Electric Vehicle Charging Infrastructure Options Report

November 2020

I. Contents

II. Proviso Text

Ordinance 19021, Section 46, Local Services Administration, P8[1]

> "The executive shall transmit a report on options to require, incentivize or otherwise ensure electric vehicle charging infrastructure in new multifamily construction and other development proposals that include expansion of parking areas in the unincorporated area and an ordinance that would establish requirements to ensure that new parking areas are designed to include some amount of electric vehicle charging infrastructure to account for increased use of electric vehicles in the future. The report and ordinance shall be developed in consultation with stakeholder groups, including representatives of the building and electric vehicle industries and utilities.
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> The executive must transmit the report and recommendations by September 14, 2020, in the form of a paper original and an electronic copy with the clerk of the council, who shall retain the original and provide an electronic copy to all councilmembers, the council chief of staff and the lead staff for the local services committee or its successor."

[1] Ordinance 19021. This language is also adopted in K.C.C. 18.22.010.F.2, included in Appendix A.

III. Executive Summary

This report fulfills requirements in King County Code (K.C.C.)[2] 18.22.010 and Ordinance 19021, Section 46, Proviso P8 to report on options to require, incentivize or otherwise ensure electric vehicle charging infrastructure in new multifamily construction and other development proposals, including parking area expansion.

This report reviews the history of electric vehicles (EVs), barriers to EV acquisition, current and projected electric vehicle (EV) ownership, its benefits to historically disadvantaged communities, and both current and projected charging patterns. In addition, different EV charging types, tiers of EV infrastructure provision, and their cost implications are reviewed. The report reviews some local government EV incentive alternatives and code requirements, summarized below.

Increased EV ownership provides many benefits. These benefits are more pronounced for communities of color, limited-English speaking communities, and individuals with low-incomes, all of whom are disproportionately affected by increased exposure to inimical vehicle emissions, air pollution and climate change. Expanding EV ownership within these communities also has the potential for additional direct economic benefit through a 65 percent reduction in vehicle fuel costs and $4,600 in average maintenance savings over an EV vehicle's lifetime.[3]

King County EV ownership levels are the highest of any county in Washington State. Of the 58,300 EVs in the state, 55 percent are in King County. In 2017, EVs were 4.3 percent of the market share for new vehicle purchases in Washington; by 2025, it is predicted that one out of every 10 new vehicles sold in King County will be electric. The proposed 2020 King County Strategic Climate Action Plan[4] (SCAP) includes a target where every passenger-class vehicle sold in King County be electric by 2035.

EV ownership has expanded over the past decade as traditional EV adoption barriers have weakened. EV battery range has improved, and EVs are predicted to reach price-parity with their equivalent gas-powered vehicle models by 2023. One of the remaining barriers – for both the general public and historically disadvantaged communities – is access to vehicle charging.

This report focuses on Level 2 electric vehicle supply equipment (EVSE) development code options, as Level 2 provides faster charging more suitable to increased EV battery ranges, while remaining cost-effective. This report also focuses on securing EV-Ready and EVSE installation parking spaces, rather than EV-Capable parking, which defers costs to a future actor and acts as a barrier to installing future EV charging.

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[2] [LINK]
[3] Consumer Reports, "Pay Less for Vehicle Maintenance with an EV," September 26, 2020. [LINK]. Accessed 10/7/2020
[4] Proposed Motion 2020-0288

Today, approximately 70 to 80 percent of United States EV drivers charge their vehicles at home. EV ownership rates are higher for those with home charging, and drivers in single family detached houses are more likely to have home charging than those in apartments. Workplace charging is a powerful tool to help address existing gaps in the home charging network. An employee with workplace charging is six times more likely than the average worker to drive an EV. However, multifamily charging faces additional barriers to secure in the open market, as multifamily tenants do not have property control, and property owners have few incentives to install EV charging.

The primary means to achieve EV charging in development is to either use incentives or use development codes to require EV charging support or installation. A review of other County and municipal EV charging programs show limited examples of incentives to increase EV charging. While some local governments have incentivized private development of public charging stations, analysis conducted for this report finds no local governments, outside of those operating power utilities, that offer incentives for private development of private charging stations. Analysis conducted for this report concludes that incentive programs are generally considered a suboptimal fit for this item, given the few existing example programs at the local level; the voluntary nature of incentives leading to the probable uneven deployment of charging; existing inequalities for multifamily charging; the increased cost of retrofits for deferred installations; and the stated SCAP goals for 100 percent EV market share of light duty vehicles goal within 15 years.

Analysis conducted for this report concludes that development codes requiring charging preparation and installation of EV charging is the better means to achieve the desired outcomes. Among jurisdictions that have required EV charger installation for multifamily and non-residential development, it is typically required to be installed for between five to ten percent of parking spaces. Additional percentages of parking spaces can be required to be prepared for future electrical capacity needs, helping support additional EV charging in the future. These requirements reduce EV charging retrofit costs, which can be up to eight times as expensive as new construction. In all cases, planning for EV parking is less expensive than retrofitting buildings to add EV chargers at a future date; retrofitting to add EV-ready parking can be up to eight times as expensive as installing at the time of building construction.

Analysis conducted for this report concludes that the most certain way to ensure the installation of EV charging infrastructure in new multifamily and other development, and in the expansion of parking areas in the unincorporated areas, is to require it in code.

This report recommends adoption of an EV parking ordinance that requires EV-readiness for single-family, townhouses, and cottage housing development; requires 10 percent of parking spaces be installed with EVSE and 25 percent of parking spaces being EV ready for apartments; and 5 percent of parking spaces be installed with EVSE, with 10 percent of parking spaces being EV ready, for nonresidential development, which would include new parking areas in the unincorporated area. An ordinance proposing these

recommended changes to the King County Code was transmitted concurrently but separately from this report.

IV. Background

Department Overview: The Department of Local Services (DLS) provides services to rural and urban unincorporated areas, including maintaining county roads and bridges, issuing permits, managing long-range community planning, and providing economic development support. DLS also coordinates service delivery with Regional Animal Services of King County, Public Health – Seattle & King County, and the King County Department of Natural Resources and Parks, including its Surface Water Management Program.

The DLS Permitting Division provides land use planning services and private development permitting review to the residents of rural and urban unincorporated King County. The Permitting Division's support services include green building policy analysis, public outreach, and building and land use code review to improve green building attainment.

Key Historical Context: Understanding the current EV market is aided by understanding both EVs historical development, as well as the historical barriers to EV acquisition.

United States History of EVs: Electric vehicles (EVs) are not a new technology; the first electric car in the United States (U.S.) was introduced around 1890. By the 1900s electric cars were popular for short city trips, composing about one third of all vehicles on the road. However, Henry Ford's Model T began to overshadow electric vehicles due to its substantively lower price. As roads improved and oil became less expensive with the discovery of crude in Texas, EVs dwindled and then disappeared from the mainstream by 1935.[5]

The EV industry was mostly dormant until the release of the Toyota Prius in 1997. The Prius became the world's first mass-produced hybrid electric vehicle, resuscitating mainstream interest in gas-powered vehicle alternatives. In 2006 a small Silicon Valley startup called Tesla Motors announced that it would start producing a luxury EV that could go more than 200 miles on a single charge. With federal funding, Tesla soon won global acclaim for its cars, which in turn spurred other automaker interest in EV production lines.

By 2010, the General Motors Company Chevrolet Division and Nissan Motor Company released hybrid and all-electric vehicles and sales began to increase. The 2009 Recovery Act supported targeted EV charging networks, installing more than 18,000 residential, commercial and public chargers across the country.[6] Today there are almost 32,000 public charging stations, with over 98,000 charging outlets.[7]

[5] Department of Energy, "The History of the Electric Car," September 15, 2014. [LINK]. Accessed 9/14/2020
[6] Department of Energy, Ibid.
[7] Level 2 and DC Fast charge public stations only. US Department of Energy Alternative Fuels Center, Electric Vehicle Charging Station Locations. [LINK]. Accessed 9/14/2020

Barriers to EV Acquisition: Studies have shown three lingering consumer concerns with EV purchase, though at varying primacy: namely price, range, and charging access.[12,13,15]

- Price. EVs have historically had higher average sales prices due to still-developing battery technology, but this is anticipated to change. Battery costs decreased 70 percent from 2012- 2018; by 2023 battery pack prices are projected to reach $100/kWh, at which point EVs are projected to reach price parity with gas-fueled vehicles.[8,9,10] While the current average price of an EV is $55,000, this figure is skewed by the popularity of some EV models such as Tesla, which has comparatively higher price points. The Kia Soul, Nissan Leaf, and Chevy Bolt EV cars are all lower than the $35,000 average price of gas cars in the United States.[11]
- Range. Range anxiety, or the fear of running out of battery charge, was a common concern that developed with early-model EVs, when battery charges commonly limited EV ranges to 70 miles before they needed recharging.[12] Although common battery ranges have since near-tripled, such that many standard models can now drive 200-plus miles on one charge, there are still lingering public fears on this topic.[13] Early EV range anxiety may also continue to be perpetuated due to lack of common knowledge of current battery ranges. The range of top-selling EVs has increased 20 percent annually since 2011 and is projected to continue increasing in coming years. As typical EV ranges are better understood, this public perception may dwindle with time.[14]
- Charging Access and Time. Charging anxiety is similar to range anxiety, save it is linked less with battery capability, and more with driver apprehension about the availability of charging stations.[15] A similar though subtly different concern is also charging time, or the concern with how long it takes to acquire a sufficient charge. Charging times are also estimated to shrink over time, though this evolution may take longer to affect average EV charging time, depending on how fast new technology can be deployed.[16]

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[8] Richmond, Canada. "Residential Electric Vehicle Charging: A Guide for Local Governments, 2018. [LINK]. Accessed 7/30/2020; Page 2

[9] Bloomberg New Energy Finance, Electric Vehicle Outlook 2020, Executive Summary: Batteries and Charging Infrastructure. [LINK]. Accessed 07/29/2020.

[10] Halvorson, Bengt. "Cost remains the biggest barrier against EV adoption, study finds," Green Car Reports. January 13, 2020. [LINK]. Accessed 07/29/2020.

[11] EnelX Blog, Electric Cars v. Gas Cars Cost, October 7, 2019. [LINK]. Accessed 7/30/20

[12] Hall, Lindsey. "Overcoming EV range anxiety with electric vehicles," Geotab. November 6, 2019. [LINK]. Accessed 8/4/20

[13] Stumpf, Ron. "Americans Cite Range Anxiety, Cost as Largest Barriers for New EV Purchases: Study," The Drive. February 26, 2019. [LINK]. Accessed 8/4/20

[14] Coren, Michael. "2019 was the year electric cars grew up," Quartz. December 6, 2019. [LINK]. Accessed 9/14/2020

[15] Stumpf, Ron. "Americans Cite Range Anxiety, Cost as Largest Barriers for New EV Purchases: Study," The Drive. February 26, 2019. [LINK]. Accessed 8/4/20

[16] Taub, Eric. "For Electric Car Owners, 'Range Anxiety' Gives Way to 'Charging Time Trauma'," New York Times. October 5, 2017. [LINK]. Accessed 8/4/20

Other barriers include limited availability of desired vehicle class (e.g., sport utility vehicle (SUV), truck), limited availability of desired make and model, and lack of familiarity with electric vehicles.[17]

Key Current Context: The transportation sector generates 38 percent of greenhouse gas emissions in the Puget Sound region, according to the Puget Sound Clean Air Agency.[18] Passenger or light-duty vehicles comprise 75 percent of emissions within the transportation section.[19] These emissions also contribute to overall outdoor air pollution, which is linked to increased rate of heart attacks, asthma, strokes, cancer and premature deaths.[20] Accelerating the rate of electric vehicle adoption will help reduce harmful air pollution from exhaust, as well as greenhouse gas emissions.[21]

Improving EV adoption aligns with and furthers the goals and objectives of King County strategic plans, such as the Strategic Plan, the Equity and Social Justice Strategic Plan, and the Strategic Climate Action plan. Supporting equitable environment and climate outcomes, the King County Equity and Social Justice Strategic Plan prioritizes the action to "2. Drive equity considerations into long-term improvements to built and natural environments, systems and policy."[22] Under the Healthy Environment goal of the King County Strategic Plan, the County lists an objective to "Reduce countywide greenhouse gas emissions by 50 percent by 2030."[23] King County's proposed 2020 Strategic Climate Action Plan (SCAP) lists multiple actions supporting EV adoption under strategy GHG 2.10, "Accelerate electric vehicle adoption that prioritizes environmental justice." The performance measure targets that 100 percent of all light duty vehicles sold in King County be electric by 2035. According to the Federal Highway Administration, light duty vehicles include most passenger vehicles on the road today, such as sedans and SUVs.[24] With this 100 percent goal, the mechanisms supporting private EV purchase must rapidly accelerate.[25]

Understanding the current context of EVs is aided by reviewing current and projected EV ownership rates; EV charging patterns; and the equity implications of EV ownership and charging.

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[17] Richmond, Canada. Residential Electric Vehicle Charging: A Guide for Local Governments, 2018. [LINK]. Accessed 7/30/2020; page 9
[18] Cascadia Consulting, "Puget Sound Clean Air Agency Greenhouse Gas Emissions Inventory," Revised June 2018. [LINK]. Accessed 9/15/2020; page 4
[19] Cascadia Consulting, Ibid.
[20] Puget Sound Clean Air Agency (PSCAA), "Facilitating Low Income Utilization of Electric Vehicles," December 2018. [LINK]. Accessed 10/26/2020; page 1
[21] PSCAA, Ibid.
[22] King County, 2016 - 2022 Equity and Social Justice Strategic Plan. [LINK]. Accessed 9/14/2020; page 28
[23] King County Strategic Plan. [LINK]. Accessed 10/27/2020
[24] Light duty includes Class 1 and Class 2 vehicles, under 6,000 pounds and 10,000 pounds respectively, covering sedans, sport-utility vehicles and utility vans. Medium duty vehicles begins to encompass mini buses and school buses, while heavy duty includes transit buses, and freight trucks See Greater New Haven Clean Cities Coalition, "What are the various vehicle weight classes and why do they matter?," April 21, 2016, [LINK]. Accessed 9/15/2020
[25] King County, Draft 2020 Strategic Climate Action Plan, [LINK]. Accessed 9/14/2020; page 78

King County EV Ownership Rates: EV ownership levels in King County are the highest of any county in Washington. There are over 58,300 EVs in the state with 31,900 (55 percent) located in King County and another 12,300 (21 percent) in surrounding Kitsap, Pierce, and Snohomish counties.[26]

The rate of EV purchases and usage within King County is projected to grow. In March 2020, the Washington State Legislature passed Senate Bill 5811 authorizing the Department of Ecology to set targets in line with California's Zero Emissions Vehicle (ZEV) standard, requiring automakers to sell certain number of zero emission vehicles each year.[27] The 2018 Washington state EV market share was 4.28 percent; the California ZEV standard would require automakers to sell an equivalent of eight percent of EVs in the open market and analysts have predicted a nine percent market share for ZEV states in 2025.[28,29,30] Given that Washington's EVs are primarily located in King County thus far, the probable EV market share for King County will likely be even higher. Seattle City Light anticipates a minimum of 50,000 additional EVs within its service territory by 2030; Business-As-Usual (BAU) projections are for 75,000 additional EVs, and aggressive assumptions indicate 140,000 additional EVs by 2030.[31]

It is important to also evaluate EV charging needs on a longer time horizon, such as projected rates of EV ownership in 2030, 2040 and 2050. Most buildings have a 30 to 50 year lifespan, depending on building type, and retrofitting to add EV charging is more expensive than doing it when a building is new.[32] As such, adequately equipping buildings to match the longer-term projected EV ownership levels will cost private developers less in the long-run, while also supporting increased EV ownership. Longer-term EV market share predictions vary, but all show increasing rates of EV adoption. Some have predicted an EV global market share of 7.7 percent by 2025, with Deloitte and others predicting a 20 percent market share by 2030.[33,34,35] More recent projections are more optimistic due to projected decreases in EV battery costs; Bloomberg New Energy Finance (BNEF) has

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[26] Washington Department of Licensing. Electric Vehicle Population Data; and Electric Vehicles by County. Last published July 8, 2020. [LINK].Accessed July 24, 2020.
[27] Washington State Department of Ecology, "Washington Clean Car Standard." [LINK]. Accessed 07/28/2020. Washington State Legislature Final Bill Report, SB 5811. [LINK]. Accessed 9/10/20.
[28] McDonald, Loren. EV Adoption, EV Market Share by State (Plug-In Hybrid EV (PHEV) and Battery EV (BEV)). [LINK]. Accessed 7/24/20.
[29] For more on how ZEV sales and EV credits work, please see Union of Concerned Scientists, "What is ZEV," Published Aug 7, 2012; updated Sep 12, 2019. [LINK]. Accessed 9/6/20.
[30] Nicholas, Michael, Dale Hall and Nic Lutsey. "Quantifying the Electric Vehicle Charging Infrastructure Gap Across U.S. Markets." White Paper, International Council on Clean Transportation. January 2019. [LINK].Accessed 07/28/2020. Page 12.
[31] Daniels, Lynn and Brendan O'Donnell, Seattle City Light Transportation Electrification Strategy, Rocky Mountain Institute, 2019. [LINK]. Accessed 10/27/2020. Page 18
[32] Pike, Ed et al. City of Oakland Plug-in Electric Vehicle Readiness Grant, Final Project Report. Energy Solutions, prepared for the California Energy Commission. January 2020. [LINK]. Accessed 7/30/20. Page 11.
[33] Cembalest, Michael. "Eye on the Market," Annual Energy Paper, April 2018. [LINK]. Accessed 9/14/2020.
[34] Deloitte, "New Market. New Entrants. New Challenges. | Battery Electric Vehicles." 2019. [LINK]. Accessed 9/14/2020. Page 4
[35] Markets and Markets, "Electric Vehicle Market by Vehicle (Passenger Cars & Commercial Vehicles), Vehicle Class (Mid-priced & Luxury), Propulsion (BEV, PHEV & FCEV), EV Sales (OEMs/Models) Charging Station (Normal & Super) & Region - Global Forecast to 2030," Report Code: AT 4907. June, 2019. [LINK]. Accessed 9/14/2020.

estimated a 30 percent market share by 2030, and a 60 percent EV market share by 2040.[36]

Most estimates are issued worldwide and include an expected lag in the rate of United States EV market share in the absence of supporting federal policies and incentives.[37,38] This lag is only expected until 2030, at which point BNEF predicts it will align with the global average.[39] It is note-worthy, however, that BNEF also predicts that charging infrastructure will constrain market growth worldwide in the 2030's, except for people with access to home or workplace charging.[40]

Another trend that may affect long-term EV adoption are increasing policies targeting the phase-out of gas-fueled engines. Roughly 17 countries have announced 100 percent ZEV targets for years between 2030 to 2050 targets, or a variant thereof.[41,42] In 2019, France was the first country to pass a 100 percent ZEV by 2040 law. In 2020 the Washington State legislature considered a proposal for the state to refuse to register any new gas-powered vehicle by 2030; although the bill failed to advance, similar legislation has been considered in five other U.S. states, the District of Columbia, and even federally.[43,44] While the future passage of such laws are uncertain, this type of legislation will be considered more in the coming decades. If passed, it will affect EV market share trends.

EV Charging Patterns: Access to home charging is closely correlated to housing type, with drivers in detached houses much more likely to have home charging than those in apartments or attached houses. For single family homes, home charges are anticipated to be the primary location for charging for most EV drivers.[45] As noted by an International Council on Clean Transportation (ICCT) White Paper in 2019,

> *Our analysis shows that over 90% of the charge points and over 70% of all the required electric energy for electric vehicles is likely to come from home charging for the foreseeable future, although the use of nonhome charging will grow more*

[36] Bloomberg New Energy Finance (BNEF), Electric Vehicle Outlook 2020, Executive Summary: Long-term passenger vehicle outlook. [LINK]. Accessed 9/11/2020
[37] Coren, Michael. "2019 was the year electric cars grew up," Quartz. December 6, 2019. [LINK]. Accessed 9/11/2020
[38] Pyper, Julia. "Global EV Market: Already on the Road to Recovery," Grid Edge. June 9, 2020. [LINK]. Accessed 9/11/2020
[39] Bloomberg New Energy Finance (BNEF) , Electric Vehicle Outlook 2020, Executive Summary: Long-term passenger vehicle outlook. [LINK]. Accessed 9/11/2020
[40] Bloomberg New Energy Finance (BNEF), Ibid.
[41] Cunningham, Nick. "IEA: EVs to Gain More Market Share," the Fuse. June 16, 2020. [LINK]. Accessed 9/11/20.
[42] International Council on Clean Transportation (ICCT), "Briefing: Update on the global transition to electric vehicles through 2019," July 2020. [LINK]. Accessed 9/11/2020
[43] Berman, Bradley. "Washington State passes bill to become a ZEV state, pushes for ban of gas cars," electrek. March 11, 2020. [LINK]. Accessed 08/18/2020.
[44] Coltura, "Gasoline Vehicle Phaseout Advances Around the World," Facts and Resources. [LINK]. Accessed 9/11/2020
[45] Nicholas, Michael, Dale Hall and Nic Lutsey. "Quantifying the Electric Vehicle Charging Infrastructure Gap Across U.S. Markets." White Paper, International Council on Clean Transportation (ICCT). January 2019. [LINK]. Accessed 07/28/2020. Page 26.

rapidly. Although the majority of charging happens at home, public and workplace charging are critical to provide options for mainstream electric vehicle adopters. [46]

According to the Edison Electric Institute, the number of EVs on U.S. roads is projected to grow to 18.7 million by 2030. To recharge these new EVs, the U.S. will need 9.6 million charge ports. Approximately 7.5 million charge ports will be needed in single-family and multifamily charging, and 1.2 million will be needed in workplace charging – or 78 percent and 13 percent of the growth in charging units, nationally. Remaining chargers include an estimated 0.8 million public charging ports and 100,000 DC fast charger ports.[47]

EVs and Equity: Expanded EV ownership may provide environmental benefits to communities disproportionately affected by air pollution and climate change. As noted by Greenlining in their Electric Vehicles for All: An Equity Toolkit,

Global warming emissions and climate change hit low-income communities and communities of color first and worst because these communities disproportionately live near busy roads and freeways, exposing them to dangerous levels of emissions. This leads to higher rates of asthma, cancer, and other pollution-related illnesses, increased health costs and more missed school and work days. Low-income communities of color also suffer more during extreme weather events because of lack of resources to escape them.[48]

Beyond general environmental improvement, expanding direct EV ownership within these communities has the potential to positively influence equity considerations, but EV growth for these demographics face additional barriers.

The typical household in the central Puget Sound region household spends 14 to 19 percent of its income on transportation.[49,50] These costs are generally lower along the I-5 corridor and sections of South King County, in areas well-served by transit; costs are higher in east King County, and in more rural areas farther from major transportation corridors.[51] It is estimated that the average Seattle-Tacoma-Bremerton resident spent $11,999 in 2018 on annual transportation expenditures, of which 88 percent was spent on buying and maintaining private vehicles (compared to the national average of 92 percent).[52] Although a good portion of these funds are dedicated to annual loan payment totals, these expenditures could be reduced through EV savings on fuel and maintenance.

Despite the current higher EV sticker price due to the popularity of high-end EV brands, long term EV ownership saves transportation expenses. The average annual cost to fuel an EV in the United States is $485, estimated closer to $360 for King County, while the

[46] Nicholas, Michael, Dale Hall and Nic Lutsey, (ICCT). Ibid.
[47] Cooper, Adam and Kellen Schefter. Electric Vehicle Sales Forecast and the Charging Infrastructure Required Through 2030, Edison Electric Institute. November 2018. [LINK]. Accessed 8/3/20. Page 3.
[48] Greenlining, Electric Vehicles for All: An Equity Toolkit, 2017. [LINK]. Accessed 7/31/20
[49] US Bureau of Labor Statistics, Consumer Expenditures for the Seattle-Tacoma-Bremerton Area: 2017–18. [LINK]. Accessed 7/30/20
[50] PSRC, Vision 2050 Housing Background Paper, June 2018. Page 28. [LINK]. Accessed 7/30/20
[51] PSRC, Ibid.
[52] US Bureau of Labor Statistics, Consumer Expenditures for the Seattle-Tacoma-Bremerton Area: 2017–18. [LINK]. Accessed 7/30/20

average cost to fuel a gas-powered vehicle in Washington was $1,338, three times as expensive.[53, 54] EVs tend to also require less in maintenance costs outside of fueling. Part of this cost difference is vehicle composition, as gas-fueled internal combustion engines (ICE) have over 2,000 moving parts compared to the 20 moving parts within an EV.[55] However, fuel is the major studied and defined EV ownership cost savings. As a fuel, electricity is cheaper than gas and also regulated, producing a more stable price than gas over time.[56]

Table 1. Rental Percentage by Household Demographic[57]

Household Type	Percentage that Rent
Average King County	43%
Black	72%
Native Hawaiian/ Pacific Islander	71%
Hispanic/Latinx	66%
Native American	61%
Two/+ Races	60%
Foreign-born	50%
Asian	42%

While EV ownership could provide sustained savings to historically disadvantaged families, one remaining barrier to supporting EV ownership across these communities has been a lack of home charging access.[58] This is due to a constricted multifamily and workplace charging supply intersecting with existing disparities in the rate of households who rent along race, ethnicity, and foreign-born status. Approximately 40 percent of King County households rent, but this percentage is higher for non-white households (see table 1).[59] Lower-income families are also more highly represented in rental households. In King County, approximately 46 percent of multifamily units are affordable to those under 80 percent of the area median income (AMI).[60] Renters are more likely to be cost-burdened or severely cost-burdened; a household is considered cost burdened or severely cost burdened if it pays may more than 30 percent or 50 percent of its income on housing, respectively.[61] Across the four-county Puget Sound region, about 30 percent of homeowners and 45 percent of renters are cost burdened or severely cost burdened.

[53] Seattle Electric Vehicle Association (SEVA), "When you purchase, lease or convert an Electric Vehicle in Washington State," 2017. [LINK]. Accessed 7/31/20
[54] Sivak, Michael and Brandon Schoettle. "Relative Costs of Driving Electric and Gasoline Vehicles in the Individual U.S. States." January, 2018. [LINK].
[55] Raferty, Tom. "Seven Reasons Why the Internal Combustion Engine is a Dead Man Walking [Updated]," Forbes. September 6, 2018. [LINK]. Accessed 7/31/20
[56] Union of Concerned Scientists, Going from Pump to Plug: Executive Summary, 2017. [LINK]. Accessed 8/1/20. Page 1.
[57] 2019 King County Analysis of Impediments to Fair Housing Choice. [LINK]. Accessed 10/27/20. Attachment A, Page 44.
[58] Greenlining, Electric Vehicles for All: An Equity Toolkit, 2017. [LINK]. Accessed 7/31/20; and Pallavi Panyam, "3 Ways California is Taking a Pro-Equity Approach to Electric Vehicles," The CityFix. February 13, 2020. [LINK]. Accessed 10/27/2020
[59] 2019 King County Analysis of Impediments to Fair Housing Choice. [LINK]. Accessed 10/27/20. Attachment A, Page 44.
[60] PSRC, Vision 2050 Housing Background Paper, June 2018. Page 31 (East and South King County results). [LINK]. Accessed 7/30/20
[61] PSRC, Ibid. Page 33

In South King County, almost 50 percent of renters are cost burdened.[62] Overall, African American and Hispanic households are also more likely to be cost burdened.[63]

The disproportionate representation of disadvantaged communities residing in multifamily housing highlights the importance of increasing multifamily EV charging. As noted in "Electric Vehicles for All: An Equity Toolkit" by Greenlining,

> *Access to home charging is a "virtual necessity" to the acceleration of the EV market.[8] Consumers are very unlikely to buy EVs if they cannot charge at home.[9] In order to ensure underserved communities have real access to EVs, ensuring they have access to home charging is critical.*[64]

Analysis conducted for this report finds that supporting workplace charging at a variety of commercial locations, not just office buildings, is another aspect to addressing equity. There is a surfeit of existing residential buildings without charging infrastructure on site and this gap can be addressed with workplace charging. The Department of Energy has reported that an employee with workplace charging is six times more likely than the average worker to drive an EV.[65]

Additional techniques can be applied to mitigate other notable barriers of EV purchases for low-income and historically disadvantaged households. Purchase incentive tools and financing assistance can help overcome initial price barriers. Multilingual and culturally relevant outreach, technical assistance, and marketing can help increase EV uptake for targeted communities. And finally, dealerships also have poor existing incentives to selling EVs, as gas-powered vehicles provide better long-term profits for their increased maintenance. Providing increased dealer education; fiscal incentives for each EV a dealership sells, tiered higher for sales to qualifying low-income individuals; and dealership recognition can also help – though this may be less necessary with Washington's entry as a ZEV state in 2020.[66]

Relatively little research can be found on EV used car sales trends, possibly because there is little market penetration by EVs. Still, used cars are purchased 2.3 times as often as new cars in the United States (39.4 million used annually versus 17.3 million new).[67] Given the lower starting price of used cars, this may be another future area for policy efforts to spur EV uptake within disadvantaged communities.

Report Methodology: To complete this report, the Department of Natural Resources and Parks retained consultant services for an initial research scan and report, including interviews with EV charging representatives, Puget Sound Energy (PSE) staff, and with

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[62] PSRC, Ibid. Page 33
[63] PSRC, Ibid. Page 34
[64] Greenlining, Electric Vehicles for All: An Equity Toolkit, 2017. [LINK]. Accessed 7/31/20
[65] U.S. Department of Energy, Workplace Charging Challenge Progress Update 2016, [LINK]. Accessed 7/31/20
[66] Greenlining, Electric Vehicles for All: An Equity Toolkit, 2017. [LINK]. Accessed 7/31/20. The Puget Sound Clean Air Agency has released a related local report, "Facilitating Low-Income Utilization of Electric Vehicles," December 2018. [LINK]. Accessed 9/15/2020
[67] McKinsey and Company, "Used cars, new platforms: Accelerating sales in a digitally disrupted market," June 6, 2019. [LINK]. Accessed 7/30/20

staff in Washington cities that have required EV charging infrastructure installation and preparation. This report informed model ordinance development, which was then evaluated with the Regional Code Collaboration (RCC) partners.[68] Staff from the Department of Local Services, Permitting Division, conducted additional research and developed this report.

A significant, multipronged stakeholder engagement effort was conducted, detailed in Section B. below.

V. Report Requirements

This section is organized to align with the requirements for this report outlined in Ordinance 19021, Section 46, Proviso P8, as stated below.

A. Report on options to require, incentivize or otherwise ensure electric vehicle charging infrastructure in new multifamily construction and other development proposals that include expansion of parking areas in the unincorporated area

King County's options for supporting electric vehicle charging infrastructure development, also known as electric vehicle supply equipment (EVSE) are outlined in the sections below. These options address the types of charging; the degree of EVSE implementation; consideration for cost impacts; incentive and code requirement options; administration; and other variables.

Technical Considerations

1. Electric Vehicle Charging Levels

EVSE has three typical charging types. The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy, defines these charging levels as follows:[69]

> ***Level 1:*** *Provides charging through a 120 V AC plug and does not require installation of additional charging equipment. Can deliver 2 to 5 miles of range per hour of charging. Most often used in homes, but sometimes used at workplaces.*
>
> ***Level 2:*** *Provides charging through a 240 V (for residential) or 208 V (for commercial) plug and requires installation of additional charging equipment. Can deliver 10 to 20 miles of range per hour of charging. Used in homes, workplaces, and for public charging.*
>
> ***DC Fast Charge:*** *Provides charging through 480 V AC input and requires highly specialized, high-powered equipment as well as special equipment in the vehicle itself. (Plug-in hybrid electric vehicles typically do not have fast charging*

[68] The RCC is a collection of Puget Sound Region jurisdictions sharing expertise and resources to develop model codes addressing material, water, energy conservation, and sustainable transportation.
[69] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (US DOE, OEERE). "Electric Vehicles: Vehicle Charging." [LINK]. Accessed 7/27/20

capabilities.) Can deliver 60 to 80 miles of range in 20 minutes of charging. Used most often in public charging stations, especially along heavy traffic corridors.

Fully charging an Electric Vehicle (EV) can take from under 30 minutes to over 20 hours based on the type of EVSE, the vehicle range and type of battery, its capacity, and degree of battery depletion. All-electric or battery-electric vehicles (BEVs) typically have higher electric ranges and battery capacity than plug-in hybrid electric vehicles (PHEVs), so charging a fully depleted all-electric vehicle takes longer.[70] Table 2 below summarizes differences in the three charging types or levels.

Table 2. EV Charging Levels and Statistics

	Level 1	**Level 2**	**Level 3** DC Fast Charge
Electric/Power Needs[71]	120 Volt 20 Amp	240 Volt (R) 208 Volt (C) 30-40 Amp typ.	480 Volt
Miles of Range Per Hour of Charging (RPH)[72]	5 RPH	12 RPH (3.7 kw) *Range 2.9 – 7.7 kw*	100 RPH (24 kw) 200 RPH (40+ kw)
Time to Charge an 80-mile Battery[73]	*Overnight* 16 hours	*Longer Stop* 3.5 Hours	*Quick Stop* 0.5 Hours
Avg. Drivers Served per Station/Day[74]	1	3-4	12+

Wireless charging is an emergent addition to the above, though its application is not yet widespread. The few commercial wireless chargers on the market share some of the same requirements as plug-in Level 2 chargers, such as requiring a 208-240 volt AC input with a dedicated circuit.[75] Currently, only a few vehicle models are known to offer wireless charging (BMW i3; Tesla Model S; Nissan LEAF; and Chevy Gen 1 Volt). Beyond the small current demand for wireless charging, public wireless charging stations have additional barriers, including the need for precise parking to achieve a charge; and the possibility of snow, ice or foreign objects potentially shutting down the wireless charging process.[76]

Current EV development codes among the jurisdictions analyzed for this report focus primarily on multifamily and commercial charging and predominantly address Level 2 charging capacity.[77] Level 1 chargers with their long charge times are less suitable for

[70] US DOE, OEERE. Ibid.
[71] US DOE, OEERE. Ibid.
[72] "Drivers Checklist: A Quick Guide to Fast Charging," Chargepoint. [LINK]. Accessed 07/27/20.
[73] Ibid, "Drivers Checklist: A Quick Guide to Fast Charging."
[74] Doyle, Kevin. "Level Up your Charging Knowledge," Chargepoint, Charging the Future. [LINK]. Accessed 07/27/20
[75] Plugless Technical Specifications, 1st generation [LINK] and 2nd generation [LINK]. Accessed 07/27/20.
[76] Quattrini, Rich. "What Wireless EV Charging Looks Like Right Now." Chargepoint, Charging the Future. January 23, 2017. [LINK]. Accessed 07/27/20.
[77] See Report Appendix C. List of Jurisdiction Codes Evaluated in Report Development; over 90 percent of codes listed address Level 2 EV charging.

multifamily and commercial charging. As EV ownership rates increase, the number of EV owners will outstrip the number of EV parking spaces available, such that an EV owner may not be guaranteed of securing a car charge every night. A few hours' charge would have to be sufficient for several days, so systems that provide more charge in a shorter period of time will better sustain individual EV owners with projected increasing demand for limited EVSE.

Level 3 charging is currently more expensive to implement, and it lacks universal support due to plug variation, though this may change over time.[78] All major EV vehicle and charging system manufacturers support the SAE J1772 standard connector and receptacle, which can use a Level 1 or Level 2 charger. Level 3 chargers are not yet standardized; although some Level 3 chargers can connect to SAE J1772 plugs, other vehicles and Level 3 chargers have CHAdeMO ports for fast-charging, such that some Level 3 EVSE cannot service all vehicle types; the Level 3 Tesla Supercharger will only charge Tesla vehicles.[79,80] However, the EV industry is characterized by rapid innovation; with increasing battery sizes and EV sales, Level 3 plugs may become more standardized and Level 3 charging may become less expensive.

Analysis: Given these findings, this report focuses on Level 2 EVSE development code as the most viable EV charging option for King County to focus on growing in association with new multifamily and other development at this time. If EV charging technology or EV ownership levels sharply diverge from the future projections as outlined in this report, the associated development codes may be amended to adjust accordingly.

2. Electric Vehicle Supply Equipment

Electric vehicle supply equipment (EVSE) code requirements among the jurisdictions analyzed for this report occur within a progression of categories. Beyond requiring EVSE installation, codes can also require EV Capable and EV Ready parking spaces. The 2021 International Energy Conservation Code development process defined these terms as follows: *(emphasis added to accentuate the differences between EV Capable and EV Ready spaces)*:

> **EV Capable Space:** "Electrical panel *capacity and space* to support a minimum 40-ampere, 208/240-volt branch circuit for each EV parking space, and the

[78] US DOE, OEERE. "Charging Infrastructure Procurement and Installation," [LINK]. Accessed 7/30/20
[79] CHAdeMO stands for, "Charge de Move," one of several rapid charging standards created by a consortium of carmakers and industry bodies. The name is derived from the Japanese phrase, "O cha demo ikaga desuka," translating to English as "How about a cup of tea?", referring to the time it would take to charge a car. For more information, please see: Beedham, Matthew. "What is CHAdeMO? Let us explain," TNW Shift. May 22, 2020. [LINK]. Accessed 9/14/2020; and Blanco, Sebastian. "CHAdeMO suggests drinking green tea while recharging your electric car," March 15, 2010. [LINK]. Accessed 9/14/2020
[80] U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy (US DOE, OEERE). "Electric Vehicles: Vehicle Charging," [LINK]. Accessed 7/27/20

installation of raceways, both underground and surface mounted, to support the EVSE."[81]

EV Ready Space: "A designated parking space *which is provided with* one 40-ampere, 208/240-volt dedicated branch circuit for EVSE servicing electric vehicles. The circuit shall terminate in a suitable termination point such as a receptacle, junction box, or an EVSE, and be located in close proximity to the proposed location of the EV parking spaces."[82]

EVSE Installed: "The conductors, including the ungrounded, grounded, and equipment grounding conductors, and the electric vehicle connectors, attachment plugs, and all other fittings, devices, power outlets, or apparatus installed specifically for the purpose of transferring energy between the premises wiring and the electric vehicle."[83]

Essentially, EV Capable or "Conduit-only" spaces must have the electrical capacity and space to later provide a dedicated branch circuit, and provide the enclosed conduit raceways through which to channel the electrical wiring at a later date. In contrast, EV Ready spaces install the branch circuit and provide wiring to potential EVSE installation locations up front. EVSE installed is the only option that provides fully operational EVSE, for either a percentage or a specific number of designated spaces.

Analysis: As EV Capable spaces still defer costs to a future actor, which in turn acts as a barrier to installing future charging, this report focuses on EV-Ready Spaces and full EVSE installation.

3. Cost Considerations

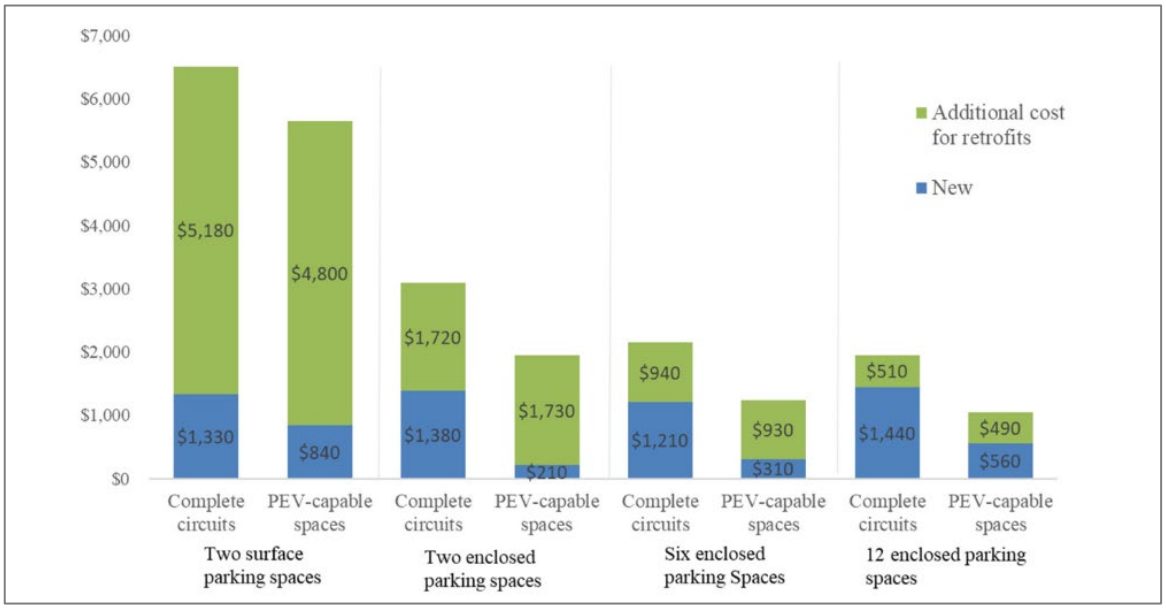
Analysis conducted for this report finds that including planning for future for EV parking in development is less expensive than retrofitting buildings to add EV chargers and supportive electrical capacity at a later date. For single family homes and duplexes the cost for wiring a 208/240 volt circuit at the point of building construction is estimated to be between $150 to $375 per space for both labor and materials, though some have estimated this cost may be potentially reduced to $35 to $115 per space with load management.[84,85]

EV parking requirements have a wider range of cost impacts on multifamily and commercial development due to variations in parking lot configuration, design, and

[81] International Code Council (ICC), 2018 International Energy Conservation Code (IECC), 2021 Proposal CE217-19 Part I, General Definitions. [LINK]. Adopted code found via Bradley Berman article, "International Code Council calls for all new homes to be ready for 240-volt EV charging," Electrek. January 15, 2020. [LINK]. Accessed 10/27/2020. Note: While these 2021 code provisions were initially fully adopted, they were later appealed as they did not fall under a conservation action. It is probable these codes will resurface in the 2024 IECC code process.
[82] IECC, Ibid.
[83] IECC, Ibid.
[84] Richmond, Canada. Residential Electric Vehicle Charging: A Guide for Local Governments, 2018. [LINK]. Accessed 7/30/2020. Page 16. Canadian Dollars converted to USD at a 0.75 Canadian/1 USD ratio.
[85] Irving, John. "Electric Vehicle Charging Infrastructure – Requirements for New Developments," Report to the City of Richmond PWT Committee, 10/15/2017. [LINK]. Accessed 7/30/20. Page 9.

development size.[86]However, studies consistently indicate that installing at the time of building construction is less expensive than retrofitting.[87] A City of Oakland study estimated the cost of an EV-Ready space at the time of building construction is $1,330 for surface parking and $1,380 for enclosed parking. In contrast, EV readiness retrofit costs are up to eight times greater than new construction, adding between $900 to over $5,000 additional expense per space. The authors attribute "breaking and repairing walls, upgrading electric service panels, breaking and repairing parking surfaces and/or sidewalks, more expensive methods of conduit installation and additional permitting and inspections" as factors driving increased costs with retrofits.[88]

Figure 1. New and Retrofit Costs per Parking Space



Retrofit costs per parking space two to eight times higher than new construction installs. Costs adjusted from 2016 to 2018 based on RS Means Historical Cost Indexes. *Source:* Pike and Steuben, 2016

Following wiring for EV-readiness, the typical cost of a Level 2 charger itself ranges from $500 to $7,500, depending on development type and degree of charger versatility.[89] A single-port residential "dumb" charger can cost $380 (2.9 kW) to $689 (7.7 kW);[90] a single-port multifamily charger with a limited interface that assigns charging to one resident, for example, may cost around $1,500. A "smart" charger that allows improved remote control such as wait-listing, locking out non-allowed users or increased dynamic pricing typically

[86] Southwest Energy Efficiency Project (SWEEP), EV Infrastructure Building Codes: Adoption Toolkit. [LINK]. Accessed 7/29/20

[87] SWEEP, Ibid. Also, Pike, Ed et al. City of Oakland Plug-in Electric Vehicle Readiness Grant, Final Project Report. Energy Solutions, prepared for the California Energy Commission. January 2020. [LINK]. Accessed 7/30/20. Page 11.

[88] Pike, Ed et al., Ibid. Page 12.

[89] Interview with Jim Blaisdell, Principal, Charge Northwest LLC - Chargepoint Distributors, on 7/30/2020. Similar to price citations by US DOE, OEERE. "Charging Infrastructure Procurement and Installation," [LINK]. Accessed 7/30/20, and to price citations in the Chris Nelder and Emily Rogers RMI study (cited below)

[90] Nelder, Chris and Emily Rogers. Reducing EV Charger Infrastructure Costs, Rocky Mountain Institute (RMI), 2019. [LINK]. Accessed 7/29/20. Page 7.

starts at $3,000 *per port* for a wall-mount, or $3,250 *per port* for a pedestal (or $6,000 to $6,500 for a single, dual-port/plug charger). Some commercial dual-port chargers have some integrated load management, meaning, for example, that while **two** full 40-ampere circuits are optimal, they can function connected to **one** 40-ampere circuit to share load and charging between two cars with a minimal increase in charging time.[91] Developers can use these types of chargers to potentially reduce electrical capacity requirements to support EV charging, and effectively split the cost of circuitry and wiring for EV-Ready spaces. Load management technology may also reduce these costs; see the section, "Other Factors."

In some cases, the added electrical capacity requirements to support EV charging can necessitate upgrades to the distribution system. One report noted that, in retrofits

> *…a standalone, low voltage (120 kilovolt Amp - 500 Amp, 240 volts) transformer with capacity to support a dozen charging circuits would cost approximately $10,000, including labor… The incremental cost of upsizing a transformer in new construction to provide this amount of capacity would be substantially less.*[92]

For smaller projects and for EV implementation at the time of building construction, these costs can still be notable.

> *An additional $2,175 to $3,450 per space may be added for smaller buildings with 9 units or less when single phase power is selected and a dedicated transformer is installed to serve the EV charging load. When transformer costs are added to raceway and panel capacity costs, the total additional cost of EV charging infrastructure represents between 0.1 to 0.5 percent of the average cost of a new multifamily housing unit.*[93]

Analysis**:** Studies consistently indicate that installing at the time of building construction is less expensive than retrofitting.[94] EVSE installation and EV readiness requirements imply relatively minimal cost additions to most developments, though the added cost of electrical transformers – especially for smaller multifamily projects – can impact the cost implications per EVSE and EV-Ready parking spaces. In such instances, flexibility may be warranted that would still ensure some functional level of charging and/or EV readiness balanced against the potential increased cost ratio per parking space.

Incentive Options

The options to support EVSE installation in new multifamily and other development falls into two areas: incentives and requirements.

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[91] Interview with Jim Blaisdell, Principal, Charge Northwest LLC - Chargepoint Distributors, on 7/30/2020. Consistent with price citations by US DOE, OEERE. "Charging Infrastructure Procurement and Installation," [LINK]. Accessed 7/30/20

[92] Pike, Ed et al. City of Oakland Plug-in Electric Vehicle Readiness Grant, Final Project Report. Energy Solutions, prepared for the California Energy Commission. January, 2020. [LINK]. Accessed 7/30/20. Page 14.

[93] California Air Resources Board (CARB), Electric Vehicle (EV) Charging Infrastructure: Multifamily Building Standards. April 13, 2018. [LINK]. Accessed 7/30/20. Page 6.

[94] SWEEP, Ibid. Also, Pike, Ed et al. City of Oakland Plug-in Electric Vehicle Readiness Grant, Final Project Report. Energy Solutions, prepared for the California Energy Commission. January 2020. [LINK]. Accessed 7/30/20. Page 11.

Fiscal incentives have been some of the most widely used mechanisms employed thus far to spur EVSE installation, primarily employed by federal and state actors. As noted previously, the federal 2009 Recovery Act helped support the installation of more than 18,000 residential, commercial and public chargers across the country.[95] Today, a 30 percent federal tax credit remains in place for hardware and installation cost, capped at $1,000 for residential installations and $30,000 for installations at businesses.[96]

Some EVSE grants have been offered from Washington State. These have either been limited to local governments and retail utilities, or been single-additions to the State budget deployed at a rapid rate which may pose challenges for use by new developments. Alternatively, a consistent stream of available state revenue would allow developers to plan ahead, matching the 18-month development window and additional time for contracting and design with more dependable fiscal support. Past and current fiscal incentives offered by Washington State include Department of Transportation grants of $1 million from 2017 to 2019 for EV charging installation, and Department of Commerce Electrification of Transportation Systems (ETS) grants in 2020 for up to $10.67 million for local governments and retail utilities.[97,98] One existing Washington State fiscal incentive available to developers is that the purchase of electric vehicle charging infrastructure is exempt from state sales taxes through July 1, 2025.[99] Some Washington State utilities have also offered incentives to install EV chargers. Pacific Power and Avista both offer rebates and grants for EVSE installation; PSE is also currently offering a smaller-scale pilot program to install EVSE at 50 workplaces and 25 multifamily residences.[100,101] One tool that local governments may pursue is requesting that the state or local utilities increase their fiscal support for EVSE development.

Some local governments offer rebates for EVSE charger installation, though these rebates require that developers provide parking available to the greater public, not just to the tenants or future occupants of their developments. A 2015 white paper found that two of the 25-most populous cities in the U.S. offered incentives for privately-owned Level 3 public charging stations.[102] Most other rebate examples come from municipally-owned power utilities, such as the City of Pasadena ($200 to $600).[103] The City of Anaheim provides $5,000 for private installation of public chargers, increasing up to $10,000 for more desirable charging locations, such as schools and affordable housing sites, or for

[95] Department of Energy, "The History of the Electric Car," September 15, 2014. [LINK]. Accessed 9/14/2020
[96] Revision Energy, "2020 New England EV Charging Incentives: Maine, New Hampshire & Massachusetts," Updated 6/18/20. [LINK]. Accessed 9/14/20
[97] Washington State Department of Transportation (WSDOT), "Innovative Partnerships - Electric Vehicle Charging Infrastructure." [LINK]. Accessed 9/14/2020
[98] Washington State Department of Commerce, "Electrification of Transportation Systems (ETS)." [LINK]. Accessed 10/28/2020
[99] Chargepoint, "Electric Vehicle (EV) Charging Incentives." [LINK]. Accessed 9/14/2020
[100] Clipper Creek, "EVSE Incentives by State." [LINK] Accessed 9/14/20
[101] Puget Sound Energy (PSE), "Host an EV Charger." [LINK]. Accessed 10/28/2020
[102] Lutsey, Nic et. al, "Assessment of Leading Electric Vehicle Promotion Activities in United States Cities," International Council of Clean Transportation (ICCT) white paper. July 2015. [LINK]. Accessed 09/14/20. Page 14.
[103] City of Pasadena Department of Water and Power, "Residential Electric Vehicle and Charger Incentive Program," [LINK]. Accessed 9/14/2020

Level 3 charging.[104] There are additional Canadian cities with local government rebates, but these were not reviewed in-depth given potential differences in governance structures.[105]

While fiscal incentives are a more common incentive type for EV and EV charging procurement, analysis conducted for this report found few non-fiscal incentive options. One example provides a parking requirement reduction to developers as a result of installing EVSE.[106] Land use codes for some jurisdictions allow spaces with installed EVSE to count as two parking spaces, allowing a reduction in required parking, sometimes with a cap on the maximum reduction allowed (i.e. for a maximum reduction of 10 percent of required parking).[107] Other typical land use incentive structures could theoretically be applied, such as the provision of density bonuses or expedited permitting review, but EVSE installation confers minimal cost additions, so the more typical land use incentive offerings may provide too big a developer "bonus" for typical EVSE installation yields.[108]

A public entity may attempt to counterbalance the costs of EVSE installation by lessening other typical parking costs such as reducing development parking minimums, as in the California example above. This may also yield several co-benefits, such as helping address affordable housing impacts and reducing impervious surface area and pollution-generating surfaces. However, if used by itself it is unlikely that EVSE installation will follow, and hence such efforts should be paired with a direct EVSE incentive structure.

Analysis: Although King County could develop a rebate program for installing publicly available EV charger installation, pursuing an incentive structure option for developers may yield suboptimal results. As a voluntary measure, it would not necessarily be deployed uniformly across the development landscape; some developers would pursue the incentives while others would not. In addition, rebates may not appeal to some forms of new or altered development. In the absence of code requirements or dependable long-term incentive structures, larger buildings with a 30- to 50-year lifespan may choose to continue the current market standard of deferring costs to a later date, where the higher cost of retrofits could still act as a barrier to increased EV charger installation.[109] And finally, the likely uneven deployment of EVSE installations may impact purchase of EVs among some user groups, particularly multifamily residents, due to lack of charging availability – perpetuating the existing issue of inequitable access.

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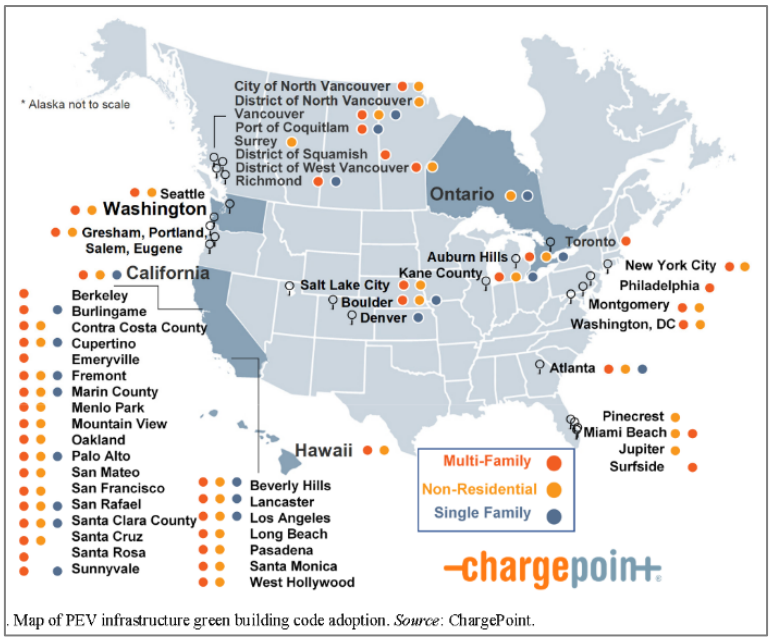
[104] City of Anaheim Public Utilities, "Public Access EV Charger Rebates." [LINK] Accessed 9/14/2020
[105] ChargeHub, "Grants and rebates for home EV chargers in Canada (Provinces and cities)" 2020 update. [LINK]. Accessed 10/27/2020
[106] Indianapolis, Indiana and Middletown, Connecticut. See Cooke, Claire and Brian Ross. "Summary of Best Practices in Electric Vehicle Ordinances," Great Plains Institute. June 2019. [LINK] Accessed 9/14/2020 Page 16.
[107] Cooke, Claire and Brian Ross. Ibid.
[108] Pannell, David J. "Public Benefits, Private Benefits, and Policy Mechanism Choice for Land-Use Change for Environmental Benefits." Land Economics 84, no. 2: 225-40. 2008 [LINK] Accessed 10/28/20.
[109] Pike, Ed et al. City of Oakland Plug-in Electric Vehicle Readiness Grant, Final Project Report. Energy Solutions, prepared for the California Energy Commission. January 2020. [LINK]. Accessed 7/30/20. Page 11.

A review of local government policies to encourage EVSE installation shows that, rather than operating rebate programs, more local governments require some degree of EV-readiness or EV installation at the time of building development as a code requirement, as described in the section below.

Code Requirement Options

More than 50 state, provincial, and local governments with a collective population of over 82 million have adopted building codes requiring charging infrastructure installation in new construction.[110] Using code to achieve EV infrastructure installation has several embedded options. These include: pursuing EV-readiness, EVSE installation, or both; the land use types targeted for EVSE support; and amount of EV parking preparedness required (usually as a percentage of overall parking spaces).

Figure 2. EV Codes in the U.S.



Map of PEV infrastructure green building code adoption. *Source*: ChargePoint.

Washington State is among those with existing EV code requirements:

> *Washington Administrative* Code *Title 51 - WAC 51-50-0427 requires 5% of parking spaces in new buildings to be equipped with EV charging infrastructure in compliance with sections 427.3, 427.4 and 427.5. If the calculated parking results is a fraction, the applicant must round-up to the next whole number. This statute excludes occupancies with fewer than 20 parking spots. The electrical room must be designed to accommodate 20% of all parking spaces with 208/240 V 40-amp.*[111]

Although this was an important first step when it was codified in 2016, WAC 51-50-0427 states that, "Additional service capacity, space for future meters, panel capacity or space for additional panels, and raceways for future installation of electric vehicle charging stations" is one form of compliant EV charging infrastructure.[112] As such, it does not provide direct EVSE charging and has limited application.

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[110] Pike, Ed et al., Driving Plug-In Electric Vehicle Adoption with Green Building Codes, American Council for an Energy-Efficient Economy (ACEEE), 2018. Page 1. [LINK]. www.aceee.org/files/proceedings/2018/#/paper/event-data/p163 Accessed 07/30/30

[111] Summary from Sierra Club and Plug In America, AchiEVe: Model State & Local Policies to Accelerate Electric Vehicle Adoption 2.0, 2018. [LINK]. Accessed 7/30/2020. Page 7.

[112] Washington Administrative Code [LINK]. Accessed 10/27/2020

Roughly 70 to 80 percent of U.S. EV drivers charge their vehicles at home;[113] one 2015 study found that lack of home charging, specifically, was a barrier to EV purchase – highlighting the importance of expanding the types of residential developments that support EV charging.[114] Assessments of some regions with higher EV parking requirements show that, even with increased requirements, there will still be a gap between projected increased EV ownership and adequate charging station provisions. The California Air Resources Board (CARB) conducted a 2018 gap analysis assessing the then-current three percent EVSE-installed spaces requirement, which applied to multifamily buildings with 17 units or more. The analysis showed that this requirement would only meet six percent of the projected need for multifamily unit charging by 2025, whereas a 10 percent EVSE-installed requirement would result in providing 65 percent of the projected multifamily EV charging need. CARB further reasoned that this was an important step to meeting 2030 GHG goals, since building lifespans of this type tend to last 30-plus years.[115]

The EV Infrastructure Building Codes: Adoption Toolkit developed by the Southwest Energy Efficiency Project (SWEEP) notes that local governments targeting higher EV adoption should consider more ambitious EV infrastructure requirements.[116] As shown in the following table, governments that have targeted greater EV access have also required higher percentages of EVSE installed and EV-Ready parking spaces for multifamily development.

Table 3. Multifamily Residential EV Parking Requirements[117]

Jurisdiction	EVSE Installed	EV Ready	EV-Capable
San Jose, CA	10% Installed	20% EV Ready 1 EV Ready/unit	70% EV Capable
Menlo Park, CA	15% Installed	1 EV Ready/unit	-
Marin County, CA	-	1 EV Ready/unit	20% EV Capable
Golden, CO	7% Installed (15+ units)	-	15% EV Capable
Denver, CO	5% Installed (10+ units)	10% EV Ready	15% EV Capable
Boulder, CO	5% Installed (25+ spaces)	10% EV Ready	40% EV Capable
Summit County, CO	5% Installed (10+ spaces)	10% EV Ready	40% EV Capable
Lakewood, CO	2% Installed	-	18% EV Capable
Salt Lake City, UT	4% Installed	-	-

[113] Union of Concerned Scientists, Going from Pump to Plug: Executive Summary, 2017. [LINK]. Accessed 7/31/20. Page 2.
[114] Richmond, Canada. Residential Electric Vehicle Charging: A Guide for Local Governments, 2018. [LINK]. Accessed 7/30/2020. Page 9
[115] California Air Resources Board (CARB), Electric Vehicle (EV) Charging Infrastructure: Multifamily Building Standards. April 13, 2018. [LINK]. Accessed 7/31/20. Page 16.
[116] SWEEP, EV Infrastructure Building Codes: Adoption Toolkit. [LINK]. Accessed 7/29/20
[117] Percentages apply to the number of total parking spaces that must meet the requirement.

Jurisdiction	EVSE Installed	EV Ready	EV-Capable
Edmonds, WA	10% Installed	10% EV Ready	-
Mountlake Terrace	10% Installed (10,000 SF)	10% EV Ready	-
Washington State	5% Installed OR added EV-Capacity (20+ spaces)	-	20-25% EV Capable R2 Occupancies – apartments; other

Non-residential land uses can provide charging opportunities for both customers and employees. A white paper by the International Council on Clean Transportation (ICCT) estimated that the Seattle Metropolitan Area had, as of 2017, developed only 26 percent of the public and workplace charging infrastructure needed by 2025; specific workplace deployment was only at 18 percent of its estimated need.[118] An estimated EVSE increase of 20 percent per year is needed to meet projected growth in large EV-demand areas, such as the Seattle metro area and King County.[119]

Many local governments with expanded multifamily EV parking requirements also require more non-residential EV parking and preparation, though multifamily requirements are more common. Example levels of non-residential EV installation requirements are outlined in the following table.

Table 4. Non-Residential EV Parking Requirements[120]

Jurisdiction	EVSE Installed	EV Ready	EV-Capable
San Jose, CA	10% Installed	-	40% EV Capable
Menlo Park, CA	10% Installed	15% EV Ready	-
Marin County, CA	-	10% EV Ready	20% EV Capable
Denver, CO	5% Installed (10+ spaces)	10% EV Ready	10% EV Capable
Boulder, CO	5% Installed	10% EV Ready	10% EV Capable
Summit County, CO	5% Installed (25+ spaces)	10% EV Ready	40% EV Capable
Lakewood, CO	2% Installed	-	13-18% EV Capable
Mountlake Terrace	1-3% Installed (10,000 SF)	2-6%EV Ready	-
Washington State	5% Installed OR added EV-Capacity (20+ spaces)		20-25% EV Capable Group B & Hotel-Motel (20+ spaces)

[118] ICCT, Quantifying the Electric Vehicle Charging Infrastructure Gap Across U.S. Markets. January 2019. [LINK]. Accessed 7/31/20. Page 20, 22.
[119] ICCT ibid, page II
[120] Percentages apply to the number of total parking spaces that must meet the requirement.

Some localities also call out hotel/motel stay locations for EV charging requirements, such as Mountlake Terrace, WA (three percent installed, six percent EV Capable/Ready); CalGreen state codes (10 percent EV Capable); and Palo Alto, CA (30 percent EV Capable), as well as Washington State's five percent EV-Capable requirement.

The most certain way to ensure the installation of EV charging equipment is to require it. Likewise, preparing for future capacity needs of EV market growth will help support its future expansion, and save developers the higher cost of retrofits in the future, reducing a significant barrier to implementation.

Analysis: This report recommends adoption of legislation amending King County Code to require some degree of EVSE installation and EV readiness for multifamily and nonresidential building types, and EV readiness for single family homes. Widespread deployment of EV charging infrastructure is needed to support and achieve the articulated SCAP goal of a 100 percent EV market share for light duty vehicles sold in King County by 2035, which this recommendation would support. Multifamily charging will help to address existing EV charging inequities, especially for limited-English speaking communities, communities of color, and individuals with low-incomes. And finally, nonresidential EVSE installation will support EV adoption in the workplace and among commercial customers.

Additional Considerations

Development codes addressing EVSE installation and EV readiness have several nuances that warrant consideration outside the scope of items already discussed. These include: under what code draft regulations should be administered; whether to allow load management; how to address signage and accessibility; and whether the regulatory scope should consider additional mechanisms to support multifamily EV charging.

1. Administration: Regulations addressing EV charging in parking spaces could be adopted and administered under at least two code sections, namely under K.C.C. Title 16 Building and Construction Standards, or under K.C.C. Title 21A Zoning. K.C.C. Title 16 is based on building codes developed by the International Code Council (ICC), used as primary standards for building construction in the United States and internationally. Proposed modifications to the ICC's International Energy Conservation Code (IECC) required a combination of EV Ready and EV Capable provisions for single-family and multi-family homes. Although the ICC approved these code changes at the end of 2019 and were slated to go into effect in 2021, these provisions were appealed in May 2020 and were ultimately repealed from the 2021 codes. The appeal argued that EV charging is not an *efficiency* provision, and hence does not belong in the IECC manual. While the ICC Board sustained the appeal, they also recommended consideration of an energy standard to replace the IECC, so it is probable this item may re-emerge for the ICC 2024 codes.[121]

[121] International Code Council, "2019 Group B Code Cycle Appeals Concluded," 2020. [LINK]. Accessed 10/28/20.

Analysis: Given the recent outcome of 2021 ICC building codes, and as K.C.C. Title 21A regulates parking, administration of EVSE parking regulations are recommended for incorporation in K.C.C Title 21A.

2. Load Management: One option to reduce EVSE installation and EV readiness costs is the application of load management. A study from Richmond, Canada, found that load management for four or more chargers can substantially reduce EV readiness costs per stall.[122]

> *Electric vehicle energy management systems (EVEMS), also referred to as "load sharing," "power sharing," or "smart charging," refer to a variety of technologies, including service provision, that allow multiple vehicles to charge on the same circuit. In contrast to a "dedicated EVSE" where one circuit services one stall, one circuit is able to service multiple stalls simultaneously by controlling the rate and timing of charging (Figure 5). This reduces the necessary electrical infrastructure and total electrical supply needed to power multiple EVSE.*[123]
>
> *There are additional load management options that may reduce the cost of multiple development types, including single-family, duplex, townhouse and larger buildings.*[124]

Analysis: In the development of this report, there were initial concerns that load management technology might be abused by attempting to service too many EVs on one circuit, which would ultimately provide insufficient power or poor charging rates to serviced vehicles. However, research did not provide evidence this was occurring in the market. While load management is an evolving technology, it may provide savings to developers, and the technology was supported in the stakeholder outreach process evaluating draft EV development codes. As such, it is recommended that proposed code changes addressing developer installation of EV charging and EV readiness infrastructure allow the use of load management technology to mitigate development costs.

3. Signage, Markings, and Other Site Considerations: The U.S. Department of Energy, Office of Energy Efficiency and Renewable Energy also notes that,

> *When installing EVSE, consider the signage and pavement markings that may be necessary to help inform drivers. Other considerations, such as installing the EVSE in a convenient location, lighting, and minimizing vandalism by using preventive strategies (e.g., motion detectors, anti-vandalism hardware). Americans with Disabilities Act (ADA) requirements should also be taken under advisement.*[125]

Washington State requirements addressing EV signage and EV accessibility are included in the Revised Code of Washington as well as Washington Administrative

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[122] Richmond, Canada. Residential Electric Vehicle Charging: A Guide for Local Governments, 2018. See Lowest cost, Level 2 option specifying a 4-way load share versus dedicated Level 2 [LINK]. Accessed 8/4/20. Page 17.
[123] Richmond, Canada. Ibid. Page 6.
[124] Richmond, Canada. Ibid. Page 7.
[125] US DOE, OEERE. "Charging Infrastructure Procurement and Installation," [LINK]. Accessed 7/30/20

Code. RCW 46.08.185 requires that EVSE must be indicated by vertical signage consistent with the manual on uniform traffic control devices (MUTCD), and that they must be also indicated by green pavement markings. WAC 51-50-0427.5 states that, "when electric vehicle charging infrastructure is required, one accessible parking space shall be served by electric vehicle charging infrastructure."[126] General state building code accessible parking requirements vary based on parking lot size; for parking lots sized between 26 and 200 spaces, the percentage of accessible parking is between three to eight percent of the total parking spaces.[127]

Analysis: To exceed accessibility minimums, but to not overly constrain the availability of EV parking spaces, the recommended EV charging ordinance that was transmitted concurrent with this report proposes that five percent of the total EVSE parking spaces are accessible, but not less than one. Additionally, the transmitted ordinance requires consistency with applicable state requirements for signage.

4. Other Regulatory Support: Were the direct requirement of EVSE installation not pursued, some other techniques could help address some multifamily barriers. California state code, for example, states that condominiums or cooperative developments may not prohibit EVSE installation in a homeowner's designated parking space. While there are still hurdles to overcome (the homeowner must obtain appropriate multi-unit development (MUD) owner/association approvals, comply with architectural standards, etc.), it still provides a degree of protection for condominium-style multifamily development.[128]

Analysis: While additional legislation could help support the development of existing and future multifamily charging in condominiums and cooperative developments, it is unknown whether such a provision in Washington State could be enacted at the local level, or if it would have to be passed at the state level. As such, the transmitted ordinance does not propose addressing this item.

Recommendation and Conclusions Summary

Below is a summary of the key recommendations and conclusions provided under each subsection discussed thus far.

- **EV Charging Level**
  EV regulations should focus on increasing Level 2 EVSE for new multifamily and other development.
- **EV Supply Equipment**
  EV regulations should focus on increasing EV-Ready Spaces and full EVSE installation.

[126] Revised Code of Washington [LINK]. Accessed 10/27/2020
[127] International Code Council, 2018 International Baking Code, Section 1106 Parking and Passenger Loading Facilities. [LINK]. Accessed 9/10/20,
[128] Sierra Club and Plug In America, AchiEVe: Model State & Local Policies to Accelerate Electric Vehicle Adoption 2.0, 2018. [LINK]. Accessed 8/3/20. Page 7.

- **Cost Considerations**
  - EV requirements imply minimal cost to most developments.
  - EV regulations should focus on installing EV infrastructure at the time of building construction, which is less expensive than retrofitting.
  - When EV requirements trigger adding a transformer in small multifamily projects, the regulations should allow reduced EV charging requirements to the point where a transformer is not needed.
- **Incentive options**
  - Outside of public electric utility operators, most City and County governments do not offer fiscal incentives to install EV charging.
  - Research conducted for this report found few non-fiscal or land use incentives used to stimulate EV charging development; parking incentives have been used in some cities.
  - Given the few existing example programs at the local level, that voluntary incentives my lead to uneven EV charging deployment, existing multifamily charging inequalities, and the stated SCAP goal for 100 percent EV market share for light duty vehicles by 2035, the analysis conducted for this report concludes that regulatory requirements will perform better in ensuring EV charging in new development proposals.
- **Code Requirement options**
  For new and substantial building improvements, this report recommends the following:

Table 5. EV Parking Requirements, Proposed King County Ordinance

Residential		
Development Type	**EVSE Installed**	**EV Ready**
Single Family, Duplex, & Townhouse	NA	1 per unit
Apartment	10%	25%
Nonresidential		
Nonresidential	5%	10%
New Paved Surface Lot & Garages	5%	10%

Note: Percentages apply to off-street parking spaces provided.

- **Additional Considerations**
  This report recommends that EV charging codes should:
  - Be administered under, and located in, K.C.C. Title 21A Zoning.
  - Allow the use of load management to mitigate development costs.
  - Comply with state requirements for signage, and require that five percent (and not less than one) of the total EVSE parking spaces are accessible.

B. Developed in consultation with stakeholder groups, including representatives of the building and electric vehicle industries and utilities

As directed by the proviso, this report was developed in consultation with stakeholder groups, including representatives of the building and electric vehicle industries and utilities.

Initial consultant research included interviews with EV charging technology representatives, Puget Sound Energy (PSE) staff, and staff from Washington cities requiring EV charging infrastructure installation. King County staff conducted additional outreach in these areas, along with holding a public comment period seeking feedback on the draft recommendations and legislation.[129] Below is a list of outreach activities and a summary of feedback received:

- Provided a draft of the EV charging supply equipment ordinance to the RCC on July 29, 2020 to solicit feedback;
- Held open public comment period from August 17-30 to gather feedback on the draft ordinance implementing the recommendations of this report;
- Conducted a stakeholder outreach meeting on August 25, 2020 during the comment period;
- Presented a summary of the draft legislation at a Master Builder's Association of King and Snohomish Counties (MBAKS) stakeholder meeting on September 3, 2020 which was also attended by members of the Seattle King County Realtors Association.
- Met with Washington State Department of Commerce staff to discuss the draft ordinance on September 23, 3030.

During the public comment period, three letters of support from organizations and four comments from members of the public were received, with another letter of support received after the comment period, described below. Staff also pursued additional correspondence with PSE staff to refine ordinance language.

Summary of Feedback

The feedback provided during and after the public comment period covered a wide range of topics. Some comments from members of the public were supportive, while others stated the draft King County regulations should focus on EV capability for single family homes and townhouses; focus on local food production to reduce greenhouse gas emissions; and consider declining personal car ownership in future years. One suggestion recommended that the County should instead limit it to systems that provide a minimum of 12 kilowatt hours per charging port rather than disallowing load management.

Some feedback from the MBAKS outreach meeting opposed requiring EV-readiness for single family homes despite the estimated cost impact of under $500 per residence, stating that the impacts of the Washington State energy code amendments would be

[129] See Report Appendix B: List of Entities Consulted in Report Development

raising housing prices. Some stakeholders also voiced opposition to potential cost impacts on townhouses.

The four organizations submitting letters of support were the Puget Sound Clean Air Agency, the Washington State Department of Commerce, Northwest Energy Coalition (NWEC), and Climate Solutions.[130] In addition, two of the comment letters suggested changes: NWEC and Climate Solutions. NWEC encouraged the County to support load management in some form and encouraged periodically assessing the code to increase the minimum EVSE Installed and EV Ready requirements, while Climate Solutions suggested two substantive changes. The changes suggested by Climate Solutions were to update legislation to require one EV-ready spot for each living unit of a duplex, rather than one per two living units, and to increase the required nonresidential EVSE installed parking spaces to 10 percent of parking spaces.

Feedback from manufacturers of electric vehicle charging stations informed some elements of this report such as cost ranges of EVSE equipment, voltage needs, and information on load management technology. Feedback from PSE staff identified that Level 2 charging times were determined by available voltage, and that the amperage range in the draft EV legislation was too narrow and not ultimately needed, despite literature and codes which include amperage ranges for Level 2 definitions.

The draft proposed legislation was modified following stakeholder feedback. Changes made address the subjects of duplexes, load management, and Level 2 charging. The proposed legislation that will be sent to the Council was updated to require one EV-ready spot for each living unit of a duplex, in line with general townhouse developments. The draft proposed legislation was changed to allow load management to meet EVSE installed and EV ready parking space requirements. Finally, EV charging definitions contained in the legislation were updated to only specify Level 2 voltages, removing amperage references.

VI. Conclusion

King County electric vehicle ownership levels are higher than the rest of Washington State. The levels are expected to grow at an accelerated rate with Washington's entry as a Zero Emissions Vehicle ZEV state, and projected EV price-parity to gas vehicles by 2023. Broader EV adoption can reduce air pollution and greenhouse gas emissions providing benefits broadly, and specifically to disproportionately affected limited-English speaking communities, communities of color, and individuals with low-incomes.

This report recommends that King County enact an amendment to King County code requiring Level 2 EV charger installation and preparation in nonresidential and residential development aligned with projected EV growth rates. Specifically recommended are adoption of regulations requiring EV-readiness for single-family, townhouse, and cottage

[130] Note: The Washington State Department of Commerce Letter of Support for the draft ordinance was received on October 15, 2020, after closure of the public comment period on August 30, 2020.

housing development; requiring 10 percent of parking spaces be installed with EVSE and 25 percent of parking spaces being EV ready for apartments; and requiring five percent of parking spaces be installed with EVSE and 10 percent of parking spaces being EV ready for nonresidential development, which includes new parking areas in the unincorporated area.

It is also recommended that the regulations allow the DLS Permitting Division director to have flexibility to reduce EV development requirements for smaller multifamily projects (nine units or less) in cases where they trigger the need for a dedicated transformer onsite. Provisions should also require some level of EVSE installation and/or Readiness when buildings are substantially modified.

A proposed ordinance addressing these items was transmitted separately from this report to the King County Council.

VII. Appendices

A. King County Code 18.22.010.F.2

Full text of Section F.2 of King County Code (K.C.C.) 18.22.010:

"The executive shall transmit a report on options to require, incentivize or otherwise ensure electric vehicle charging infrastructure in new multifamily construction and other development proposals that include expansion of parking areas in the unincorporated area and an ordinance that would establish requirements to ensure that new parking areas are designed to include some amount of electric vehicle charging infrastructure to account for increased use of electric vehicles in the future. The report and ordinance shall be developed in consultation with stakeholder groups, including representatives of the building and electric vehicle industries and utilities.

The executive must transmit the report and recommendations by September 14, 2020, in the form of a paper original and an electronic copy with the clerk of the council, who shall retain the original and provide an electronic copy to all councilmembers, the council chief of staff and the lead staff for the local services committee or its successor."

B. List of Entities Consulted in Report Development

Charge Northwest
Chargepoint
City of Edmonds
City of Seattle
Climate Solutions
Clipper Creek
King County Permitting Division Staff
Master Builders Association of King and Snohomish County
Northwest Energy Coalition
Regional Code Collaboration
Puget Sound Clean Air Agency
Puget Sound Energy
Seattle King County Realtors Association
SEMA Connect
Vancouver Electric Vehicle Association, Past President
Washington State Department of Commerce

C. List of Jurisdiction Codes Evaluated in Report Development[131]

Cities:

Aspen, CO
Atlanta, GA
Boulder County, CO
Chicago, IL
City of Boulder, CO
Denver, CO
Edmonds, WA
Flagstaff, AZ
Fort Collins, CO
Golden , CO
Honolulu, HI
Indianapolis, IN
Lakewood, CO
Marin County, CA
Menlo Park, CA
Middletown, CT
Mountlake Terrace, WA
New York City, NY
Oakland, CA
Palo Alto CA
Salt Lake City, UT
San Francisco, CA
San Jose, CA
Seattle, WA
Sedona, AZ
Stockton, CA
Shoreline, WA
Summit County, CO
Tucson, AZ
Vancouver, BC

States:

California
Massachusetts
Oregon
Washington

[131] Note: Many of these codes have been collected and assessed by the Southwest Energy Efficiency Project (SWEEP), EV Infrastructure Building Codes: Adoption Toolkit. [LINK]. Also see Claire Cooke, and Brian Ross. "Summary of Best Practices in Electric Vehicle Ordinances," Great Plains Institute. June 2019. [LINK] Accessed 9/14/2020