responsiveness to team queries.

## Design programming

To begin the urban design process, the site was divided into nine smaller areas with different functions. The number of areas is labeled generally from west to east and from top to bottom, as shown in Figure 4.3.

1 **North parking lot** - includes short-term (30 mins-1 hour max), high-capacity charging, accessible vehicle charging, bicycle house w/solar panels

2 **Parking garage** - the existing garage is skinned for aesthetic appeal and security, swipe entrance/egress, and secured long-term charging (1 hour+), and car storage. Include special rates for nearby residents and for customers with ORCA Lift.

3 **SW Corner/TOD site** - ground floor commercial/retail building with possible second-floor office space, affordable residential rental units above, could include a bike shop and secure bike alternative to the bike house, pedestrian plaza with trees and site furniture (Note:

please confirm next week what zoning allows on this site for height, setbacks, and building use - e.g., can we do retail, commercial, and office? What does the zoning allow for in terms of residential uses?)

4 **Drop-off zones** - indented sidewalks for easy drop-off/pick-up (City of Burien takes ownership)

5 **Pedestrian spine/zone** - accessible walkways throughout the site, site furniture, trees, weather protection, and customer amenities,

6 **Transit plaza** - bus stops, layovers, and charging

7 **Pedestrian island** - operator lounge and bathroom, lighting, weather protection, WiFi, ticket kiosks, vending, public bathrooms

8 **Intersection and street design** to unify the areas and promote a "there there" and neighborhood feeling (City of Burien takes ownership)

9 **Supporting spaces** - high-quality sidewalks, street trees, and street furniture as appropriate (City of Burien takes ownership)

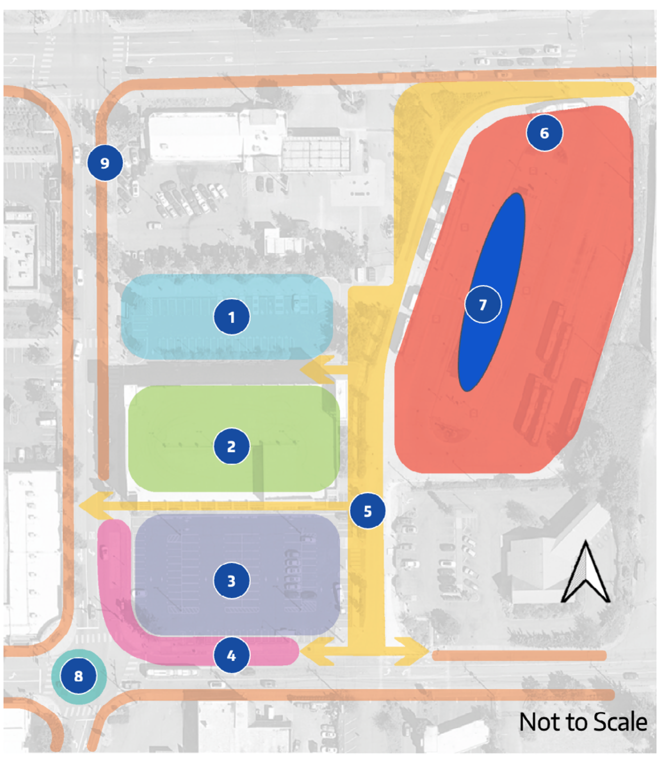



**Figure 4.3: Burien Transit Center Diagrammatic Site Plan**

# Detailed description of design

## North parking lot

This plan view and section drawing (Figures 4.4 and 4.5) offer a comprehensive overview of the predominant functions along the north-south axis of the designated area. The focal point within this northern sector is the renovation of the north parking lot, strategically designed to accommodate both short-term and long-term electric vehicle charging requirements. The parking lot design facilitates quick and convenient charging for pick-up and drop-off vehicles and offers charging stations for vehicles that need accessible parking spots. Enhancing the user experience, the north parking lot incorporates covered pedestrian walkways, ensuring sheltered and secure pathways for individuals moving between vehicles, charging stations, and bus stations.

A standout feature of the north parking lot is the provision of a dedicated bike house, reinforcing the commitment to alternative modes of transportation and eco-friendly commuting options. This facility has amenities tailored for bicycles, including secure storage, repair stations, charging for personal electric bikes, and integrated solar panels. It aims to encourage and support cyclists, providing a convenient and safe space for bicycle parking, charging, maintenance, and storage.

## Parking garage

The parking garage will be reprogrammed to have car/van share and agency fleet parking on the ground level. The ground floor could help prioritize parking for those who use the vanpool and van share programs.

The upper levels of the parking garage, specifically the second and third floors, are designated to host new Level 2 charging stations. This idea is based on the assumption that vehicles parked in the garage typically remain for longer periods of time. By incorporating additional charging stations in these areas, the aim is to offer convenience for future charging needs, catering not only to transit users but potentially to residents of the TOD building. A visual depiction of this layout can be found in Figure 4.5, depicted within the Burien Transit Center Section.

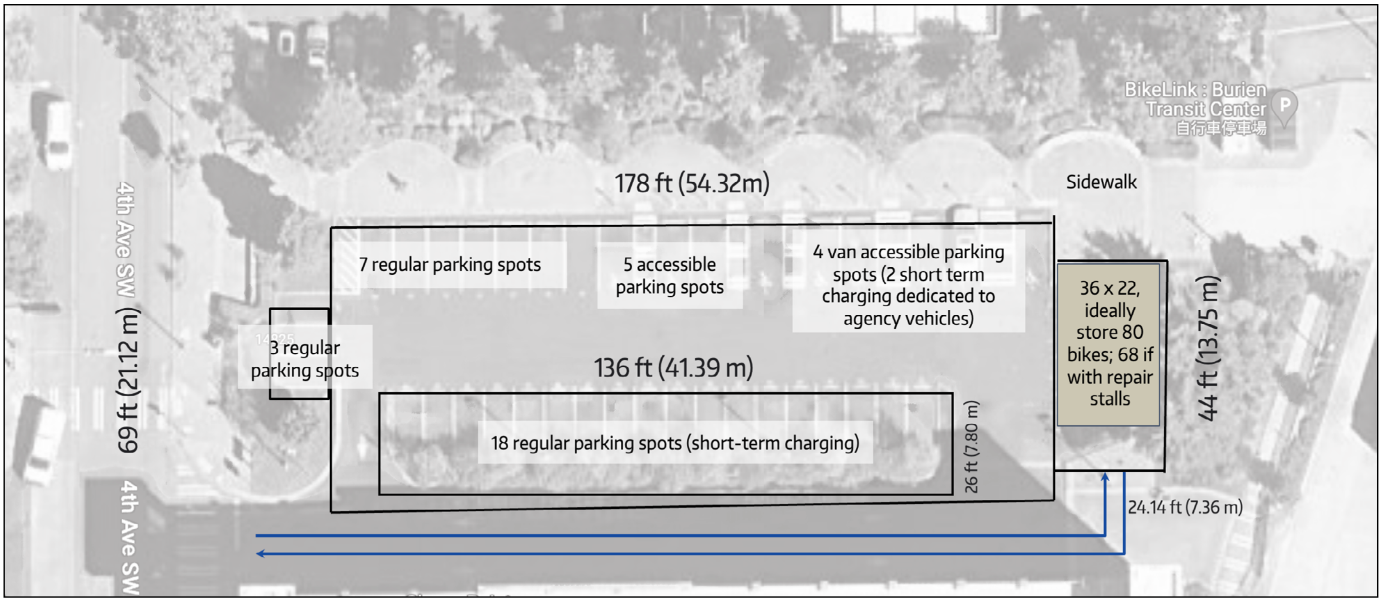



**Figure 4.4:** North Parking Lot

Security gates are recommended for the parking structure, potentially to coincide with the installation of chargers on the second floor. Design and operation of such a facility would have to address concerns for safety and equity. Safety concerns revolve around potential access blockages if the gate malfunctioned or was breached, potentially posing hazards in emergencies. Gates could be accessed with ORCA cards, which are available with cash or credit. This would exclude vehicle access for individuals without ORCA cards, limiting access to the garage.

Assuming the development of a TOD residential facility onsite, the team recommends connecting the parking garage to the adjacent building through a skybridge. This connectivity allows TOD building residents to access the charging facilities and parking spaces within the garage. In theory, TOD facility siting and development reduces demand for parking by replacing the need for auto ownership with easy access to transit. In practice, this is an aspirational goal for the vast majority of urban as well as rural parts of the US. Exceptions would be Manhattan and San Francisco, for their century long dedication of resources to citywide subway and light

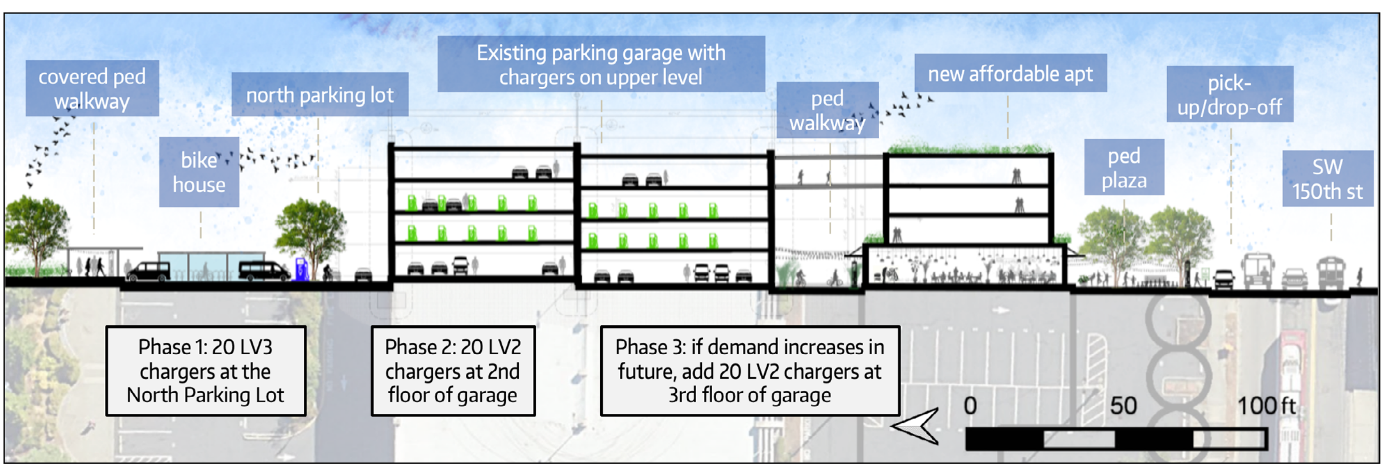



**Figure 4.5:** Burien Transit Center Section (North-South)

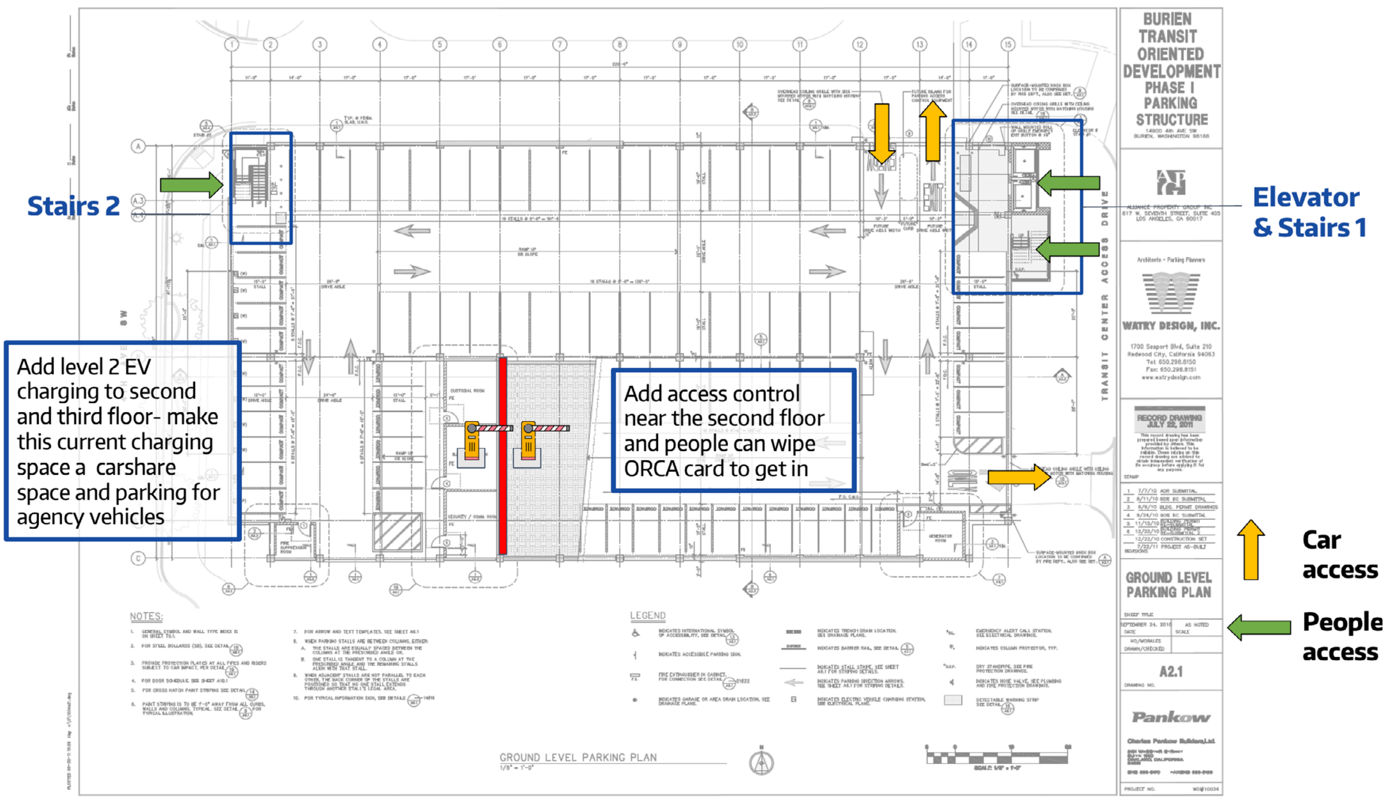



**Figure 4.6: Parking Garage Layout (2nd Floor)**

rail systems. Aside from these noteworthy exceptions, it is very difficult to reduce both perceived and actual household demand for the automobile. Providing easy access to existing garage spaces with charging facilities for residents of affordable multifamily house units would support climate justice and avoid furthering inequities in transportation services. In addition, connection between the residential building and one or more upper floors of the garage can provide the security that comes from having "eyes on the street", or visibility from residents onto the property they care about.

Initial discussions entertained the idea of integrating different pricing mechanisms into charging rates (e.g. discounts for ORCA users and residents within a certain radius). However, a more comprehensive understanding of the business models to be adopted by the site owner is required before delving into the details of charging rates.

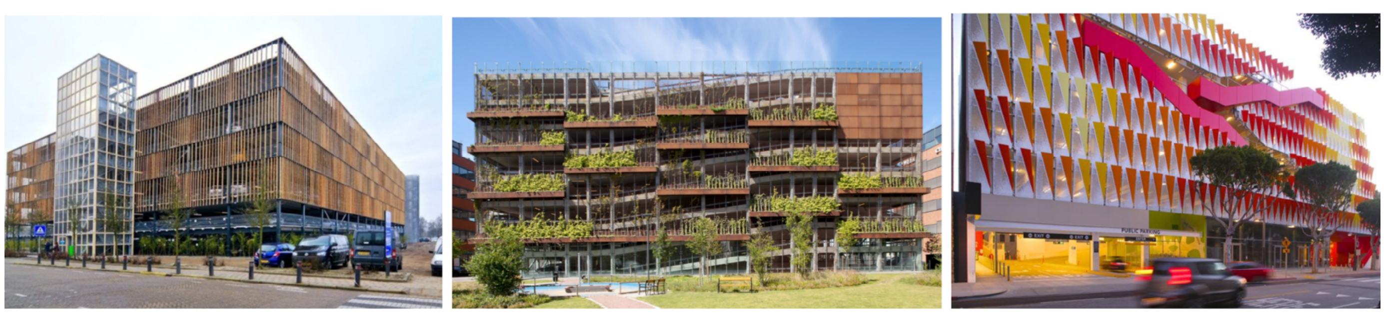


**Figure 4.7: Garage Skin Inspirations:**
*Left- MCS car park (Gortemaker Algra Feenstra, n.d.); Middle- P-hus Dockan Car park, Malmö, Sweden (Space Arkitekter AB, 2009); Right- City of Santa Monica Parking Structure (Behnisch Architekten, 2015)*

## SW corner/TOD site

The public agencies are considering the conversion of the current southwest parking lot into a multifamily residential and possibly mixed-use transit-oriented development building with a multifaceted structure that embodies convenience, community engagement, and sustainable living.

According to the literature, successful TOD at the site level should enhance compactness, diversify land uses, and concentrate commercial, cultural, and educational amenities. It should also promote walking and cycling while creating a vibrant public realm (World Bank, 2017).

We recommend that TOD design in general could offer a mix of commerce, workspaces, affordable housing, and recreational areas. For example, the ground floor may feature commercial/retail spaces to cater to the diverse needs of residents and visitors, potentially including restaurants and shops such as bike stores. The second floor could provide office spaces to support local businesses. The upper floors could house residential units, with a percentage designated as affordable housing to ensure a diverse, mixed-income community. Including a bike shop would cater to cyclists, offering repairs, purchases, and related services. Additionally, a secure bike storage facility could reinforce the commitment to promoting active transportation modes.

A pedestrian plaza could be placed next to the TOD building to serve as a communal space, fostering interaction and relaxation among residents and visitors. As envisioned, the plaza's south-facing design integrates greenery, street furniture, and comfortable seating to encourage social gatherings and recreational activities.

## Drop-off zone

In this concept for an e-mobility hub, the west and south sides of the TOD building are strategically allocated as dedicated curb spaces to facilitate seamless and efficient drop-off and pickup experiences for visitors,

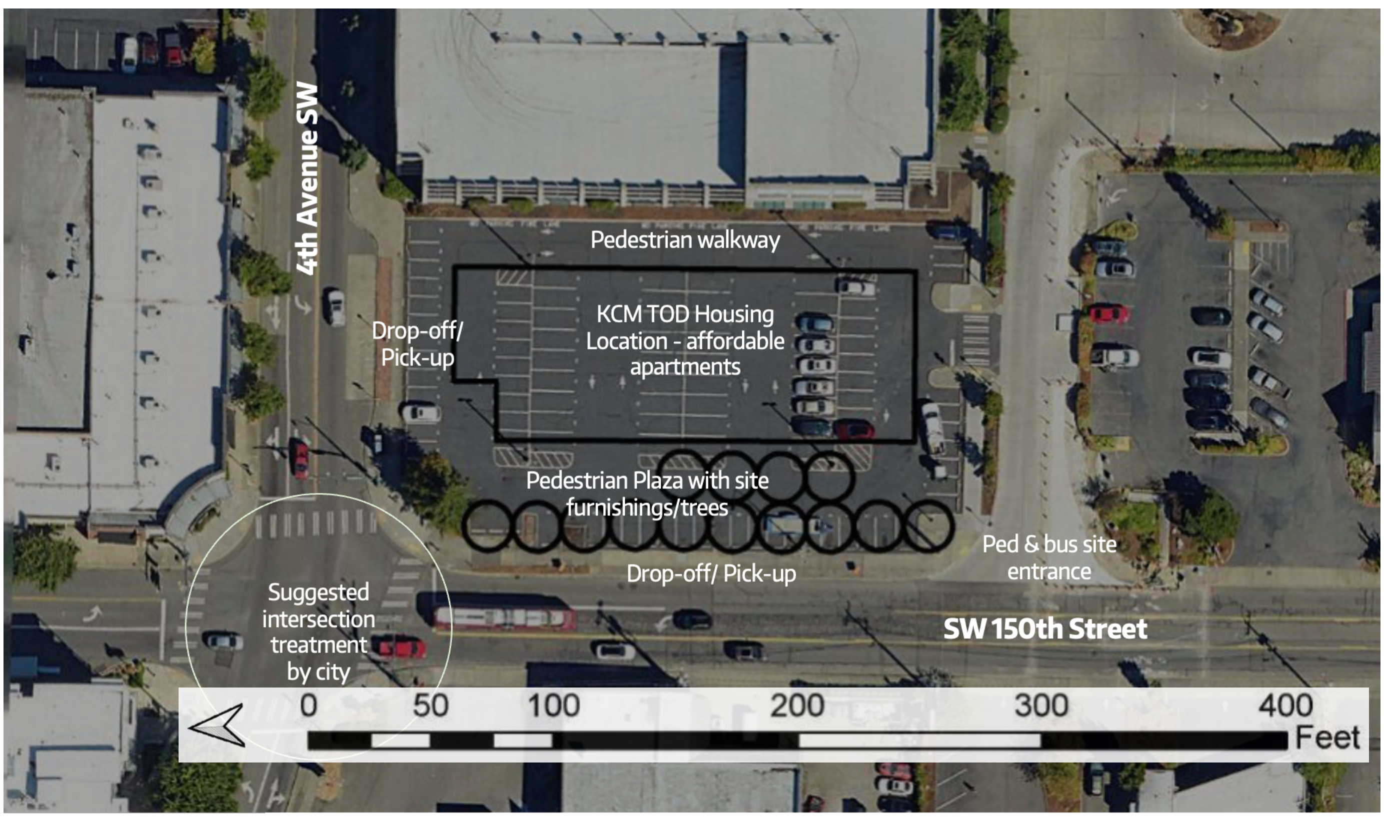



**Figure 4.8: Transit-Oriented Development**

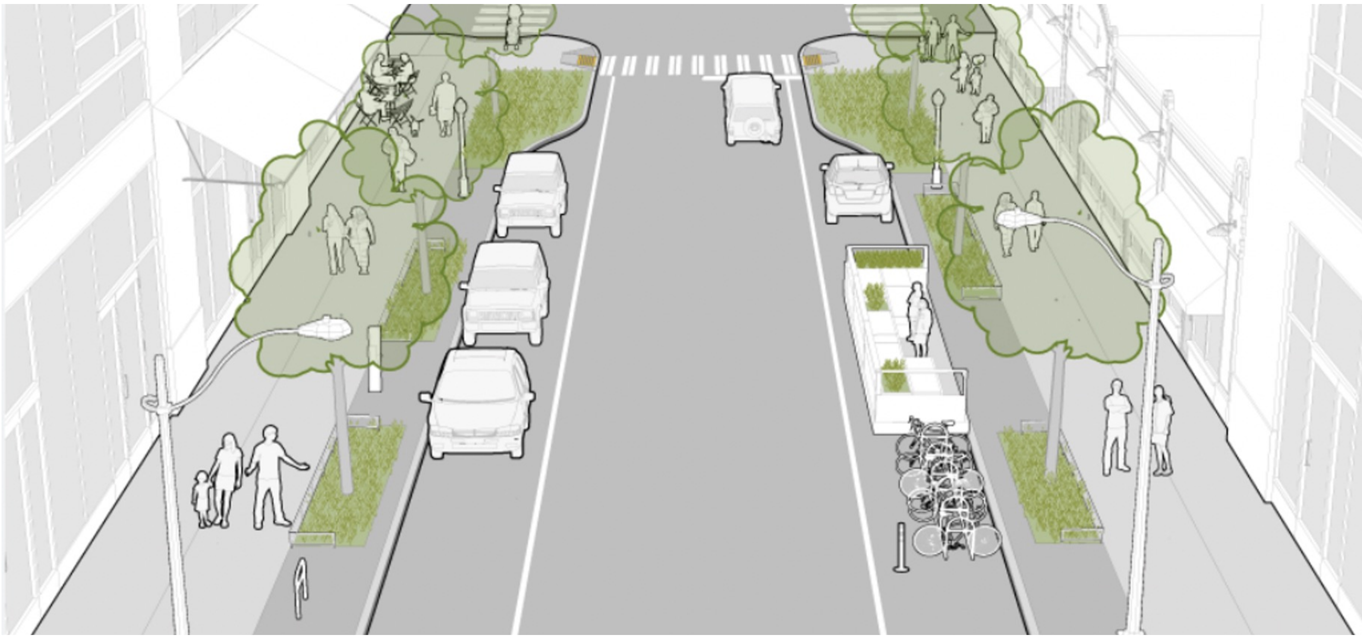


**Figure 4.9: Multiple Mode Sharing Street with Pickup and Dropoff, Micro-mobility Parking, and Street Furniture (Seattle Streets Illustrated 2017)**

residents, and commuters. Such an arrangement would require collaboration with the city of Burien. These designated areas prioritize convenience and align with the electrified mobility hub's intent to provide a user-friendly and accessible experience for all individuals who use various modes of transportation. In case of the charging needed by TNCs, some curb spaces could be developed into curbside charging in the future with permission from the City of Burien.

## Pedestrian spine/zone

Accessible walkways with weather protection ensure convenience, inclusivity, and comfort for individuals navigating the area. Weather protection features such as canopies and covered walkways should be integrated to shield pedestrians from inclement weather conditions like rain or extreme sunshine. Incorporating site furniture adds functionality and comfort to the environment. Benches and seating arrangements encourage relaxation and social interaction. Including trees within the landscape enhances the aesthetic appeal, provides shade, improves air quality, and creates a serene ambiance.

Moreover, customer amenities further enhance the overall experience by catering to the needs of visitors and residents. These amenities could include water fountains, information kiosks, and designated areas for recreational activities. Such facilities contribute to the convenience, satisfaction, and enjoyment of those frequenting the site, promoting a positive and engaging experience within the community space.

## Transit plaza - bus stops, layover, and charging

The planned renovation of the existing transit plaza aims to transform it into a sustainable transit hub serving both King County Metro and Sound Transit buses. This upgrade involves implementing distinct charging technologies: pantograph charging for King County Metro buses and wireless charging for Sound Transit buses.

Both pantagraph charging and wireless charging have their advantages and disadvantages. Pantagraph charging has lower initial investment costs and simpler infrastructure requirements. This method is relatively reliable and also reduces the impact on operations if a

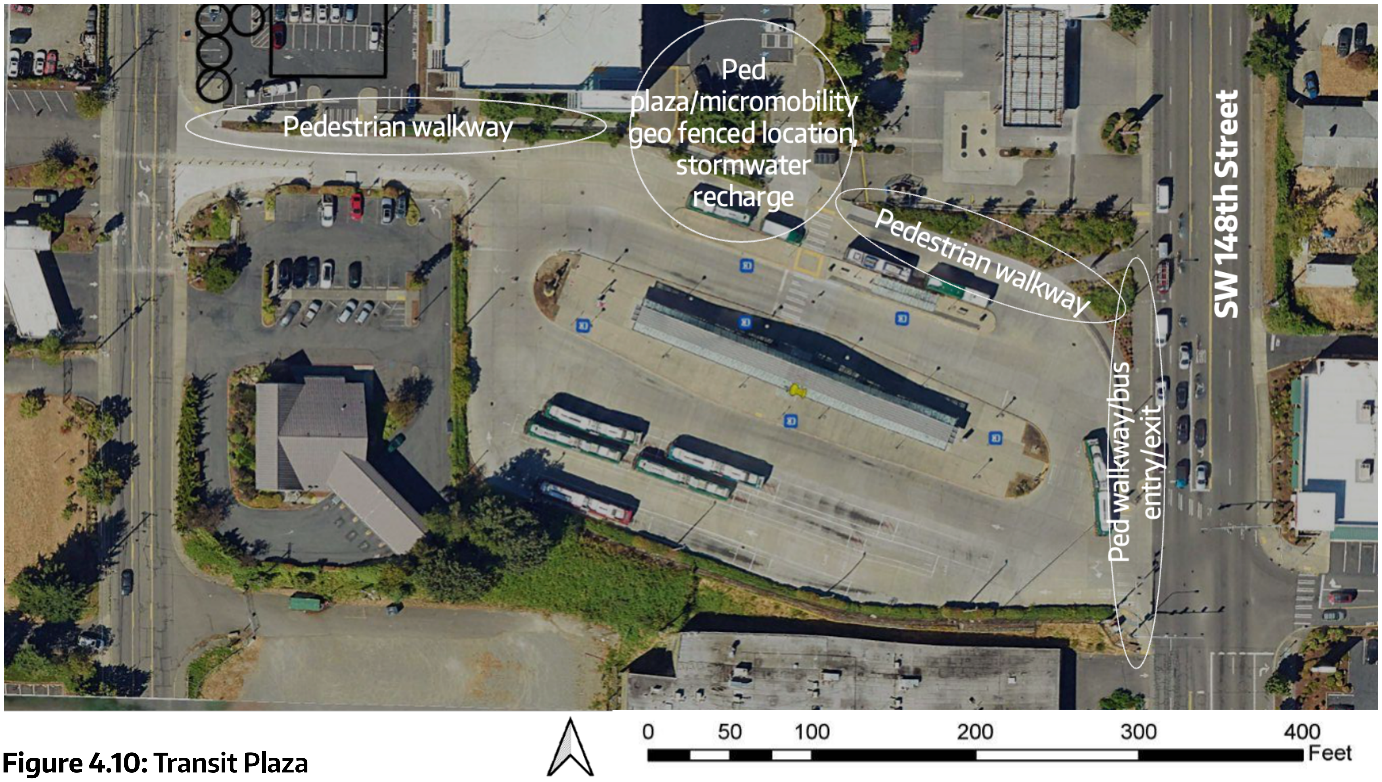



**Figure 4.10: Transit Plaza**

charger fails, provided that multiple chargers are available at the depot. On the other hand, wireless charging, although initially more expensive, may offer lower life cycle costs due to these reduced battery requirements. It also enhances safety and aesthetics by eliminating physical connections. However, wireless charging has its own safety issue of electrical and magnetic fields exposure (Ashkezari, Kaleybar and Brenna, 2024).

This decision to integrate these differing technologies within the same transit plaza sets the stage for an experimental study to see how the technologies work. The coexistence of these technologies provides an opportunity for a comparative assessment across various dimensions, such as safety, accessibility, reliability, maintenance, charging speed, scalability, future-proofing, and charging network interoperability.

Such an experiment will offer insights for transit agencies, enabling them to learn about the technologies, and how they operate in implementation. However, this is contingent upon their willingness to embrace the experimental nature and readiness to adapt as technology uncertainties diminish. Otherwise, initial decisions regarding charging technologies could lead to path-dependent outcomes. The lock-in effect of path dependency can be costly. Once significant investments are made in a particular technology, it becomes increasingly difficult and expensive to shift to a different system, even if a more efficient or advanced option becomes available.

## Pedestrian island

This site's designated operator lounge and restroom area comprises essential amenities tailored to support operational needs and ensure a conducive environment for transit staff. It includes requisite lighting fixtures for adequate illumination, provisions for weather protection, self-service ticket kiosks, and vending machines.

Future renovation of the pedestrian island could focus on providing users with more comfort, such as adding WiFi internet access, open and well-operated concessions, and public bathroom facilities. Providing wireless internet aids staff members in accessing essential information, coordinating tasks, and maintaining communication channels. Moreover, the availability of public bathroom facilities ensures accessibility for all transit hub visitors, promoting convenience and hygiene within the communal space. These amenities collectively contribute to a functional and user-centric environment, addressing the needs of transit operators, staff, and passengers alike within the transit facility. CCTV could also be present to enhance safety, and give people a greater sense of security.

## Intersection and street design

The envisioned intersection and street design represent a comprehensive approach aimed at fostering cohesion and enhancing the visual appeal of the transit area. The design emphasizes pedestrian safety by implementing tailored safety treatments. These treatments include clearly defined crosswalks, designated pedestrian paths, and enhanced visibility with high-contrast colors. The integration of clear sightlines further enhances safety measures, allowing for unobstructed views that promote a safer environment for pedestrians and motorists. Bike routes are potentially integral to this design, providing designated pathways for cyclists, offering safe and accessible paths, and encouraging and supporting alternative modes of transportation within the neighborhood.

A significant aspect of this design strategy is the creation of a distinct neighborhood ambiance, seeking to infuse the area with a sense of place and community. The proposed design features fall under the jurisdiction of the City of Burien. Collaboration between the transit agency and the city would be imperative to implement these improvements effectively.

## Supporting spaces

King County Metro would need to work with the city of Burien to implement sidewalks that meet accessibility standards requirements, and are easy to navigate, with amenities that provide a sense of place. Street trees and suitable street furniture in the designated supporting areas can help contribute to the functionality and aesthetics of the public spaces. Integrating these elements aligns with Burien's vision for a "vibrant and creative community, where the residents embrace diversity, celebrate arts and culture, promote vitality, and treasure the environment."

## CHAPTER 5

# Developing a Cost Model for Electric Mobility Hubs

This chapter presents a summary of the process and analysis that the project team performed to develop a cost model for electrified mobility hubs. The cost model is designed to support transportation agencies during early stages of planning, design, and programming, by offering conceptual cost estimates based on conceptual layouts and design information. The cost model development meets two objectives:

1. Develop an MS Excel-based interactive model that uses user design inputs to generate a conceptual cost estimate of an electrified mobility hub, with a focus on the provision of electrification.
2. Validate the usability and applicability of the developed model by applying the Burien Transit Center (BTC) as a case study.

With a focus on electrification, this cost model addresses the least understood aspects of design, programming, and conceptual cost estimating for mobility hubs, and avoids duplication of systems already in use by transit agencies to estimate costs of typical transit center and park-and-ride features.

## Data sources

A number of published and unpublished sources were reviewed for the cost database of the model. The three published sources include some well-known cost data books, including:

- 2023 Building Construction Costs Book (Gordian 2023): the most reputed construction cost book in the US, published by Gordian
- 2023 National Electrical Estimator (Tyler 2023): Comprehensive cost book on installation of all common electrical work, published by Craftsman Book Company
- JOBS EVSE 2.0 (Argonne National Laboratory 2023): Excel-based tool to estimate the economic impacts of developing EV supply equipment, developed by Argonne National Laboratory

In addition to the published sources, the following unpublished sources were also collected and reviewed:

- Cost estimating input from the electrical industry: the project team collaborated with an industry partner (local electrical contractor/design-builder) to gain their expertise and insight on cost estimating structure of electrified mobility hub electrification as well as cost data.
- Charger equipment installation cost data from WA State EV Coordinating Council (Washington State Plan for Electric Vehicle Infrastructure Deployment | WSDOT, 2022): This interagency council aimed at collaborating on EV adoption and advancement in WA State collected installation costs of various charging equipment.

## Cost model structure

Uniformat II classification system (ASTM standard 2020) was selected as a basis for the cost model structure. Uniformat II is one of the two most widely-used cost estimating structures along with MasterFormat® (Construction Specifications Institute (CSI) 2018).

In general, Uniformat II is a preferred structure for conceptual estimating when project designs and scope are not fully developed (such as schematic design phases), because Uniformat II is based on building systems and assemblies. For this reason, Uniformat II was determined to serve the purpose of e-mobility hub cost modeling better than MasterFormat. Based on Uniformat II, the following Divisions are included in the model, as the highest level of the cost hierarchy:

Division A. Substructure
Division B. Shell
Division C. Interiors
Division D. Services
Division E. Equipment and Furnishings
Division F. Special Construction and Demolition
Division G. Building Sitework

Because nearly all charging equipment is situated outside in a typical e-mobility hub, cost items for charging equipment and infrastructure are allocated under Division G. Building Sitework. Consultations with industry partners informed the selection of the following electrification items (i.e., the second level of cost hierarchy):

1. Trenching/electrical duct bank
2. Communication
3. Distribution gear
4. Transformer
5. Utility feed
6. 450kW bus charging
7. Level 3 EV charging
8. Level 2 EV charging
9. Micro-mobility charging (for eBike and eScooter
10. Harmonic filtering: the filtering aims to reduce the harmonic voltage distortion in a power system by reducing the harmonic current draw.

**Figure 5.1: Data Input Box - Capacity**

| | Capacity in Amp | How many? |
|---|---|---|
| Switchgear Capacity Input | 4000 | 2 |

**Figure 5.2: Data Input Box - Dimensions**

| | Length in feet | How many conduits | Size in inches |
|---|---|---|---|
| Comm Input | 1000 | 2 | 4 |

**Figure 5.3: Cost Output Box**

| Unit cost | Total |
|---|---|
| $ 44 | **$ 35,200** |

**Figure 5.4: Electrification Cost Estimate Summary**

| | **System Group Description** | Total |
|---|---|---|
| 1 | Trenching/Elect Ductbank | $ - |
| 2 | Communication | $ - |
| 3 | Distribution Gear | $ - |
| 4 | Transformer | $ - |
| 5 | Utility Feed | $ - |
| 6 | 450kW Bus Charging | $ - |
| 7 | L3 EV Charging | $ - |
| 8 | L2 EV Charging | $ - |
| 9 | Micromobility Charging | $ - |
| 10 | Harmonic Filtering | $ - |
| | Total | $ - |

Each electrification item has a data input box and a cost output box. The data input box allows a user to input schematic quantity (such as length and count) and design information (such as dimension, capacity, type). Data input boxes are color-coded in yellow (Figure 5.1, 5.2). Based on user input, the model will automatically generate and display cost information in cost output boxes, which are color-coded in gray (Figure 5.3)

Cost outputs from each electrification item are carried forward to the second level and presented in an electrification cost estimate summary table (Figure 5.4). Summary tables are color-coded in blue.

Finally, all cost outputs and information are displayed in a summary table known as an Estimate Summary (Figure 5.5). The Estimate Summary is structured based on Uniformat II for direct cost items in terms of Divisions. At the bottom of the Estimate Summary, users are to input percentage information for necessary indirect cost items, including:

- General Conditions: Jobsite overhead for project management, covering personnel salaries, temporary construction, etc.
- WA State B&O Tax: Washington State's Business & Occupation tax
- City B&O Tax: City's Business & Occupation tax
- Permitting & Design Review: Optional budget item in case a contractor handles permitting and design reviews
- Design Services: Optional budget item in case a contractor is hired as a design-builder
- Design contingency: Contingency budget item for solving unforeseen issues during design period
- Construction contingency: Contingency budget item for solving unforeseen issues during construction period
- Insurance & Bond
- Contractor's Fee

## Application to Burien Transit Center

As the final step of the cost model development, the usability and applicability model were validated by using the Burien Transit Center (BTC) as a case study.

### Design assumptions

This validation exercise was conducted by combining feedback and information from the industry partner selected to be an Energy Service Company (ESCO) to electrify the Burien Transit Center with the team's own charging layout design presented in Chapter 4. The following electrification components were assumed for the testing of the developed cost model.

- 3 of 450kW conductive pantograph bus chargers
- 20 of Level 3 EV chargers
- 20 of Level 2 EV chargers

**eMobility Hub Conceptual Cost Estimate**

| | | | | |
|---|---|---|---|---|
| **Project** | Burien Transit Center Electrification | | | |
| **Location** | Burien, WA | | Total Electrical Demand | 2,140 kW |

| | UniFormat Level 1 | | Total | $/kW |
|---|---|---|---|---|
| | **DIRECT COSTS** | | | |
| A | Substructure | | 0 | 0.00 |
| B | Shell | | 0 | 0.00 |
| C | Interiors | | 0 | 0.00 |
| D | Services | | 0 | 0.00 |
| E | Equipment and Furnishings | | 0 | 0.00 |
| F | Special Construction and Demolition | | 0 | 0.00 |
| G | Building Sitework | | 0 | 0.00 |
| | Sub Total Direct Costs | | 0 | 0.00 |
| | **INDIRECT COSTS** | | | |
| | General Conditions | 0.00% | 0 | 0.00 |
| | WA State B&O Tax | 0.000% | 0 | 0.00 |
| | City B&O Tax | 0.000% | 0 | 0.00 |
| | Permitting & Plan Review | 0.00% | 0 | 0.00 |
| | Design Services | 0.00% | 0 | 0.00 |
| | Design Contingency | 0.00% | 0 | 0.00 |
| | Construction Contingency | 0.00% | 0 | 0.00 |
| | Insurance & Bond | 0.00% | 0 | 0.00 |
| | Sub Total | | 0 | 0.00 |
| | Contractors Fee | 5.00% | 0 | 0.00 |
| | **Design-Build Estimate Total** | | 0 | 0.00 |

**Figure 5.5: Project Estimate Summary**

Two important points should be noted. First, a typical e-mobility hub project should have more design components than just electrification items. Non-electrification items in an e-mobility hub can include canopies, site concrete structures, lighting, security system, public address system, etc. However, for efficient development and validation of the developed model, non-electrification items were excluded. Second, charging for micro-mobility is not included in this application for three reasons: (1) charging for eBike and eScooter only requires regular 120V, and does not have to be a part of electrical demand calculation; (2) simple outlets and options may be provided onsite to allow users to plug in and recharge personal devices, including eBike batteries; and (3) it is presumed that private vendors for shared eBike and eScooter (such as Bird or Lime in the Seattle region) will install, operate, and maintain their own charging devices.

**Figure 5.7: Conceptual Direct Cost Estimate of BTC Electrification**

| | System Group Description | Total |
|---|---|---|
| 1 | Trenching/Elect Ductbank | $ 1,411,200 |
| 2 | Communication | $ 300,000 |
| 3 | Distribution Gear | $ 1,610,125 |
| 4 | Transformer | $ 283,303 |
| 5 | Utility Feed | $ 209,200 |
| 6 | 450kW Bus Charging | $ 3,838,125 |
| 7 | L3 EV Charging | $ 4,140,800 |
| 8 | L2 EV Charging | $ 208,400 |
| 9 | Micromobility Charging | $ - |
| 10 | Harmonic Filtering | $ 600,000 |
| | Total | $ 12,601,153 |

**Figure 5.6: Estimate Summary of BTC Project**

| | | | | |
|---|---|---|---|---|
| | eMobility Hub Conceptual Cost Estimate | | | |
| Project | Burien Transit Center Electrification | | | |
| Location | Burien, WA | Total Electrical Demand | | 5,083 kW |
| | UniFormat Level 1 | | Total | $/kW |
| | DIRECT COSTS | | | |
| A | Substructure | | 0 | 0.00 |
| B | Shell | | 0 | 0.00 |
| C | Interiors | | 0 | 0.00 |
| D | Services | | 0 | 0.00 |
| E | Equipment and Furnishings | | 0 | 0.00 |
| F | Special Construction and Demolition | | 0 | 0.00 |
| G | Building Sitework | | 12,601,153 | 2,479.08 |
| | Sub Total Direct Costs | | 12,601,153 | 2,479.08 |
| | INDIRECT COSTS | | | |
| | General Conditions | 8.00% | 1,008,092 | 198.33 |
| | WA State B&O Tax | 0.471% | 94,791 | 18.65 |
| | City B&O Tax - Burien | 0.100% | 20,125 | 3.96 |
| | Permitting & Plan Review | 5.00% | 630,058 | 123.95 |
| | Design Services | 10.00% | 1,260,115 | 247.91 |
| | Design Contingency | 20.00% | 2,520,231 | 495.82 |
| | Construction Contingency | 5.00% | 630,058 | 123.95 |
| | Insurance & Bond | 2.00% | 402,510 | 79.19 |
| | Sub Total | | 19,167,132 | 3,770.83 |
| | Contractors Fee | 5.00% | 958,357 | 188.54 |
| | **Design-Build Estimate Total** | | **20,125,489** | **3,959.37** |

## Results from cost model

Based on the Burien Transit Center design assumptions and with support of an industry partner, schematic quantities were determined and input into the cost model. Listed below are inputs for the indirect cost items:

- General Conditions: 8% (suggested range: 6%-10%)
- WA State B&O Tax: 0.471% (as of December 5, 2023)
- City B&O Tax: 0.100% (Burien's rate as of December 5, 2023)
- Permitting & Design Review: 5% (suggested)
- Design Services: 10% (suggested)
- Design contingency: 20% (=industry standard contingency rate at schematic design)
- Construction contingency: 5% (suggested range: 3%-10%)
- Insurance & Bond: 4%
- Contractor's Fee: 5%

CHAPTER 6

# Conclusions

When considering the transformation of existing sites, such as park-and-rides, into electrified mobility hubs, it is essential to understand that while they may all have similar elements and purpose to one another, the design of each location must fit within the future context for the service that it is intended to provide. Promoting mobility is not the sole outcome, but rather a function that supports the livability and quality of life that a community desires. Therefore, an electrified mobility hub requires engagement within and among each participating agency, and with the public, to get it right.

Throughout this project, it has been clear that each public agency represented in the work group desires similar outcomes. However, achieving this can be somewhat challenging given the existing agency structures and even policy choices, such as charging equipment, that can set future decisions in motion and present a missed opportunity to maximize the value and return on public investment. One such example is the interoperability of charging systems for revenue service vehicles, with two different transit providers pursuing different charging equipment but still seeking to use shared facilities en route.

Given the timelines and potential needs for electrical transmission upgrades and perhaps storage, early identification of energy demand is crucial. Doing so includes an inventory of planned charging equipment for all vehicle types, which may be phased over time with new charging components added as the need increases and funds become available. A cost estimation model provides a ballpark figure for electricity demand to ground discussions with utility providers to ensure adequate power is delivered to the facility in the desired time frame, and identify funding considerations that must be addressed.

Since the development of the traditional transit park and rides, much has changed in how the public is engaged. There is purposeful and meaningful intent to collaborate, consult, or confirm choices to develop a shared vision to maximize the value and use of a funded asset. It is in this vein of co-creation that electrified mobility hubs with each public-sector entity with a role in the operations, management, and connections to the transportation system must be willing to collaborate early to leverage their collective resources and abilities for the public good.

The following are a series of recommendations for consideration for public agencies in developing an electrified mobility hub, applicable to various locations and sizes:

## Mobility hub design is a team effort.

Early partner and stakeholder engagement, including transportation providers, city departments of transportation, and utilities, is needed to jointly and efficiently determine operational and user needs and their implications for capital investment in electrified mobility hubs.

- Each agency has its own policy guidance and goal for mobility and electrification. Putting these on the table is a starting point while seeking to find common ground for how these align to provide momentum.
- Ensure appropriate representation for each agency to accelerate design discussions and decisions.
- Early engagement on visioning, use, and electrical demands will help create a roadmap and identify timelines with utility providers if upgrades will be needed.

## Agree to set standards together.

Develop consensus amongst transportation agencies for charging equipment and standards to ensure transit and light-duty vehicle interoperability across agency fleets. Design standards can reduce the cost of maintaining service through interoperability and the cost of providing resilience through redundancy.

- Evaluate fleet charging options with agencies that overlap in service areas and would share facilities before procurement.
- Partner to leverage potential federal grant funding opportunities to reduce upfront capital costs.

## Everyone needs reliable electrification.

Electrification raises the value and utility of public assets. Protect publicly funded charging equipment to maintain availability and confidence with users and reduce costs for maintenance and repair. Doing so may include using parking garages and gates to control access to equipment.

- Identify locations for charging equipment that can be physically protected and monitored to deter vandalism.
- Evaluate project delivery and operational options to determine if an arrangement like an energy service contract can provide value and service for charging equipment.

## Make the system easy to use.

Information technology has the potential to reduce barriers to electrification, micro-mobility, and transit. Seek opportunities to leverage existing technology for new applications, such as transit cards for EV charging and reservations.

- Connect the e-mobility hub seamlessly with existing modal networks, such as sidewalks and bike lanes. If gaps exist, work closely with the city to create safe, multimodal access to the network ahead of planned development.
- Manage charging and parking to maximize turnover and availability.

## Design to provide value to the community.

Transit and transport facilities occupy valuable space in densifying urban environments. Identify opportunities to create a welcoming space for the community and address potential needs, such as affordable housing within the existing facility footprint.

- Bring the community into the design process early to understand their needs and vision for an e-mobility hub.
- Evaluate activation opportunities, such as events, food trucks, and other concepts serving the space and the community.

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## Appendix A

# King County Transit Hub V.S. San Diego eMobility Design Guideline

● indicates design and functional equivalent
○ Indicates either design or functional equivalence

King County Transit Hub Design Guideline

| | | |
|---|---|---|
| Environment | Accessibility | Step free access |
| | | Audible Information |
| | | Tactile Information |
| | | Clear, well-defined paths |
| | | Iconography and High or |
| | Safety | Slip resistant surfaces |
| | | Pedestrian guardrails |
| | | Pedestrian satefy treatm |
| | Personal Security | Lighting |
| | | Clear sight lines |
| | | Emergency call boxes |
| | | Staff presence |
| | | CCTV |
| | | Operator notification bea |
| | Protected Environment | Benches and Leaning rail |
| | | Shelters |
| | | Wind breaks and sound b |
| | | Continuous weather pro |
| | | Enclosed, climate contro |
| | Environmental Sustainability | Energy efficiency |
| | | Sustainably sourced and/ |
| | | Sustainable landscaping |
| | | Multi-stream litter recep |
| Convenience | Ease of Movement | Passenger pick up and D |
| | | Off-board fare collection |
| | | Car-share parking spaces |
| | | Electric vehicles charging |
| | | Bicycles racks |
| | Bicycle Facilities | Enclosed bicycle parking |
| | | Bicycle and Scooter shar |
| | | Bicycle stairway ramps |
| | | Bicylce repair stands |
| | | Bicycle centers or Bicycle |
| | Clean and Well-Matinained Facilities | Single stream litter recep |
| | | Recycling and Compost r |
| | | Operator comfort station |
| Information | Wayfinding | Bus top signage |
| | | Guide Signs |
| | | Station or Transit center |
| | | Station maps and Area m |
| | | Digital information kiosk |
| | | Staff or Agency ambassa |
| | Service Information | Static schedule signs |
| | | Real time information di |
| | | Digital information kiosk |
| | | Multi-language signage a |
| Comfort | Sense of Place | Coordination of the visua |
| | | Public art |
| | | Landscaping |
| | | Landmark Architecture |
| | Multi-use Spaces | Public wifi and Charging |
| | | Public restrooms and Wa |
| | | Reail uses, ATMS, and Ve |
| | | Public spaces |
| | | Mail-dropoff boxes, Pack |
| | | Advertising |

## San Diego eMobility Design Guideline

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| | Transit Amenities | | | | | | | | | | Pedestrian Amenities | | | | | | | | | | |
| | Enhanced Transit Waiting Areas | | | | | | | Passenger Loading Zone | Bus Infrastructure | Real-Time Travel Information | Walkways | | | | | | Crossings | | | | |
| | Seating | Landscaping | Bus shelter | Trash receptacles | Complimentary WIFI | Real-time transit arrival alerts | Schedule information | Curbspaces | Bus layover zones | Real-time travel information | Wide walkways | Landscaping | Pedestrian scale lighting | Enhanced paving | Pedestrian cut-throughs | Street furniture | Curb bulbs | Signal timing treatments | Mid-block crossings | Refuge islands | Crossing protections |
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| age pick up lockers and Newspaper boxes | | | | | | | | | | | | | | | | | | | | | |

To be continued on the next page

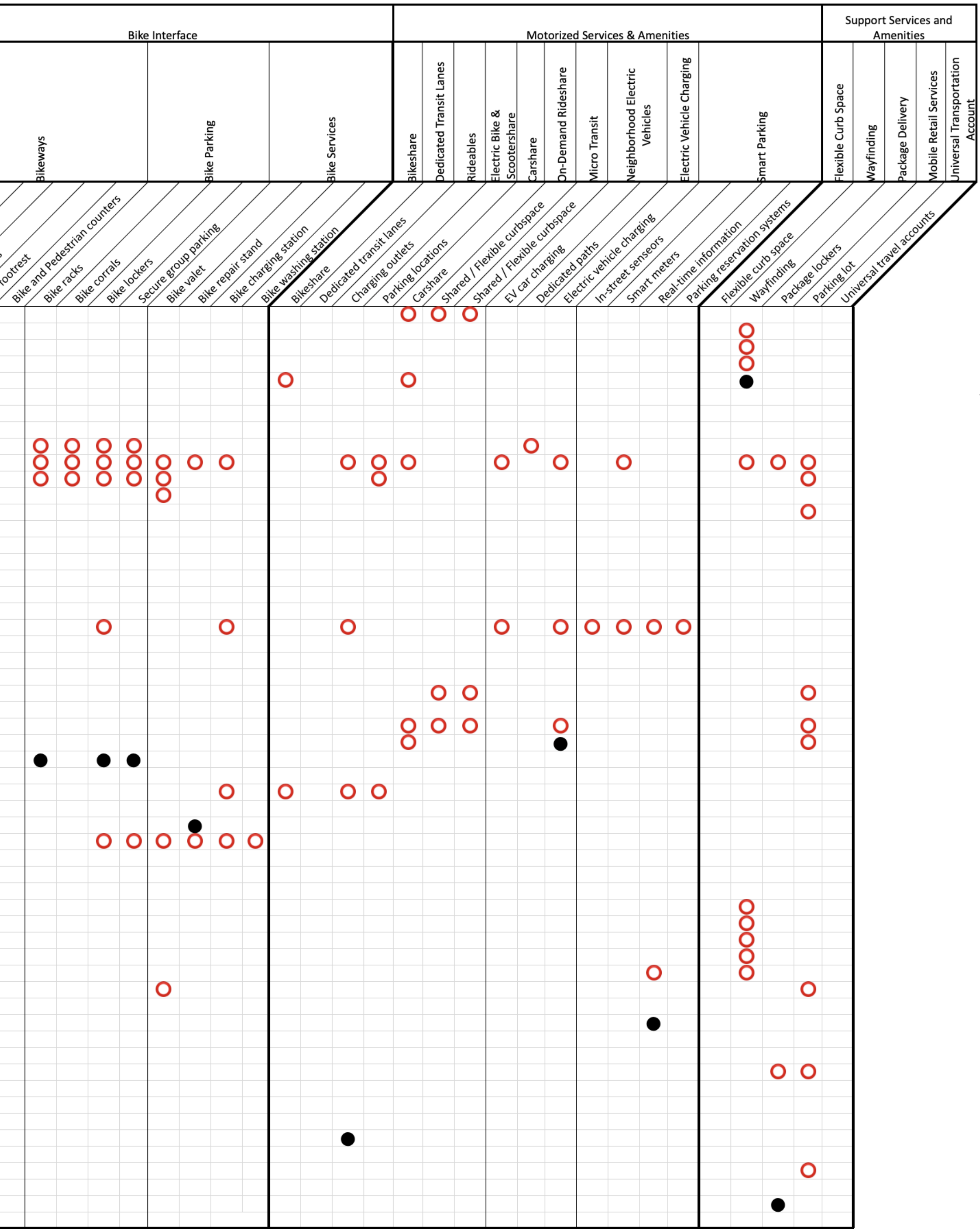
Continued from previous page

King County Transit Hub Design Guideline

● indicates design and functional equivalent
○ Indicates either design or functional equivalence

| | | | Bikeways | Median refuge | Bike signals | Bike boxes | Bike channels | Bike |
|---|---|---|---|---|---|---|---|---|
| Environment | Accessibility | Step free access | | | | | | |
| | | Audible Information | | | | | | |
| | | Tactile Information | | | | | | |
| | | Clear, well-defined paths | | | | | | |
| | | Iconography and High ontrast colors | | | | | | |
| | Safety | Slip resistant surfaces | | | | | | |
| | | Pedestrian guardrails | | | | | | |
| | | Pedestrian satefy treatments | | | | | | |
| | Personal Security | Lighting | ○ | ○ | | | ○ | |
| | | Clear sight lines | ○ | | | | | |
| | | Emergency call boxes | ○ | | | | | |
| | | Staff presence | | | | | | |
| | | CCTV | | | | | | |
| | | Operator notification beacons | | | | | | |
| | Protected Environment | Benches and Leaning rails | | | | | | |
| | | Shelters | | | | | | |
| | | Wind breaks and sound barriers | | | | | | |
| | | Continuous weather protection | | | | | | |
| | | Enclosed, climate controlled waiting rooms | | | | | | |
| | Environmental Sustainability | Energy efficiency | | | ○ | | | |
| | | Sustainably sourced and/or Recyclable material | | | | | | |
| | | Sustainable landscaping | | | | | | |
| | | Multi-stream litter receptacles | | | | | | |
| Convenience | Ease of Movement | Passenger pick up and Drop off zones | | | | | | |
| | | Off-board fare collection | | | | | | |
| | | Car-share parking spaces | | | | | | |
| | | Electric vehicles charging stations | | | | | | |
| | | Bicycles racks | | | | | | |
| | Bicycle Facilities | Enclosed bicycle parking | | | | | | |
| | | Bicycle and Scooter share areas | | | | | | |
| | | Bicycle stairway ramps | | | | | | |
| | | Bicylce repair stands | | | | | | |
| | | Bicycle centers or Bicycle hubs | | | | | | |
| | Clean and Well-Matinained Facilities | Single stream litter recepticles | | | | | | |
| | | Recycling and Compost receptacles | | | | | | |
| | | Operator comfort stations | | | | | | |
| Information | Wayfinding | Bus top signage | | | | | | |
| | | Guide Signs | | | | | | |
| | | Station or Transit center identifiers | | | | | | |
| | | Station maps and Area maps | | | | | | |
| | | Digital information kiosks | | | | | | |
| | | Staff or Agency ambassadors | | | | | | |
| | Service Information | Static schedule signs | | | | | | |
| | | Real time information displays | | | | | | |
| | | Digital information kiosks | | | | | | |
| | | Multi-language signage and Anouncements | | | | | | |
| Comfort | Sense of Place | Coordination of the visual design with surrounding areas and communities | ○ | | | | | |
| | | Public art | | | | | | |
| | | Landscaping | | | | | | |
| | | Landmark Architecture | | | | | | |
| | Multi-use Spaces | Public wifi and Charging stations | | | | | | |
| | | Public restrooms and Water fountains | | | | | | |
| | | Reail uses, ATMS, and Vending machines | | | | | | |
| | | Public spaces | | | | | | |
| | | Mail-dropoff boxes, Package pick up lockers and Newspaper boxes | | | | | | |
| | | Advertising | | | | | | |

## San Diego eMobility Design Guideline



## Appendix B

# Electrified Mobility Hub Wishlist

### Amenities or physical features needs for an electrified mobility hub

- Real-time information system
- Covered bus stops
- Bus layover zones
- Site furnishings
  - Benches, garbage, and recycling cans
- Bicycle parking and secure storage
  - Including for cargo bikes, other larger e-bikes
  - Weather protection ideal
- Personal devices micro-mobility parking and secure storage
- Paratransit pick-up/drop-off
- MetroFlex pick-up/drop-off
- Rideshare pick-up/drop-off
- Carshare pick-up/drop-off
- Kiss-and-ride pick-up/drop-off
- Shared program micro-mobility pick-up /drop-off
- Well-marked sidewalks and pedestrian signals
- Pedestrian-scale site lighting
  - Wildlife friendly
- Universal wayfinding system
  - Include bicycle infrastructure map
- WiFi & cell phone charging stations
- Orca card kiosks & ticket vending machines
- Bus charging
- Paratransit charging
- TNC charging
- Personal vehicle charging
- Personal micromobility charging
- Carshare charging
- Rideshare charging
- Kiss-and-ride charging
- Shared program micromobility charging
- Integrate hub with context
  - Might be scale dependent.
  - Could include bike infrastructure, green space development.
- Vehicle parking
- Comfort stations (aka restrooms), and sometimes breakrooms, for operators, including a safe walkway between bus layover zones and comfort stations
- Demand for the supply of electricity (e.g., Burien has a Natural Gas line into the parking garage)
  - Can include how the electricity is provided, including space required for transmission equipment and charging cabinets and other transit bus charging components and sub-metering.
- Micromobility pick-up/drop-off
  - Scooter share and bikeshare pick-up/drop-off zones
  - As close to bus platform as possible
  - On the station side with the best infrastructure for bicycling/scooting (bike lanes, multi-use trails, etc.)
  - Keeps paths of travel clear
- Charging for private/personal e-bicycles and e-scooters
  - perhaps in secure bike parking (lockers and/or cages)
- Fast charging that could support access to paratransit vehicles, TNCs
  - Include Level 3 chargers to facilitate transient use? (such as ride share, kiss and ride, etc)

## Functional needs for an electrified mobility hub

- Equity
    - Importance of payment method options
    - Diversity of language and communication types
    - Real-time travel information
    - Dedicated bike lanes
    - Pedestrian scale lighting near hubs
    - Accessible pedestrian paths that prioritize desired lines
    - Standardize infrastructure to provide positive user experience and accessibility.
- Variety/flexibility
    - Provide a robust array of options.
    - Accommodate different needs.
    - Increase destinations available by transit
    - Flexibility for change
- Accommodate possible future growth, expansion, new technologies.
- Access
    - Pedestrian access
    - Cyclist access
    - Micromogiliy access
    - Rolling access
- Accommodate
    - Commuters
    - Tourists/recreational use
    - Travelers with special needs
- Real-time information system
- Making sites ready for EV charging
- What level of charging and for whom?
- Blend user and agency-centered needs in hub
- Integrate hub with context
    - Might be scale dependent.
    - Could include bike infrastructure, green space, development.

## Operational needs for an electrified mobility hub

- Operational roles and responsibilities
- Number and types of vehicles in service
- Dwell times for vehicles
- Number of people expected to serve
    - (pedestrians, bikes, parking, charging, vehicular turnover, personal versus mobility, etc.)
- Security needs
- Custodial services
- How should third parties like ChargePoint, data providers/cell sites participate?
- Relationships with ancillary service providers
    - Police
- Third-party vendors
- Vandalism
- Safe operation of vehicles on site
- Limitations based on vehicle type (e.g., turning radius, etc.)
- Service/maintenance vehicles and access
- Landscape maintenance, including irrigation
- Demand for the supply of electricity (e.g., Burien has an NG line into the parking garage)
    - Can include how the electricity is provided, including space required for transmission equipment and charging cabinets and other transit bus charging components and sub-metering.
- Shared versus differentiated roles and responsibilities for agency operation of the site
    - Number of personnel/FTE
    - Costs
- Comfort stations (aka restrooms), and operator breakrooms
    - Safe walkway between bus layover zones and comfort stations

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UNIVERSITY of WASHINGTON